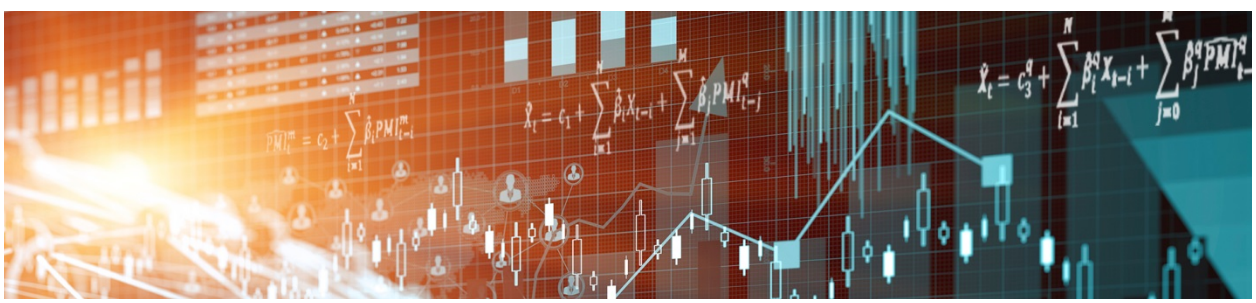
BANK OF CANADA
BANQUE DU CANADA

Staff Working Paper/Document de travail du personnel 2016-41

The Impact of Macroprudential Housing Finance Tools in Canada: 2005–10



by Jason Allen, Timothy Grieder, Brian Peterson and Tom Roberts

www.bank-banque-canada.ca

Bank of Canada Staff Working Paper 2016-41

August 2016

The Impact of Macroprudential Housing Finance Tools in Canada: 2005–10

by

Jason Allen, Timothy Grieder, Brian Peterson and Tom Roberts

Financial Stability Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
jallen@bankofcanada.ca
tgrieder@bankofcanada.ca
petb@bankofcanada.ca
robm@bankofcanada.ca

ISSN 1701-9397

Acknowledgements

We have benefited from comments provided by Gabriel Bruneau, Gino Cateau, Ricardo Correa, Leonardo Gambacorta, Lu Han (discussant), Seung Jung Lee, Chris Mitchell, Miguel Molico, Yasuo Terajima, Alexander Ueberfeldt, as well as members of the BIS CGDFS working group. All errors are our own.

Abstract

This paper combines loan-level administrative data with household-level survey data to analyze the impact of recent macroprudential policy changes in Canada using a microsimulation model of mortgage demand of first-time homebuyers. Policies targeting the loan-to-value ratio are found to have a larger impact than policies targeting the debt-service ratio, such as amortization. This is because there are more wealth-constrained borrowers than income-constrained borrowers entering the housing market.

Bank topic: Financial system regulation and policies
JEL codes: D14, G28, C63

Résumé

Dans la présente étude, nous combinons des données administratives sur les prêts et les données d'une enquête réalisée auprès des ménages afin d'analyser l'incidence des modifications apportées récemment aux politiques macroprudentielles au Canada. Nous utilisons pour ce faire un modèle de microsimulation de la demande de prêts hypothécaires des accédants à la propriété. Nous constatons que les politiques qui visent le rapport prêt-valeur ont un effet plus marqué que celles visant le ratio du service de la dette, comme les politiques relatives à l'amortissement. Ce résultat s'explique par le fait que, chez les accédants à la propriété, les emprunteurs soumis à des contraintes de richesse sont plus nombreux que ceux qui subissent des contraintes liées au revenu.

Sujet : Réglementation et politiques relatives au système financier
Codes JEL : D14, G28, C63

Non-Technical Summary

Since the global financial crisis, macroprudential housing-finance tools have been increasingly utilized to reduce financial system vulnerabilities related to housing market imbalances. This paper combines loan-level administrative data with household-level survey data to analyze the impact of recent macroprudential policy changes in Canada using a microsimulation model of mortgage demand of first-time homebuyers. Macroprudential policy can directly affect household borrowing through wealth and income constraints by limiting or expanding access to the mortgage market. The macroprudential tools we analyze include changes to the maximum allowable amortization and the maximum allowable loan-to-value (LTV) ratio. We find that policies targeting the LTV ratio are found to have a larger impact than policies targeting the debt-service ratio, such as amortization. This is because there are more wealth-constrained borrowers than income-constrained borrowers entering the housing market.

