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Abstract

The authors empirically analyze the price-setting behaviour of the major Canadian banks in the residential mortgage market over the period 1991–2007. They use weekly posted prices of the major mortgage providers to study the degree of competition in mortgage price setting. Their results suggest that the residential mortgage market is imperfectly competitive. They find distinct price leaders and that, as market concentration increases, so does price dispersion – helped by the increased use of discounting from posted prices. The authors also find that, although banks' pass-through of input price changes to mortgage prices is complete in the long run under reasonable assumptions regarding discounting, there exists some level of pricing asymmetry in the short run.

JEL classification: G2, D4
Bank classification: Financial institutions; Financial services

Résumé

Les auteurs analysent empiriquement les pratiques des grandes banques canadiennes en ce qui concerne l'établissement des prix sur le marché des prêts hypothécaires à l'habitation au cours de la période 1991-2007. Pour évaluer le degré de concurrence dans la détermination de ces prix, ils utilisent les taux – publiés chaque semaine – des principaux prêteurs hypothécaires. Leurs résultats semblent indiquer que le marché des prêts hypothécaires à l'habitation est imparfaitement concurrentiel. Les auteurs observent une nette présence de chefs de file en matière de prix et notent que, à mesure que le marché devient plus concentré, la dispersion des prix augmente, favorisée par l'octroi accru de rabais par rapport aux taux publiés. Ils constatent également qu'il existe une certaine asymétrie dans l'établissement des prix à court terme même si, à long terme, les banques répercutent complètement les variations du prix des intrants sur leurs taux hypothécaires, selon des hypothèses raisonnables quant aux rabais consentis.

Classification JEL : G2, D4
Classification de la Banque : Institutions financières; Services financiers

1 Introduction

Most studies find that the Canadian banking industry is monopolistically competitive (Bikker, Spierdijk, and Finnie (2006), Allen and Liu (2007)). This implies that banks have some degree of market power regarding the prices of services they sell. Since mortgages are an important product for Canadian banks (representing around 31 per cent of total income) and the largest liability of Canadian households (representing almost 70 per cent of total debt), it is interesting to examine how competitively banks set residential mortgage rates.

In this paper, we empirically analyze the competitiveness of major Canadian banks' residential mortgage rate-setting behaviour over the 1991 to 2007 period. We use a new micro dataset consisting of individual banks' posted mortgage rates to study this price-setting behaviour. In doing so, we analyze the determinants of Canadian mortgage rates and find that they have changed since previous papers were published on this subject, such as Caron (1992) and Clinton and Howard (1994). In particular, the role of future interest rate expectations is more significant in our sample than those of earlier periods.

This paper provides the most comprehensive review of competition in the Canadian mortgage market that we are aware of by studying the issues from three perspectives: price leadership, pricing asymmetries, and long run pass-through of capital market rates to mortgage rates. Each of these measures provides some insight into how Canadian banks set prices. Throughout, we relate our empirical findings to theoretical papers on price competition in the banking literature and suggest further avenues of research on mortgage markets.

First, we use a discrete choice framework, similar to that of de Haan and Sterken (2006), to look for evidence of price leadership, or whether some banks systematically react to movements in input costs more quickly than other banks. Berger (1995) argues that dominant banks are able to set pricing less competitively, which may manifest itself in higher, more rigid, and asymmetric prices. It would likely be in the best interest of other banks to follow the dominant's bank's pricing strategy, so a clear price leadership relationship in conjunction with those indicators would probably imply imperfect competition. We find some evidence of price-leadership from the banks that have the largest share of the mortgage market, on average, over

our sample period.

Second, we consider the size of banks' markups and whether changes in capital market rates are fully passed through to mortgage rates in the long run. It is important for central banks to understand the degree of pass-through, since this will help them judge the required magnitude of monetary policy actions. Higher markups for a particular bank may signal either that it has market power or that it is less efficient and faces higher funding costs. Higher markups combined with lower pass-through likely, but not necessarily, indicate that a bank has market power. The work of Kashyap and Stein (2000) indicates that lower pass-through can be the result of a bank being highly liquid and well capitalized, which allows it to smooth rates and react less to monetary policy than other banks. We examine how mortgage rates react to different capital market rates - the Bank Rate, Bankers' acceptance rate, short- and long-term treasury bill rates, and government bond rates. When we base our analysis on posted mortgage rates, we find that long run pass-through is incomplete, and that banks with the highest markups and lowest pass-through are the dominant banks in the mortgage market, although the differences across banks do not appear to be economically important.[1] When we take mortgage discounting into account, which we argue produces a more meaningful, though more difficult, measure of pass-through, we find that pass-through is complete.

Lastly, we test whether changes in fixed residential mortgage rates feature asymmetry - that is, whether cost increases are passed through more quickly than cost decreases, and whether banks adjust mortgage rates upwards more quickly than downwards to reach equilibrium. Asymmetries that favour the lender may signal imperfect competition. Specifically, if the market is concentrated, if banks have market power, or if consumers face search costs, banks may pass on increases in input costs more quickly than cost decreases to mortgage rates. Asymmetries may also simply result from the fact that Canadian mortgage rate offers are guaranteed for up to 120 days, so that the borrower will receive the lowest of the guaranteed rate and the rate prevailing at the time the loan is taken. Cooper (1986) finds that this type of pricing policy can lead firms to pass on cost increases more quickly than cost decreases. On the other hand, banks encounter moral-hazard and adverse-selection problems when raising rates, because by doing so they narrow the pool to riskier borrowers. Banks may therefore

[1] This is true for the 5-year mortgage, which is the most popular mortgage term in Canada. For the much less popular 3-year mortgage, one of the price leaders actually had the lowest markup and highest pass-through.

be reluctant to raise rates when faced with a temporary cost shock. We find some evidence that banks pass on cost increases more quickly than cost decreases.

Our findings generally support the conclusion that the price setting behaviour of the major Canadian banks is imperfectly competitive. Specifically, the dominant banks act as price leaders to the other banks, and all banks induce search frictions by posting prices that differ from transactions prices. While pass-through of funding costs to effective mortgage rates appears to be complete, banks display some asymmetry in the timing of the pass-through.

This paper is organized as follows. In section 2 we discuss the structure of the Canadian mortgage market. In section 3 we report our empirical analysis of price movements in the Canadian mortgage market. We examine price leadership, the interest rate channel of the monetary transmission mechanism, and pricing asymmetry using weekly posted mortgage rates of Canada's most important mortgage lenders and a variety of market rates. Section 4 concludes.

2 The Canadian Mortgage Market

At the end of 2007, the size of the Canadian mortgage market was $818 billion, representing approximately one-third of total credit outstanding. The mortgage market is dominated by the six largest Canadian commercial banks, whose combined market share, shown in Figure 1, increased from 39 per cent at the start of our sample to 65 per cent by 2007.[2] The increase in market share was largely the result of the major banks acquiring trust companies over the 1992 to 2000 period.

As market concentration increased, so did price dispersion. The coefficient of cross-sectional variation of the 5-year mortgage terms across all banks in our sample (Figure 2) and for the big six (Figure 3) increased substantially over our sample period.[3] The dispersion in mortgage rates allows us to study price-leadership.

[2]The six largest banks by asset size (the big six) are: the Bank of Montreal (BMO), CIBC (CIBC), National Bank (NAT), RBC Financial Group (RBC), Scotiabank (BNS) and TD Bank Financial Group (TD).

[3]The coefficient of variation is slightly misleading, because in the post-2000 period a "no haggle" mortgage (where the posted rate equalled the transactions rate) was offered from November 2002 to August 2004 (TD) and from March 2005 to May 2006 (BMO).

Five of the six major banks have extensive operations across Canada, whereas National Bank's operations are located primarily in the province of Quebec. The major banks set pricing nationally by posting a mortgage rate that applies to borrowers across the country. This means that we cannot analyze how the degree of competition in individual local markets affects major banks' rates in those markets.

Historically, a large majority of Canadian mortgages have had fixed 5-year terms. While we do not have data on the shares of various mortgage products throughout our entire sample period, the Canadian Financial Monitor Survey, conducted by Ipsos Reid indicates that 63 per cent of mortgages held by households surveyed between 1999 and 2007 had a fixed 5-year term, while 5 and 12 per cent had mortgages with one- and 3-year terms, respectively.

In the early 1990s, some high-quality borrowers started receiving discounts on posted mortgage rates, meaning that the rate paid by some borrowers (the effective rate) was lower than the posted mortgage rate. Our estimates of mortgage rate discounts are based on an exponentially smoothed version of survey information and anecdotal evidence from banks and mortgage brokers. Discounts are believed to have increased from approximately 25 basis points in the early 1990s to around 125 basis points at the end of our sample. Discounts received by individual borrowers likely depend on factors such as credit score, age, mortgage term and loan amount, and the customer's relationship with the bank. We believe that the spread between effective mortgage rates and banks' funding costs has actually remained stable as mortgage rate discounts increased (see Traclet (2005)).

The very fact that mortgage rates tend to be discounted suggests that mortgage pricing is imperfectly competitive. Specifically, the practice of posting rates that exceed actual transactions rates impedes price discovery and increases consumer search costs. See the seminal paper by Stigler (1961) or the recent paper by Raskovich (2007) for an example of bargaining discounts on posted prices. Furthermore, absent differences in borrower riskiness, transactions rates should be the same for different customers under perfect competition. This is not the case in the Canadian market. As noted by the Canadian Mortgage and Housing Corporation (CMHC (2005)), "Rate discounts tend to be larger for lower-risk, asset-rich borrowers living in highly competitive markets."[4]

[4]An argument can be made that, over our sample period, the widespread adoption of mortgage broker services by mortgage seekers has lowered the search frictions caused by high posted rates.

Depending on the question, we use posted and/or discounted mortgage rates for our analysis. We use posted rates for price-leadership, because we are interested in the signal given by mortgage rate changes. We use our estimate of discounted rates, where possible,[5] for the analysis of pass-through, because we are interested in how changes in banks' funding costs are passed onto effective mortgage rates (which is more important, from a monetary policy perspective, than the signal given by the posted rate).

3 Empirical Analysis

Our empirical analysis is conducted using weekly posted rates by the six largest Canadian banks for the period January 1991 to June 2007. Approximate mortgage rate discounts are applied in certain parts of the analysis. Posted mortgage rate data were collected every Wednesday from the *Globe & Mail* newspaper archives. The big six banks currently represent around 65 per cent of the mortgage market share and are therefore considered the major firms in the industry. The banks offer a variety of fixed mortgage rates, ranging from 6 months to 10 years.[6] The 10-year rate began to be offered only in October of 1996 by four of the big six. A fifth bank started offering a 10-year rate in March 1999. We therefore exclude it from this analysis. We also exclude the 6-month rate for similar reasons. Finally, since our focus is on fixed mortgage rates, we exclude variable mortgages, which have only recently become popular. Future work might want to consider variable rate mortgages as their market share relative to fixed-rate mortgages have recently increased.

Since brokers theoretically have access to many lenders they can offer a better rate, thereby enhancing competition. This may be true for a certain class of borrowers, just as above, but there remains substantial variation in who receives a discount and the level of the discount.

[5]The discount estimate is available only for the 5-year mortgage rate and not for other, less popular terms.

[6]Occasionally, some Canadian banks have offered a 25-year mortgage rate, but, unlike the U.S. experience, mortgage terms in Canada are relatively short.

3.1 Price leadership

The only paper we are aware of that studies price-leadership in the mortgage market is by de Haan and Sterken (2006). They hypothesize that the dominant bank is likely to show little or no sensitivity to the pricing decisions of other banks, and that non-dominant banks would react to this by not changing their price until the dominant bank does. de Haan and Sterken (2006) expect that there will not be a systematic price leader in a perfectly competitive market, but that the market would deviate from perfect competition if there were a systematic price leader. While they find a price leader in the Dutch mortgage market, they also find that banks set rates competitively using the Coccorese (2005) conjectural variation model.

Table 2 shows the distribution of weekly price changes in the Canadian residential mortgage market for the 1-, 3- and 5- year rates. Most of the time (between 63 and 66 per cent depending on the term), prices do not change. When prices do change, between 13 and 16 per cent of the time all six banks move, between 6 and 8 per cent of the time, only one bank moves. We are interested in analyzing whether some banks always move first and who follows.

The modelling approach is a standard discrete choice framework. Every week, a bank has three choices: maintain the previous week's rate, lower the rate, or increase the rate. This choice can be written as follows:

$$C_{i,t} = \alpha r_{i,t-1} + \sum_{j \neq i} \beta_j r_{j,t-1} + \lambda r_{M,t-1}, \tag{1}$$

where C_i is the choice of bank i, either neutral (0), up (1), or down (-1); $r_{i,t-1}$ is bank i's posted rate at $t-1$; $r_{j,t-1}$ is bank j's posted price at $t-1$; and r_M is the market rate. The market rate is meant to capture the cost of funding for banks. If the cost of funding increases (decreases), banks will increase (decrease) the rate at which they will lend. We consider four alternatives for the market rate: the rate at which the Bank of Canada will lend funds to financial institutions for one day (the Bank Rate), the 90-day Bankers' acceptance rate (90-d BA), the 3-month and 1-year Treasury Bill rates (T-bills), and three different government bond rates (the bond rate that we use depends on the mortgage term, and proxies banks' funding costs). We also adjust the bond rate using the swap rate, meaning that we are using a swap-adjusted rate. Table 1 reports the correlation matrix for the Bank Rate, T-bill rates and the 3-, 5-,

and 10-year bond rates. The correlation between the Bank Rate, T-bill rates, and the bond rates is relatively high. Figure 4 shows the swap rate plotted against the 5-year Government of Canada bond rate. Because banks hold short-term liabilities (deposits) and long-term assets (mortgages), there is a maturity mismatch. Banks therefore use swaps to hedge their position. The T-bill rates typically move according to the market's belief about the Bank Rate.[7,8]

The main coefficients of interest in equation (1) are λ and β_j. The first should be positive if mortgage rate changes follow the market rates. If bank i follows bank j, then β_j will be positive. If bank i moves in the opposite direction of bank j, then β_j will be negative. If the banks set their rates independently of each other, then the coefficient will be zero.

We include market rates to test the mechanism whereby they affect administered rates. If the central bank attempts to tighten monetary policy by increasing the borrowing rate and this is not passed on to consumers in the form of higher mortgage rates, then the transmission mechanism is weak or non-existent. Although outdated, Smith (1974) finds evidence that mortgage rates tend to adjust more slowly than other capital market rates. Goebel and Ma (1993) and Allen, Rutherford, and Wiley (1999) find that capital markets and mortgage markets are more integrated post-1980 than pre-1980, and they attribute the level of integration to deregulation. As the swap market developed, bond rates became more closely linked to banks' funding costs at long maturities than other market rates.[9] The bond rate also captures expectations of how the central bank will adjust its Bank Rate. In this sense, bank mortgage rates might move more in line with bond rates than the Bank Rate.