An important caveat of our results is that we have taken as given that lenders are able to change the supply of credit exogenously in response to changes in macroprudential policy. More importantly, we do not capture general equilibrium effects. A relaxation of mortgage insurance guidelines leads to entry of first-time homebuyers, which can lead to house price appreciation, which leads to further entry and greater house price appreciation. This can affect both current and future mortgage demand in a way that is not captured in the model. Future work should focus on these extensions.

1 Introduction

Since the global financial crisis, macroprudential housing-finance tools have been increasingly utilized to reduce financial system vulnerabilities related to housing market imbalances (Galati and Moessner (2012)). For instance, many countries in Europe, Asia, and the Americas responded to imbalances in their domestic housing markets, in part by tightening household borrowing constraints. Despite broad-based implementation, the effectiveness of such policies are not well understood. This paper attempts to fill this gap by analyzing loan-level data on first-time homebuyer (FTHB) mortgage choices in Canada over a period of both loosening and tightening macroprudential regulation. To quantify the aggregate impacts of macroprudential policy on borrower behavior and the dynamic responses of total credit, we propose, calibrate, and implement a microsimulation model of mortgage demand.

Macroprudential policy can directly affect household borrowing through wealth and income constraints by limiting or expanding access to the mortgage market. The macroprudential tools we analyze include changes to the maximum allowable amortization and the maximum allowable LTV ratio. Changes to the allowable amortization affect how much of a household's income is dedicated to its monthly mortgage payment. Between 2006 and 2007, we observe an increase in the allowable amortization from 25 to 40 years. This is followed by a tightening of the maximum allowable amortization to 35 years in 2008. The second macroprudential change was to the LTV ratio, which is closely related to wealth. A relaxation of the LTV requirement allows individuals to enter the housing market with less financial wealth, while a tightening has the reverse effect. In 2006, regulatory changes were made to allow for 100% LTV loans, whereas prior to this the maximum allowable was 95%. The LTV was tightened back to 95% in 2008.

The first contribution of this paper is to present descriptive evidence of the impact of changes in Canadian macroprudential housing-finance policy on household demand for mortgage credit using detailed data on FTHB mortgage contracts. Our data cover the period 2005 to 2010, during which macroprudential tools were both loosened and tightened and when the housing market experienced a prolonged boom followed by a short bust and a long rebound.[1] Institutional features of the Canadian mortgage environment—the fact that by law, mortgage insurance is required on all high LTV mortgages, and that this insurance is backed by the federal government—allows us to focus on the effectiveness of macroprudential tools without modeling the endogenous supply of credit, which hampers most empirical work in this literature. Given government-backed insurance, lending is free of default risk,[2] allowing us to assume credit is supplied elastically and that any impact from macroprudential policies is driven by demand and the effect of the policies on households' borrowing constraints.

There are two main results from our analysis of the loan-level data, which is easiest to interpret if we assume that households target a fixed mortgage payment. That is, households budget a fixed percentage of their income towards housing in the same way that households budget for consumption, savings, etc.[3] First, we find that on average, households are more constrained by savings (wealth) than monthly cash flow (income). A key observation is that households' average monthly mortgage payments increase even as the government slackens the income constraint. Only a fraction of households take advantage of the longer allowable amortization to lower their monthly payments. This implies that the average household has a preference for a larger mortgage-to-income ratio, and thus FTHBs were not constrained by income.

We do observe, on the other hand, a substantial increase in the fraction of households with no more than 5% equity at origination as the constraint is loosened. Households' demand for credit increased since they had the required income to make larger monthly payments but were constrained by the size of their down payment. That is, they targeted a monthly payment greater than their actual payment but were unable to borrow a large enough loan to reach the target. Once the LTV constraint is loosened, households are able to increase leverage and optimize their monthly payment choice. Note that this is not universally true. We show that there is a set of borrowers

[1] We therefore miss some of the further tightening that occurred between 2011 and 2016. See the Appendix for a complete list of rule changes in Canada between 1992 and 2016.

[2] Furthermore, there are substantial prepayment penalties, limiting prepayment risk, and mortgages are short-term (five years), limiting refinancing until the renewal date.

[3] Although not strictly necessary, it is helpful to think of households choosing to budget in fixed proportions. Gorman (1964) shows when this is optimal (utility is additively separable) and Davis and Heathcote (2005) provide evidence that this was at least true in the U.S. over the period that they study (1984–2001), justifying Cobb-Douglas utility over housing, consumption, and leisure.