We report results for the 1-, 3-, and 5-year mortgage rates in Tables 3 to 6 using the Bank Rate and T-bill rates, and in Tables 7 and 8 using a swap-adjusted bond rate.[10] For each mortgage term, we estimate an ordered probit model for the whole sample (1991-2007) and two subsamples (1991-2000) and (2001-2007). We divide the

[7]From March 1980 to February 1996, the Bank Rate was actually set as the average yield on the 3-month T-bill plus 25 basis points. Therefore, the causality is reversed in the first part of our sample.

[8]None of the ordered probit estimates is statistically significant when using the 30-day rates as proxies for cost of funding. This means that mortgage rates do not follow the 30-day rates in our sample.

[9]Note also that this weakened the link between mortgages and guaranteed investment certificates.

[10]Results are nearly identical when we use the 90-day T-bill and 3-month Bankers' acceptance rates instead of the Bank Rate. Accordingly, we do not provide these results.

sample in 2000, since that is the approximate period when the coefficient of variation in posted prices increased substantially. The end of the year 2000 also coincides with the Bank of Canada implementing fixed announcement dates for its decisions regarding changes in the Bank Rate.

3.1.1 *One-year mortgage rates*

Results for the 1-year mortgage and Bank Rate, reported in Table 3, suggest that, for the whole sample as well as the first subsample, all of the banks followed the Bank Rate. It is also the case that CIBC and RBC are price leaders. In the post-2000 sample, neither the Bank Rate nor the 90-d T-bill rate are significant. Table 4 reports results for the 1-year mortgage and the 1-year T-bill. Perhaps not surprisingly, given the matched term, the 1-year T-bill rate is a significant leader of 1-year fixed mortgages in all subsamples. The results for the 1-year T-bill rate, therefore, are more aligned with those we find in the following sections using bond rates than with those we find using short-term rates.

3.1.2 *Three-year mortgage rates*

Results reported in Table 5 for the 3-year posted mortgage rate with the Bank Rate as the market rate are similar to those reported in Table 3. For the whole sample and the first subsample, all the Canadian banks follow the Bank Rate. We also find that CIBC and RBC are price leaders. In the whole and the post-2000 sample, we find that the NAT takes its lead from TD.[11]

Results in Table 5 can be compared to results reported in Table 7, which uses the 3-year bond rate instead of the Bank Rate. In this case, in the whole sample and the two subsamples, all of the banks follow the bond rate. There is no clear price leader in the 1991-2000 subsample, but CIBC emerges as the clear price leader in the post-2000 sample.

[11] In the province of Quebec the Caisses Desjardins is a significant lender and it is likely that the National Bank would take the lead from them. Weekly data for this credit union, however, are unavailable over our sample period; therefore, we cannot test this hypothesis.

3.1.3 *Five-year mortgage rates*

Table 6 reports results for the 5-year posted mortgage rate with the Bank Rate as the market rate. For the complete sample, CIBC and RBC are price leaders. The Bank Rate leads, in a statistical sense, BNS, CIBC, and NAT. For the 1991-2000 subsample, the evidence of price leadership is more ambiguous at the 5-year rate than at the shorter rates. We find that BNS follows CIBC and RBC. For the post-2000 subsample, all the banks follow CIBC, and all but MTL follow RBC. As with the short-term rates, the Bank Rate is not statistically significant in the latter sample period.

Table 8 reports results for the 5-year bond rate. As per the results in Table 7, the bond rate is a clear price leader for all samples. CIBC and RBC are price leaders, as well, for the whole sample. In the post-2000 subsample, CIBC is the price leader.

We find a weakening link between the shorter-term rates (Bank Rate, Bankers' acceptance rate, and 90-day treasury bill rate) and the fixed mortgage rates after the year 2000. A strong link remains, however, throughout the sample between the government bond rates and fixed mortgage rates. This result is expected, given the Bank of Canada's decision to implement a system of fixed announcement dates (FADs) for the target overnight interest rate in late 2000. Empirical evidence by Parent (2003) shows that, in the pre-FAD period, changes to the overnight rate had a significant impact on longer-term interest rates, but they did not have this impact in the FAD period. In the latter period, financial markets became "able to accurately anticipate the general trends in interest rates" (Parent 2002-2003, 33) which means that banks could price longer-term contracts based more accurately on their longer-term funding costs. Furthermore, expected future changes in the overnight rate may be partially incorporated into mortgage rates, so these rates would not necessarily change following a change to the Bank Rate.

To summarize, the results reveal three main findings. First, price leadership appears more prevalent in the first part of the sample. It may be, however, that the price leadership relationship has not weakened, but that price followers adjust mortgage rates too quickly after a change by the price leader(s) for us to be able to pick this up in our results based on weekly data. Second, in the latter part of the sample, mortgage rates follow short-term rates less frequently and long-term rates more frequently.

Third, consistent with de Haan and Sterken (2006), the banks that are, on average, largest by mortgage asset size over our sample are the most frequent price leaders. Specifically, CIBC is the most frequent price leader, followed by RBC and TD.

3.2 Pass-through

This section examines the effective pass-through of movements in the Government of Canada bond rates to bank mortgage rates. We consider long- and short-run pass-through of the 3- and 5-year bond rates to the 3- and 5-year mortgage rates, respectively.[12] Combined, the 3- and 5-year fixed rate mortgage contracts make up 75 per cent of the market.

The size of markups and the completeness of the pass-through of banks' funding costs are often thought to be related to the degree of competition in the market. A number of authors find that rates are more rigid in concentrated markets: Hannan and Berger (1991) and Neumark and Sharpe (1992) for U.S. deposit rates, Arbatskaya and Baye (2004) for U.S. Internet mortgage rates, and Mojon (2000) for loan and deposit rates in many European countries. De Graeve, De Jonghe, and Vander Vennet (2007) also find that dominant Dutch banks - i.e., those with a large market share and capital base tend to charge higher loan markups and have lower long run pass-through. de Haan and Sterken (2006) confirm that one dominant Dutch bank displays dominant pricing behaviour. Finally, many papers, including Mojon (2000), De Graeve, De Jonghe, and Vander Vennet (2007), and Hofmann and Mizen (2004) for U.K. mortgage and deposit rates, find that pass-through is incomplete.

Previous research on Canadian mortgage rates has focused on explaining short- and long-run movements in the average or "typical" (defined as the median rate charged by the big six banks) mortgage rate, leaving out possible heterogeneity across banks (for example, Caron (1992); Clinton and Howard (1994)). On average, these researchers find that the median mortgage rates responded quickly to changes in the median short-term rates, which means that pass-through is strong.

[12] In preliminary analysis, we also considered the Bank Rate and T-bill rate as market rates. We reject the null hypothesis that the relationship between these short-term rates and the posted mortgage rates are stable over time, and therefore we do not focus on these relationships.

Consider the following linear regression:

$$m_{i,t} = \alpha_i + \beta_i b_t + \epsilon_{i,t}, \tag{2}$$

where $m_{i,t}$ is the mortgage rate for bank i at time t, and b_t is the bond rate. We conduct analysis of pass-through to posted mortgage rates for both the 3- and 5-year mortgage terms. In addition, since we have an estimated 5-year mortgage rate discount series, we conduct analysis based on 5-year discounted mortgage rates. Given that this is a better proxy for the rates borrowers are actually paying, we put more stock in the results obtained using the 5-year discounted series than in those obtained using the posted rate series.