(those in the 25th percentile of the income distribution) who are income-constrained and cannot increase leverage.

The results we obtain during the tightening period are similar: as the government lowers the maximum allowable amortization length and LTV there is a greater fraction of borrowers at the maximum allowable LTV. FTHBs make larger down payments as a fraction of their income as house prices continue to rise, but more households are at the LTV constraint. We also observe a decrease in average monthly payments, driven by accommodating monetary policy. However, the total debt-service ratio remains flat, indicating that non-mortgage debt is higher. If households could borrow more they would, further highlighting the role of the LTV constraint. If households are targeting the same mortgage-payment-to-income ratio as in the loosening period, they are now constrained from doing so, and the constraint is coming from the lack of savings. As in the case of loosening, this is especially true for high-income households.

Although our descriptive analysis of the observed choices of consumers during the loosening and tightening provides valuable insight, it is difficult to quantitatively measure the impact of a change in an income constraint or wealth constraint on consumer choice. Individuals are sorting themselves along several dimensions, for example, housing choice, in addition to the different mortgage contract options. Furthermore, the macroeconomic environment, including monetary policy, is changing throughout our sample. Our second contribution, therefore, is to use a microsimulation model of mortgage demand to summarize the quantitative impacts of the changes in macroprudential policies on FTHB mortgage demand. We label this model HRAM, which stands for Household Risk Assessment Model. This model imposes some structure on how we interpret the data while still being highly flexible in capturing nonlinear responses that more traditional, rational forward-looking dynamic general equilibrium models generally have difficulty capturing. A version of HRAM that focused on household debt-servicing was introduced in Faruqui et al. (2012).

The model imposes the following structure: there is a set of heterogeneous renters and homeowners. These households and their characteristics are taken from an annual survey of Canadian households conducted by Ipsos-Reid. Every period a renter can qualify to become a homeowner if the renter has enough income and wealth to afford a house. This depends on the renter's characteristics as well an exogenous process for the renter's income, financial assets, regional house prices, and the macroeconomic environment. The model, therefore, is not one with optimizing households. The probability that a renter in the survey data qualifies for and purchases a house, however, is chosen to match the loan-level data based on the joint distribution of income and mortgage-payment-to-income and LTV ratios. When the government changes access to mortgage insurance it affects the probability of renters qualifying to become homeowners and whether or not they purchase a house. Using the model, therefore, we can map the impact of a policy change on the percentage of FTHBs who have sufficient wealth to enter the market, whether they purchase a house, and their demand for credit. The results of our microsimulation model suggest that the wealth constraint has the largest impact on the number of FTHBs who enter the housing market. However, for FTHBs who have accumulated wealth, changes to the income constraint can also be substantial. This is because, conditional on income, high-wealth individuals are much more likely to own homes than low-income individuals. For example, we find that the tightening of the LTV constraint from 100% to 95% led to a 51% decrease in loan qualifications, a 7.9% decrease in FTHBs, and an 8.1% decrease in mortgage debt. We observe a 7.3% decrease in loan qualifications, a 5.1% decrease in FTHBs, and a 7.2% decrease in mortgage debt following a tightening in the amortization from 35 to 30 years. The impact of tightening the LTV is more than 10 times larger on qualifying to purchase a starter home, and the change in the number of FTHBs is larger following a change in LTV; however, the average mortgage size falls by about the same amount following changes in LTV and amortization.

This paper is related to the nascent but growing literature on the impacts of macroprudential tools on households, financial institutions, firms, and the aggregate economy. Allen et al. (2015), for example, study the impact on credit demand in Canada in 2003 when the government eliminated house-price differentiated minimum LTV requirements. Using Korean data, Igan and Kang (2011) find house prices and transactions respond to changes in LTV, although not leverage. Han et al. (2016) study the Canadian market and the $1 million cap on mortgage insurance implemented in 2012. They conclude that for macroprudential policy to be effective it must be targeted at liquidity-constrained borrowers, and that policy-makers need to take into account how agents (lenders, buyers, sellers, etc.) will respond to the regulation. Godoy de Araujo et al. (2015) use credit registry data in Brazil and find that tightening of the LTV leads to a change in the composition of borrowers. Work at the International Monetary Fund (IMF) and Bank for International Settlements (BIS) has focused more on the impact of macroprudential tools on bank lending. See for example Cerutti et al. (2016) and Kuttner and Shim (2013).[4]

Our paper is also related to the small set of papers that have used microsimulation models to study vulnerabilities in the household sector. This includes papers on Finland (Herrala and Kauko (2007)), Sweden (Johansson and Persson (2006)), and Chile (Fuenzalida and Ruiz-Tagle (2011)). Microsimulation models provide an advantage in that they can summarize large amounts of micro-level information and inference can be made about what changes might be expected regarding hypothetical policy changes (Harding (1996) and Gupta and Kapur (2000)). Compared with these papers, we focus on modeling mortgage demand with the explicit goal of understanding how consumers respond to changes in macroprudential policy.