After pre-testing, not reported here, we model the residuals with a GARCH(1,1) process: $\epsilon_{i,t} \sim N(0, h_{i,t})$, where $h_{i,t} = a_{i,0} + a_{i,1}\epsilon^2_{i,t-1} + a_{i,2}h_{i,t-1}$. The presence of conditional heteroskedasticity can affect the rejection rate of unit root tests (for example, see Alexakis and Apergis (1996)). The mortgage rates and bond rates are non-stationary.[13] Table 9 reports tests for the null hypothesis of no cointegration between the 3- and 5-year bond rates and bank rates. We reject the null hypothesis and therefore find evidence of cointegration. In the long run, therefore, we can interpret β_i as the amount of pass-through from bond rate movements to bank mortgage rates. In a reduced-form way, and if $\beta = 1$, we can also interpret α_i as a markup rate.[14]

Table 10 reports parameter estimates for pass-through to posted mortgage rates. We find incomplete pass-through of changes in bond rates to changes in posted mortgage rates. There is some dispersion in markup and pass-through parameters across banks. The two dominant banks, in terms of market share and price leadership - CIBC and RBC - have the highest markups and lowest pass-through for the 5-year mortgage. The differences across banks, however, do not appear to be economically important.

The last two columns of Table 10 report regression estimates using the discounted 5-year rate. In this case, the markup is substantially lower than in the posted-rate case, and pass-through is complete. Why is this the case? Over our sample period, the bond rate is downward trending and the discount upward trending, implying that the rates are negatively correlated. Omitting the discount rate, therefore, leads to a

[13]This is expected, since rates generally fell during the 1990s as the Bank of Canada brought inflation down. Results for the stationarity tests are available upon request.

[14]More generally, the markup is equal to $\alpha - (1 - \beta)\overline{b}$.

downward bias in pass-through in the posted rate regression. For the markup, if the true model has complete pass-through and we use the posted rates, the typical gap between the posted rate and the bond rate would rise over time, and the intercept term would increase as the discount increases.

We next consider short run dynamics, allowing for the possibility of asymmetry. That is, we test whether cost increases are passed through more quickly than cost decreases, or whether banks adjust their mortgage rates upwards more quickly than downwards to reach equilibrium. There are a number of reasons why there may be asymmetric adjustment of mortgage rates to changes in input costs that are favourable to the lender and unfavourable to the borrower.

First, if there is sufficient market concentration, or if banks have some market power, which from Allen and Liu (2007) we believe to be the case, there is scope for banks to coordinate prices explicitly or implicitly. If input prices are not fully transparent, a bank that is acting collusively may be hesitant to lower its mortgage rate after a fall in its input costs, since other banks may interpret this as a sign of deviation. An increase in the bank's mortgage rate, however, is a signal that funding costs have increased. Even if input prices are fully transparent, if input prices fall and no bank reduces its mortgage rate, all banks will earn higher profits. However, if one bank lowers its price, all banks will immediately follow, and the bank that originally lowered its price will not gain market share.

Second, if search is costly or input prices are volatile, it may be possible for banks to maintain their current high rate even after input costs have fallen, because it will take customers some time to realize that rates should have fallen. This is especially important in price-inelastic markets. It may seem that this argument would not hold in the latter part of our sample when mortgage rates are posted on the Internet. However, the literature on online markets generally finds that search costs are not zero even in these markets;[15] Bakos (2001) provides a good discussion. The fact that posted prices differ from transactions prices in the Canadian mortgage market provides further evidence that search costs remain a factor in that market.

[15]In a CMHC survey conducted in 2005, roughly 55 per cent of Canadian mortgage purchasers and 27 per cent of mortgage renewers reported searching the Internet for a rate. Less than 3 per cent completed a mortgage application online and the average Canadian mortgage borrower negotiated with two or fewer financial institutions when searching for a mortgage (CMHC (2005)).

Third, some features of the Canadian mortgage market could cause banks to adjust mortgage rates upwards more quickly than downwards when there is a change in their input cost. For example, banks generally offer a 60 to 120-day rate guarantee when they approve a mortgage application. The terms are such that, if mortgage rates rise during the guarantee period but before the mortgage is finalized, the client will receive the guaranteed rate; if mortgage rates fall, the client will receive the lower prevailing rate. This would induce banks to react more slowly to cut than to increase rates. Many mortgages also include early payment options, a borrower option that raises the cost of a mortgage to the lender. Banks may therefore be slower to pass on input cost decreases than increases.

Of course, pricing asymmetry may also favour borrowers. Banks encounter moral-hazard and adverse-selection problems when they raise loan rates in response to higher market rates. Specifically, by increasing interest rates, banks leave themselves with a riskier pool of borrowers. Banks may be slower, therefore, to raise rates when facing a temporary cost increase.

Most studies of asymmetric pricing of loans and deposits find that the asymmetries favour the lender. See, for example, Neumark and Sharpe (1992) and Hannan and Berger (1991) for the U.S. deposit market; Allen, Rutherford, and Wiley (1999) and Arbatskaya and Baye (2004) for the U.S. mortgage market; Mojon (2000) for loan and deposit rates in many European countries; and de Haan and Sterken (2005) and Toolsema and Jacobs (2001) for the Dutch mortgage market using macro and micro data, respectively. A few papers, however, find asymmetries that favour the borrower, such as Frost and Bowden (1999) for New Zealand mortgage rates; Chong, Liu, and Shrestha (2006) for Singapore loan rates; and Liu, Margaritis, and Tourani-Rad (2008) for New Zealand loan rates.

We estimate the following error-correction model:

$$\Delta m_{i,t} = \lambda_i^+ B_t^+ + \lambda_i^- B_t^- + \omega^+ \hat{\epsilon}_{i,t-1}^+ + \omega^- \hat{\epsilon}_{i,t-1}^- + \nu_{i,t}, \tag{3}$$

where for $Y_t \in \{B_t, \epsilon_{i,t-1}\}$, $Y_t^+ = \max\{0, Y_t\}$ and $Y_t^- = \min\{0, Y_t\}$, $\hat{\epsilon}$ are the residuals from the first-stage regression, (2), and $B_t = \frac{\sum_{s=0}^{3} b_{-s}}{4}$. Given the lumpiness of weekly price movements, we use B_t to smooth price changes across a month. Collectively, (λ^+, λ^-) are amount-asymmetry parameters and (ω^+, ω^-) are adjustment-asymmetry parameters. Amount asymmetry concerns short run dynamics – whether mortgage

prices respond as quickly to input price increases as they do to price decreases.[16] The adjustment-asymmetry parameters measure whether prices move towards the long run equilibrium from below at the same rate as they do from above.

Table 11 reports parameter estimates for the 3-year posted rates. Tables 12 and 13 report estimates for the 5-year posted and discounted rates, respectively. None of the amount-asymmetry parameters (λ^+, λ^-) are statistically different for any mortgage term or type. This means that banks respond similarly to input cost increases and decreases on impact. The adjustment-asymmetry parameters, however, are statistically different in some cases. Specifically, the parameters are statistically different for NAT, BNS, RBC, and TD for 3-year posted rates, and also for TD for 5-year posted rates. With the exception of MTL, once we control for the discount rate, we reject the null hypothesis of no adjustment asymmetry. This means that most banks adjust their rates upwards when they are below equilibrium more quickly than they adjust them downwards when they are above equilibrium. One reason for this finding is that discounting in the first experiment puts the discount into the residuals, blowing them up and masking any price asymmetry. Once we control for the discounts, we uncover price discrimination associated with the increasing search costs imposed by discounting. That is, we find pricing asymmetry in the short run for all banks except MTL.

An important caveat of this analysis is that we do not use individual transactions rates (i.e., the rate that individual customers pay). Using aggregated prices may mask demographic and geographical heterogeneity in transactions prices that may be due to differences in market concentration.[17,18] A more thorough analysis of pricing asymmetry would require actual transactions prices.

[16] This is equivalent to asking whether the price increases as fully as input price decreases in the short run.

[17] For example, young urban dwellers are more likely to receive higher discounts than older individuals, mostly because the young are new customers. Older customers face higher switching costs, and are therefore less likely to receive a high discount. Very few Canadians, regardless of demographic grouping, appear to switch banks – only 3.1 per cent of households surveyed by Ipsos Reid switched between 1999 and 2006, according to Allen, Clark, and Houde (2008).

[18] Geographically, the heterogeneity in housing market conditions across Canadian cities (Allen, Amano, Byrne, and Gregory (2006)) can lead to mortgage discounts that are different across the country.

4 Conclusion

This paper considers price movements in the Canadian mortgage market using individual bank rates. First, we document tendencies in price leadership for the 1-, 3-, and 5-year fixed-rate mortgages. For the majority of cases, the price leaders were the two banks with the largest mortgage portfolios over our sample period. Second, we examine short- and long-run pass-through from government bond rates to mortgage rates. Based on posted mortgage rates, we find that pass-through is incomplete and that the dominant banks tend to have the lowest pass-through and highest markups. However, based on discounted rates, we find that pass-through is complete. We also test for pricing asymmetry in the Canadian market for 3- and 5-year mortgages. We find almost no evidence of short run amount asymmetry, but we do find some evidence of adjustment asymmetry, particularly once we control for discounting. Namely, rates adjust slightly more quickly upwards than downwards.

In summary, most of our evidence suggests that the Canadian residential mortgage market is imperfectly competitive. Specifically, we find evidence that dominant banks are price leaders and that banks introduce search costs by posting rates that differ from transactions rates. While pass-through is generally complete, there is some short run pass-through asymmetry. Given the complete pass-through, we cannot definitively conclude that the mortgage rate-setting behaviour of the major banks is imperfectly competitive. However, this may be due to the fact that we must rely on aggregate rather than individual transactions rates. Analysis using transactions prices would allow for more definitive conclusions and would be a useful extension of this work. A further extension would be to construct and estimate a structural model of mortgage demand and supply. This would allow us to estimate the welfare costs (if any) of the type of deviations from perfect competition that we report in this paper.