This paper is organized as follows. Section 2 presents institutional details of the Canadian mortgage market. Section 3 highlights the key macroprudential rule changes implemented in Canada between 2005 and 2010. Section 4 presents the data. Section 5 presents the microeconometric results based on the household-level data. Section 6 presents the microsimulation model and results on credit growth from macroprudential changes, and Section 7 concludes.

2 Institutional Background

Canada's *Bank Act* (section 418) requires mortgage insurance on all high-ratio mortgages, where high-ratio is defined as less than 20% equity at origination, although this cut-off has changed over time. With insurance, financial institutions are willing

[4]The impacts of macroprudential tools have also been studied in dynamic stochastic general equilibrium (DSGE) models. Much of this literature is concerned with determining whether introducing macroprudential tools into monetary-policy-only economies can help policy-makers better achieve their mandates of inflation targeting and employment. Lambertini et al. (2013) find that a combination of a countercyclical LTV rule responding to credit growth in addition to a Taylor-type interest rate rule augmented to also respond to credit growth reduces the volatility of house prices and the debt-to-GDP ratio relative to a baseline policy based on a typical Taylor-type rule. See also Angelini et al. (2012). All rational forward-looking DSGE models, however, have difficulty capturing the important non-linearities inherent in the financial frictions in mortgages.

to lend to borrowers previously excluded from the mortgage market. Since high-ratio mortgages are insured, financial institutions do not face default risk.[5] Furthermore, there are steep prepayment penalties in Canada, limiting lender prepayment risk.

Conditioning mortgage access on mortgage insurance also allows the government to change access through insurance guidelines/rules.[6] There were a number of important changes to mortgage insurance underwriting guidelines in the 1990s that led to a sharp increase in insured mortgage uptake. As a response to the 1991 recession, and to spur investment in housing, the maximum allowable LTV for insured mortgages was increased in 1992 from 90% to 95% as a pilot program for FTHBs. In May 1998, changes to legislation and regulation allowed for the finalization and extension of the 95% maximum allowable LTV to all homebuyers within regional house price limits. In September 2003 the government removed regional house-price caps on mortgage insurance access. Allen et al. (2015) document a 75% increase in leverage following this relaxation of the borrowing constraint.

Loosening of macroprudential tools continued in 2005 through to 2007. However, following the onset of the global financial crisis and growing imbalances in Canada's housing markets, the government tightened mortgage insurance access between 2008 and 2016 by lowering the maximum allowable amortization length and LTV and debt-service ratios, and reintroduced house price caps for mortgage insurance. We discuss some of these changes in Section 3. See Schembri (2014) and Crawford (2015) for a discussion of Canada's policy framework and how it functioned during the crisis.

In Canada, there is one public insurer, Canada Mortgage and Housing Corporation (CMHC), and now two private insurers (Genworth Financial and Canada Guaranty; Canada Guaranty entered the market on the last day of our sample). In the case of

[5]Approximately half of total mortgage credit is uninsured. Banks do face default risk on these low-ratio mortgages. However, house prices would have to fall dramatically for homeowners to have negative equity and walk away from their homes in this case. Furthermore, most provinces have full recourse mortgages, meaning that most Canadians who forfeit on their homes would owe the difference between the recovered value of the house and the face value of the mortgage.

[6]In Canada, the government also has authority over mortgage securitization since CMHC is in charge of securitizing insured mortgages. CMHC introduced the *National Housing Act* Mortgage-Backed Securities program in 1987 and Canada Mortgage Bond program in 2001. This paper abstracts from changes to securitization that could affect bank funding. Note that private securitization is nearly non-exist given the low-cost, publicly available funding (Mordel and Stephens (2015)).

borrower default, lenders are protected by the insurer. In the case of borrower and insurer default, lenders have a government guarantee that pays 100% if the mortgage is insured by CMHC and 90% if it was insured by a private insurer. The government therefore establishes mortgage insurance regulations and guidelines to manage its contingent liabilities stemming from vulnerabilities related to housing markets and household indebtedness.