Figure 1: **Residential Mortgage Market Share of Canada's Six Largest Banks**

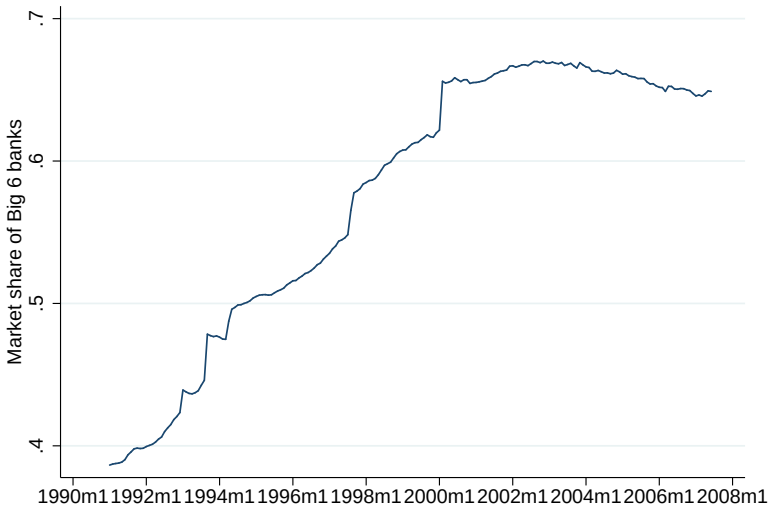

Figure 2: **Coefficient of Variation 5-Year Rate**

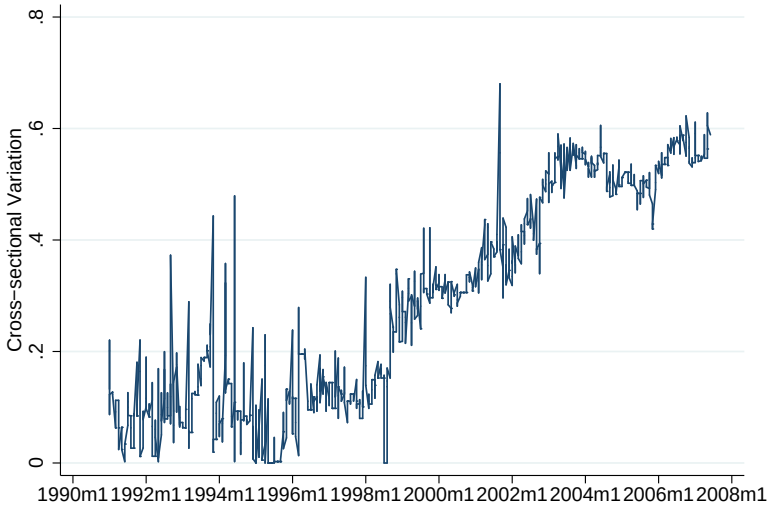

Figure 3: **Coefficient of Variation, Big Six**

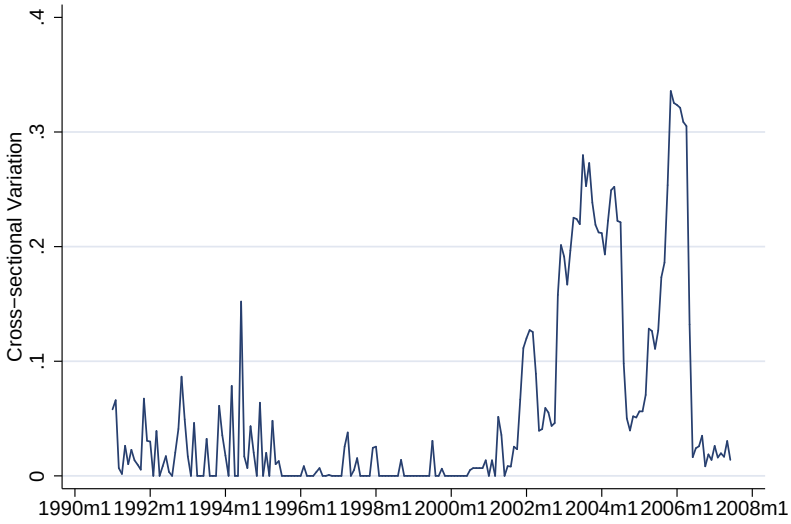

Figure 4: **5-Year Bond Rate and Swap Rate**

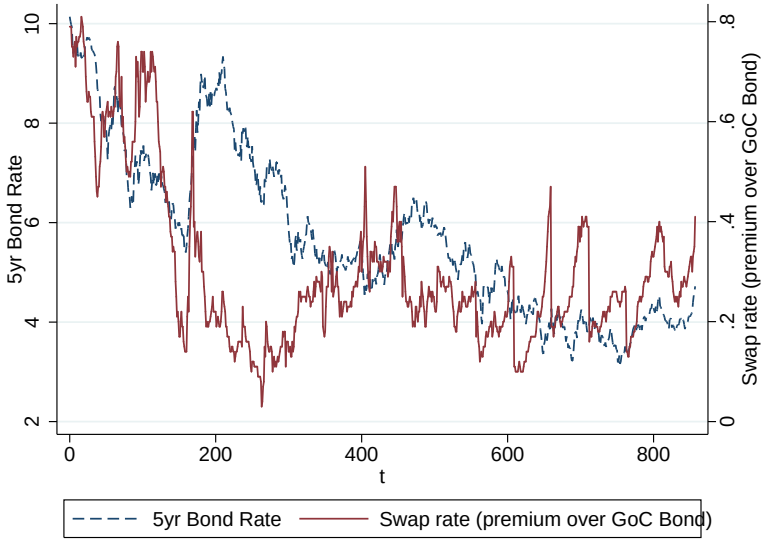

Table 1: Correlations, 1991-2007

	Bank Rate	90-d BA	3-m T-bill	1yr Tbill	3-yr bond	5-yr bond	10-yr bond
Bank Rate	1						
90-d BA	0.9950	1					
3-m T-bill	0.9946	0.9981	1				
1-yr T-bill	0.9666	0.9718	0.9711	1			
3-yr bond	0.9135	0.9172	0.9202	0.9707	1		
5-yr bond	0.8737	0.8759	0.8824	0.9367	0.9894	1	
10-yr bond	0.8074	0.8071	0.8175	0.8727	0.9531	0.9853	1

Table 2: Number of Banks Changing Prices (%)

	1-yr	3-yr	5-yr
No move	65.8	65.1	63.0
1 move	8.09	6.1	7.4
2 move	3.99	4.4	3.2
3 move	1.54	2.7	3.1
4 move	3.17	2.7	2.6
5 move	4.45	4.0	5.0
6 move	12.78	15.0	15.7

Table 3: Probit Estimates: 1-Year Rates and Bank Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.751**	-0.492*	-0.495*	-0.469*	-0.576**	-0.689**
L.BNS	-0.999	-4.312**	-0.584	-0.022	-0.139	0.140
L.CIBC	0.678	1.852**	-0.415	1.609**	0.983*	1.654**
L.NAT	-0.739	-0.337	-0.744	-5.519**	-0.896	-0.970
L.RBC	1.233*	2.374**	1.867**	2.368**	-0.634	2.106**
L.TD	0.132	0.382	-0.026	1.583*	0.746	-2.733**
L.Brate	0.282**	0.327**	0.257**	0.268**	0.345**	0.260**
1991-2000 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-4.458**	-0.810	-0.785	-2.152*	-0.277	1.032
L.BNS	-0.986	-4.835**	-0.838	-0.678	-0.329	-0.804
L.CIBC	2.190*	2.404*	-1.999*	2.961**	2.832**	2.521*
L.NAT	-0.823	-0.216	-0.471	-6.546**	-0.712	-1.246
L.RBC	1.543	3.109**	3.586**	4.000**	-3.033**	2.474
L.TD	1.951	-0.264	-0.085	1.919	0.911	-4.529*
L.Brate	0.353**	0.406**	0.383**	0.343**	0.413**	0.350**
2001-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.512*	-0.320	-0.469	-0.265	-0.573*	-0.699**
L.BNS	-0.223	-3.893**	0.954	1.447	-0.527	0.899
L.CIBC	-0.198	1.527*	-0.568	1.549*	0.150	1.628**
L.NAT	-1.236	-0.981	-1.592	-7.081**	-0.442	-0.926
L.RBC	0.346	1.847*	0.790	1.366	-0.331	1.993**
L.TD	2.060	1.756	1.138	2.939*	1.647	-3.130**
L.Brate	-0.285	-0.093	-0.368	-0.284	-0.042	-0.015

Note: $*$ and $**$ denote significance at the 1 per cent and 5 per cent level, respectively.

Table 4: Probit Estimates: 1-Year Rates and 1-Year TBill Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.890**	-0.585*	-0.615**	-0.562*	-0.666**	-0.745**
L.BNS	-0.528	-4.264**	-0.079	0.535	0.432	0.525
L.CIBC	-0.339	1.008*	-1.570**	0.800	0.019	0.810
L.NAT	-0.782	-0.206	-0.782	-5.919**	-0.965	-1.095
L.RBC	0.536	1.865**	1.210*	1.840**	-1.490**	1.436*
L.TD	0.692	0.914	0.543	2.112**	1.373*	-2.140**
L.Tbill	1.080**	1.009**	1.086**	0.955**	1.070**	0.921**
1991-2000 RHS variables	**MTL**	**BNS**	**CIBC**	**NAT**	**RBC**	**TD**
L.MTL	-3.597**	0.620	0.720	-1.038	0.973	2.341
L.BNS	-0.946	-5.427**	-0.798	-0.564	-0.289	-0.796
L.CIBC	0.852	1.201	-4.204**	1.875	1.580	1.202
L.NAT	-0.642	0.083	-0.172	-6.750**	-0.484	-0.988
L.RBC	2.054	3.776**	4.475**	4.410**	-2.933**	3.413
L.TD	0.759	-1.794	-1.655	0.747	-0.346	-6.665**
L.Tbill	1.285**	1.341**	1.420**	1.178**	1.310**	1.289**
2001-2007 RHS variables	**MTL**	**BNS**	**CIBC**	**NAT**	**RBC**	**TD**
L.MTL	-0.022	0.250	-0.046	0.228	-0.127	-0.193
L.BNS	-1.457	-5.636**	0.048	0.861	-1.401	0.311
L.CIBC	-1.542*	0.491	-1.860**	0.553	-0.972	0.494
L.NAT	-0.866	-0.522	-1.233	-8.148**	0.000	-0.456
L.RBC	0.916	2.574**	1.305	1.888*	0.041	2.889**
L.TD	0.174	-0.346	-0.808	1.650	-0.135	-6.406**
L.Tbill	3.314**	3.624**	2.987**	3.121**	2.978**	3.712**

Note: $*$ and $**$ denote significance at the 1 per cent and 5 per cent level, respectively.

Table 5: Probit Estimates: 3-Year Rates and Bank Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.656*	-0.206	-0.057	-0.200	-0.637*	-0.249
L.BNS	-0.790	-5.013**	0.500	-1.111	0.885	-0.881
L.CIBC	1.048	3.526**	-2.783**	2.608**	1.182	2.752**
L.NAT	-0.389	-0.225	-0.398	-4.757**	0.094	0.089
L.RBC	0.280	1.572**	0.344	1.384**	-1.724**	0.696
L.TD	0.259	0.104	2.063**	1.767*	-0.059	-2.687**
L.Brate	0.163**	0.159*	0.213**	0.193**	0.176**	0.157**
1991-2000 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-5.986**	-0.417	-0.574	-0.945	-0.896	-0.649
L.BNS	-0.544	-7.816**	-0.715	-1.389	0.248	-1.993
L.CIBC	1.862	2.699*	-3.067**	2.018	1.013	2.211*
L.NAT	0.412	1.376	-0.154	-3.877**	0.945	1.070
L.RBC	3.220	4.089*	2.917	3.556*	-2.598	1.631
L.TD	0.687	-0.267	1.239	0.313	0.955	-2.592*
L.Brate	0.176*	0.194**	0.215**	0.181*	0.185*	0.167*
2001-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.604	-0.628	-0.063	-0.252	-0.744*	-0.304
L.BNS	-0.133	-3.525**	1.253	-0.119	1.686	0.724
L.CIBC	1.831	5.687**	-2.356*	4.080**	2.592**	4.937**
L.NAT	-1.813*	-1.928*	-1.331	-6.966**	-0.884	-1.717
L.RBC	-0.296	0.394	-0.240	0.576	-2.223**	-0.333
L.TD	0.787	-0.018	2.090*	2.109*	-0.734	-3.759**
L.Brate	0.155	0.076	0.275*	0.302*	0.171	0.215

Note: $*$ and $**$ denote significance at the 1 per cent and 5 per cent level, respectively.

Table 6: Probit Estimates: 5-Year Rates and Bank Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.781*	-0.334	-0.465	-0.298	-0.520	-0.570
L.BNS	-2.834**	-9.921**	-0.094	-3.062**	-1.146	-2.136*
L.CIBC	1.867*	4.727**	-3.323**	3.425**	2.892**	1.464*
L.NAT	-0.776	-0.811	-0.871	-6.341**	0.009	-1.540*
L.RBC	2.222**	6.038**	4.436**	5.921**	-1.654*	2.538**
L.TD	0.158	0.115	0.129	0.185	0.271*	0.102
L.Brate	0.095	0.119*	0.119*	0.100*	0.084	0.092
1991-2000 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-4.120*	0.185	-0.791	0.691	-0.231	1.700
L.BNS	-1.863	-7.947**	-1.026	-2.357	-0.875	-3.249**
L.CIBC	1.747	2.624*	-3.645**	1.494	1.479	1.684
L.NAT	-0.164	-0.509	-0.523	-4.518**	0.138	0.243
L.RBC	2.028	5.012**	2.927	2.781	-3.757*	2.475
L.TD	2.088	0.379	2.773	1.658	2.982*	-3.120*
L.Brate	0.154*	0.158*	0.197**	0.172**	0.176**	0.156*
2001-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.769*	-0.493	-0.419	-0.359	-0.682	-0.712*
L.BNS	-1.964	-11.028**	0.985	-1.351	0.289	-1.927
L.CIBC	3.329*	7.358**	-3.745**	8.973**	5.552**	3.511**
L.NAT	-3.022*	-1.613	-1.292	-13.913**	-1.835	-4.495**
L.RBC	2.313	5.413**	4.176**	6.289**	-3.737*	3.518*
L.TD	0.117	0.122	0.104	0.248	0.291*	0.081
L.Brate	-0.049	0.041	-0.010	-0.060	-0.101	-0.039

Note: $*$ and $**$ denote significance at the 1 per cent and 5 per cent level, respectively.

Table 7: Probit Estimates: 3-Year Rates and Adjusted 3-Year Bond Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.801**	-0.310	-0.109	-0.307	-0.791**	-0.329
L.BNS	-0.647	-5.434**	0.674	-1.044	1.264	-0.726
L.CIBC	0.806	3.727**	-3.508**	2.700**	0.984	2.735**
L.NAT	-1.117	-1.048	-1.123	-6.120**	-0.563	-0.610
L.RBC	-0.285	1.147*	-0.118	0.965	-2.573**	0.193
L.TD	0.623	0.545	2.720**	2.403**	0.256	-2.668**
L.Brate	1.181**	1.142**	1.189**	1.139**	1.184**	1.130**
1991-2000 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-5.688**	0.871	0.758	-0.475	-0.392	-0.065
L.BNS	0.635	-8.618**	-0.112	-0.501	1.385	-1.284
L.CIBC	1.098	1.873	-4.815**	1.222	-0.080	1.411
L.NAT	-1.088	0.464	-1.575	-6.075**	-0.356	-0.191
L.RBC	2.772	4.285	2.910	3.892*	-3.212*	1.630
L.TD	0.737	-0.311	1.313	0.439	1.123	-2.941*
L.Brate	1.333**	1.277**	1.361**	1.333**	1.361**	1.266**
2001-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	0.485	0.456	1.309**	0.801*	0.184	1.025**
L.BNS	-0.811	-4.996**	0.850	-1.081	1.493	0.197
L.CIBC	-0.298	4.425**	-6.041**	2.445*	0.752	3.242**
L.NAT	-1.955*	-2.307*	-1.300	-7.899**	-0.777	-1.672
L.RBC	0.187	0.933	0.391	1.543*	-2.197**	0.236
L.TD	-0.666	-1.422	0.908	1.186	-2.233*	-6.694**
L.Brate	3.059**	3.053**	3.531**	2.789**	2.709**	3.450**

Note: $*$ and $**$ denote significance level at 1% and 5% level, respectively.

Table 8: Probit Estimates: 5-Year Rates and Adjusted 5-Year Bond Rate

1991-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-1.244**	-0.730*	-0.889**	-0.686*	-0.959**	-1.006**
L.BNS	-2.422**	-10.229**	0.612	-2.519*	-0.576	-1.551
L.CIBC	1.646*	4.843**	-4.132**	3.310**	2.856**	1.212
L.NAT	-0.978	-0.916	-1.020	-6.853**	-0.091	-1.818**
L.RBC	1.598	5.688**	4.040**	5.427**	-2.797**	1.857*
L.TD	-0.030	-0.061	-0.062	0.016	0.084	-0.095
L.Brate	1.214**	1.179**	1.217**	1.087**	1.245**	1.190**
1991-2000 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-4.974**	0.191	-1.101	0.213	-0.713	1.445
L.BNS	-0.982	-7.900**	-0.381	-1.209	0.201	-2.447
L.CIBC	1.266	2.097	-4.912**	0.881	0.988	1.263
L.NAT	-0.641	-0.692	-0.870	-5.099**	-0.245	-0.167
L.RBC	2.414	5.650**	3.615*	3.036	-3.984*	2.935
L.TD	1.399	-0.722	2.127	0.821	2.221	-4.577**
L.Brate	1.332**	1.230**	1.382**	1.231**	1.390**	1.379**
2001-2007 RHS variables	MTL	BNS	CIBC	NAT	RBC	TD
L.MTL	-0.126	0.195	0.420	0.461	0.200	-0.062
L.BNS	0.801	-10.524**	5.099**	1.282	3.619*	0.503
L.CIBC	1.087	6.717**	-8.528**	8.286**	4.207**	1.531
L.NAT	-5.600**	-4.214**	-3.507*	-19.365**	-4.164**	-7.123**
L.RBC	-1.322	2.515	0.812	4.175*	-9.898**	0.592
L.TD	0.282	0.323	0.280	0.449**	0.522**	0.203
L.Brate	5.028**	4.885**	5.345**	4.677**	5.413**	4.448**

Note: $*$ and $**$ denote significance level at 1% and 5% level, respectively.