Although mortgage insurance premiums have varied over time, they are largely based on LTV ratios and access is conditional on a maximum debt-service ratio and, more recently, a minimum credit score.[7] Mortgages in Canada are typically fixed-rate and the contract term is five years. Historically, mortgages have had a 25-year amortization, with insurance for the life of the mortgage. The insurance premium, which is between 1.75% to 3.75% of the mortgage loan for a standard product, is almost always rolled into the monthly payment and therefore spread out over the amortization period. The qualifying rules and premiums are common across lenders. In Section 4 we present summary statistics describing the typical contract.

3 Mortgage Access Constraints and Rule Changes

In this section we highlight some key changes to mortgage insurance guidelines over the period 2005 to 2010. We analyze the impact of most of these changes on household mortgage demand in Section 5 and Section 6. The main rule changes were to the LTV constraint and the amortization length, the latter of which operates through the total debt-service (TDS) constraint.

3.1 Mortgage insurance constraints

Access to mortgage credit is controlled through mortgage insurance guidelines, especially those related to LTV and TDS constraints. The LTV constraint is defined as follows:

$$\frac{\text{loan}}{\text{house value}} \times 100 \leq \overline{LTV},$$

[7] The government introduced LTV-based pricing in 1982 following large losses to CMHC following the 1980–81 recession.

where historically in Canada $\overline{LTV}$ has fluctuated between 90 and 100 and is currently at 95. According to the IMF (2013), LTV constraints appear to be the most popular macroprudential tool used by authorities to manage demand for household credit. The TDS constraint is defined as follows:

$$\left(\frac{\text{mortgage payment} + \text{other housing costs} + \text{other debt payments}}{\text{household income}}\right) \times 100 \leq \overline{TDS},$$

where $\overline{TDS}$ in Canada is currently 44.

3.2 Rule changes

The specific rule changes we study are as follows. First, on February 25, 2006 CMHC increased its maximum amortization from 25 to 30 years in what was supposed to be a four-month pilot program.[8] Soon after, on March 16, 2006, Genworth Financial ("Genworth") increased its maximum amortization from 25 to 35 years.[9] On June 28, 2006, CMHC allowed contracts to amortize over 35 years and matched Genworth's insurance premiums. Following these increases in amortization, on October 2, 2006 Genworth increased the maximum allowable LTV from 95 to 100. This was followed closely on October 10, 2006 when Genworth increased its maximum amortization from 35 years to 40 years. On November 19, 2006 CMHC increased its maximum allowable LTV from 95 to 100, and also increased its maximum amortization from 35 to 40 years. We label the period February 25, 2006 to November 14, 2008 as the "loose" period in the data.

The "tightening period" begins October 15, 2008. The tightening concerned changing amortization lengths for high-ratio mortgages from 40 to 35 years and LTV ratios from 100 to 95, and imposing a new TDS constraint of 45. The government also established a minimum credit score and loan documentation standards.

[8]The insurance premium for this product was an additional 25 basis points. We do not believe that small changes in insurance premiums affect demand. Premiums are amortized over the full amortization period, and therefore represent only a small fraction of the cost of borrowing. In our analysis of premium changes we do not find any impact on borrower demand.

[9]The insurance premium was 20 basis points for each extra five years over 25.

3.3 Expected impact of rule changes

The impact of changes to the income and wealth constraints can be best understood by considering a borrower's housing and mortgage choice problem. An increase in $\overline{LTV}$ allows the household to borrow more for the same housing choice. If $\overline{LTV}$ equals 100, the household can borrow the full value of the house, subject to the TDS constraint. For the TDS constraint, given a fixed level of non-mortgage debt, an increase in amortization loosens the payment constraint. A borrower's monthly payment is given by:

$$\text{payment} = \frac{L((1+r/2)^{1/6}-1)(1+r/2)^{2T}}{(1+r/2)^{2T}-1},$$

where L is the principal loan amount, T is the amortization period measured in years and r is the nominal interest rate. In Canada, loan interest is compounded semi-annually. One can see that as the amortization length increases, the monthly payment decreases. Households that are income-constrained therefore benefit from longer amortization periods, even though the total cost of the mortgage increases. Notice that the impact of changes to amortization will be nonlinear.