Table 9: Cointegration Tests

	Three Year Bond		Five Year Bond		Five Year Bond w. Discounting	
Variable	ERS	PP	ERS	PP	ERS	PP
CIBC	-1.979	-7.834	-1.867	-7.615	-4.659	-8.726
MTL	-2.166	-6.995	-2.785	-7.043	-5.105	-7.572
NAT	-2.036	-7.760	-2.057	-7.726	-4.625	-8.771
BNS	-2.205	-7.713	-1.932	-7.639	-4.848	-8.705
RBC	-2.383	-7.699	-1.973	-7.703	-5.084	-8.894
TD	-2.140	-7.770	-1.845	-5.696	-3.760	-6.528

Notes: We report Elliott, Rothenberg, and Stock τ test statistics (ERS) and Phillips-Perron test-statistics. The 5 per cent critical value for the ERS test is -1.964 and for the PP test it is -2.860. The lag selection for the ERS test is chosen using the MAIC criterion (Ng and Perron 2001). The null hypothesis is that the residual from the interest rate equation has a unit root.

Table 10: Long Run Estimates

	3-Year Bond		5-Year Bond		5-Year Bond with Discounting	
Variable	α_i	β_i	α_i	β_i	α_i	β_i
CIBC	2.867	0.803*	3.001	0.804*	1.095	1.000
MTL	2.810	0.808*	2.975	0.805*	1.049	1.005
NAT	2.820	0.807*	2.980	0.809*	1.077	1.003
BNS	2.760	0.813*	2.992	0.804*	1.079	1.003
RBC	2.694	0.820*	3.000	0.802*	1.088	1.003
TD	2.825	0.807*	2.950	0.809*	0.944	1.019

Notes: * denotes β_i significantly different from 1 at the 5 per cent level. Residuals are modelled as GARCH(1,1). For MTL and TD 5-year rates we include a dummy variable for the "no haggle" subperiod.

Table 11: Asymmetry Estimates: 3-Year Rates

Variable	λ_i^+	λ_i^-	ω_i^+	ω_i^-	$H_0 : \lambda^+ = \lambda^-$	$H_0 : \omega^+ = \omega^-$
CIBC	0.301	0.390	-0.115	-0.178	1.22	2.64
	(0.000)	(0.000)	(0.000)	(0.000)	[0.270]	[0.105]
MTL	0.321	0.354	-0.114	-0.140	0.16	0.48
	(0.000)	(0.000)	(0.000)	(0.000)	[0.689]	[0.487]
NAT	0.252	0.329	-0.108	-0.199	0.84	5.03
	(0.000)	(0.000)	(0.000)	(0.000)	[0.360]	[0.025]
BNS	0.307	0.391	-0.112	-0.180	1.11	3.35
	(0.000)	(0.000)	(0.000)	(0.000)	[0.293]	[0.068]
RBC	0.294	0.387	-0.104	-0.195	1.33	5.74
	(0.000)	(0.000)	(0.000)	(0.000)	[0.249]	[0.017]
TD	0.259	0.359	-0.098	-0.198	1.52	6.56
	(0.000)	(0.000)	(0.000)	(0.000)	[0.218]	[0.011]

Notes: p-values for the null hypothesis that the parameters are equal to zero are shown in parentheses. p-values for the null hypothesis that coefficients are equal are shown in square brackets.

Table 12: Asymmetry Estimates: 5-Year Rates

Variable	λ_i^+	λ_i^-	ω_i^+	ω_i^-	$H_0 : \lambda^+ = \lambda^-$	$H_0 : \omega^+ = \omega^-$
CIBC	0.354	0.569	-0.116	-0.127	2.31	0.08
	(0.000)	(0.000)	(0.000)	(0.000)	[0.129]	[0.779]
MTL	0.393	0.466	-0.113	-0.110	0.26	0.01
	(0.000)	(0.000)	(0.000)	(0.000)	[0.610]	[0.936]
NAT	0.325	0.500	-0.109	-0.151	1.34	0.94
	(0.001)	(0.000)	(0.000)	(0.000)	[0.248]	[0.333]
BNS	0.337	0.545	-0.104	-0.137	2.14	0.71
	(0.000)	(0.000)	(0.000)	(0.000)	[0.144]	[0.399]
RBC	0.339	0.516	-0.107	-0.148	1.59	1.07
	(0.000)	(0.000)	(0.000)	(0.000)	[0.207]	[0.301]
TD	0.518	0.525	-0.132	-0.047	0.00	4.79
	(0.000)	(0.000)	(0.000)	(0.001)	[0.962]	[0.029]

Notes: p-values for the null hypothesis that the parameters are equal to zero are shown in parentheses. p-values for the null hypothesis that coefficients are equal are shown in square brackets. For MTL and TD we include a dummy variable for the "no haggle" subperiod.

Table 13: Asymmetry Estimates: 5-Year Rates with Discounting

Variable	λ_i^+	λ_i^-	ω_i^+	ω_i^-	$H_0 : \lambda^+ = \lambda^-$	$H_0 : \omega^+ = \omega^-$
CIBC	0.192	0.397	-0.106	-0.238	2.34	11.35
	(0.036)	(0.000)	(0.000)	(0.000)	[0.135]	[0.001]
MTL	0.378	0.337	-0.123	-0.130	0.04	0.09
	(0.000)	(0.000)	(0.000)	(0.000)	[0.837]	[0.767]
NAT	0.168	0.319	-0.092	-0.275	1.08	19.35
	(0.077)	(0.002)	(0.000)	(0.000)	[0.300]	[0.000]
BNS	0.165	0.377	-0.097	-0.245	2.38	14.8
	(0.073)	(0.000)	(0.000)	(0.000)	[0.124]	[0.000]
RBC	0.162	0.338	-0.098	-0.268	1.71	19.55
	(0.068)	(0.000)	(0.000)	(0.000)	[0.192]	[0.000]
TD	0.491	0.443	-0.129	-0.069	0.15	3.11
	(0.000)	(0.000)	(0.000)	(0.000)	[0.702]	[0.078]

Note: p-values for the null hypothesis that the parameters are equal to zero are shown in parentheses. p-values for the null hypothesis that coefficients are equal are shown in square brackets. For MTL and TD we include a dummy variable for the "no haggle" subperiod.

Appendix: Data Descriptions

The following statistics are available through the "Bank of Canada Banking and Financial Statistics" and "Weekly Financial Statistics" and through CANSIM. CANSIM identifiers are specified. All mortgage rates are in per cent and all outstanding values are in nominal Canadian dollars.

- Bank Rate (source: Bank of Canada) - v122785, v39078
- 90-day Bankers' acceptance rate (source: Bank of Canada) - v121775
- 91-day treasury bill rate (source: Bank of Canada) - v121778
- 1-year treasury bill rate (source: Bank of Canada) - v121801
- 3-year Government of Canada bond yield (source: Bank of Canada) - v121787
- 5-year Government of Canada bond yield (source: Bank of Canada) - v121788
- Residential mortgage credit outstanding (source: Bank of Canada) - v122746
- Total credit outstanding (source: Bank of Canada) - v122648
- The swap spread (source: Bloomberg) is the spread over 5-year Government of Canada bond yields that commercial banks must pay to swap 4- to 5-year fixed-term funding back to floating rate funds.
- Mortgage rates (source: CANNEX via the *Globe and Mail* newspaper) - The newspaper reports mortgage rates every Wednesday. Financial institutions included in the study include: Royal Bank of Canada (RBC), Canadian Imperial Bank of Canada (CIBC), Bank of Montreal (MTL), Scotia Bank (BNS), National Bank of Canada (NAT), Toronto-Dominion Bank (TD), Laurentian Bank, ING, First Line, London Life, HSBC, Montreal Trust, National Trust, Royal Trust, Canada Trust, General Trust, Alberta Treasury Branch, and Central Guaranty Trust.

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