4 Data

In this section we introduce the main variables used in our analysis for the individual-level data at mortgage origination. These data form the basis of our descriptive analysis of the impact of the changes in macroprudential regulation on mortgage contracts. We also use these data to discipline the household-level survey data and therefore calibrate the microsimulation model presented in Section 6.

4.1 Mortgage insurance data

Information on the mortgage contract, borrower, and lender is collected by the public insurer (CMHC) at the time of origination for all insured mortgages. The information collected includes the interest rate, loan amount, house price, debt-service ratio, term, amortization, household income, credit score, and lender name.[10] On average, 60% of contracts are new originations and 40% are refinancing. We drop all refinancing and focus on the more homogenous set of new orginations. As of July 2012, refinancing has been eliminated from the mortgage insurance space. Since our focus is on FTHBs, we also drop all repeat buyers. Approximately 20% of new originations are repeat homebuyers and not the focus of our analysis.[11] Table 1 presents summary statistics of the key variables for three subperiods using the population of CMHC-insured FTHB residential purchases. All dollar values are in nominal CAD. The subperiods broadly coincide with a "pre" period, a "loosening" period, and a "tightening" period. The pre-period is from February 24, 2005 to February 24, 2006, and occurs before the rapid loosening of insurance guidelines for fixed-rate mortgages. The loosening period corresponds to February 25, 2006 to October 14, 2008, during which mortgage insurance guidelines for amortization length and LTV were relaxed multiple times for home purchases and refinancing. We focus our discussion on the cumulative impact of the loosening on mortgage contract characteristics such as amortization, LTV, TDS, and interest rates. We also examine the impact of rule changes on borrower characteristics such as credit score and income. Finally, the tightening period corresponds to October 15, 2008 to April 18, 2010.[12] Over this period, the government tightened amortization, LTV, and TDS constraints.[13] These periods form the basis for measuring the impact of macroprudential changes on mortgage demand.

[10]Similar data have been used in Allen et al. (2014b) and Allen et al. (2014a) to study price dispersion in the Canadian mortgage market and bank competition, respectively.

[11]Anenberg and Bayer (2013) point out that the internal movement of repeat buyers is especially volatile—20% of U.S. originations in down years and 40% in peak years. Allen et al. (2014b) document that repeat buyers take out larger loans to purchase larger homes than FTHBs. However, on average, they have lower LTV ratios and similar TDS ratios as FTHBs. They also document that the share of repeat buyers between 1999 to 2004 is around 20%, which is similar to what we observe between 2005 and 2011. Where repeat buying is likely more volatile is in the uninsured mortgage space, where we do not have data, and where the macroprudential tools are largely outside of scope.

[12]On April 19, 2010 the government changed the TDS formula for variable-rate mortgages (VRMs) and for mortgages of terms longer than five years, which substantially affects loan qualifying in an additional manner we have chosen not to study in this paper.

[13]There is also tightening for investment properties, which we exclude given data limitations.

Table 1: Summary statistics of transaction-level data for new purchases

The variable (rate-bond) represents an estimate of a lender's profit margin. It's the contract rate minus funding costs, approximated by the matched-term Government of Canada bond rate. The variable income captures total household income. I(detached) is an indicator equal to 1 for detached homes and 0 for all other dwelling types. I(FRM) is an indicator variable equal to 1 if the mortgage is fixed-rate and 0 if variable-rate. I(FICO≥680) is an indicator equal to 1 if the borrower's (best) credit score is at least 680. I(downpayment=unconventional) is an indicator equal to 1 if a borrower's down payment was non-traditional, a gift, or sweat equity and 0 otherwise. All dollar figures are nominal Canadian dollars.

	mean	**sd**	**p25**	**p75**
	Sample: 2005/02/24-2006/02/24			
House price	207,614	103,627	138,550	260,680
Mortgage	190,646	93,024	128,639	239,144
Income	78,523	38,817	53,971	93,939
rate-bond	1.05	0.63	0.71	1.23
I(detached)	0.66	0.47		
LTV	92.29	3.92	90.00	95.00
TDS	33.42	6.01	29.83	38.33
amortization (months)	296.93	19.22	300.00	300.00
I(FRM)	0.93	0.26		
Term(months)	58.82	15.05	60.00	60.00
I(FICO≥680)	0.77	0.42		
I(down payment=unconventional)	0.27	0.44		
	Sample: 2006/02/25-2008/10/14			
House price	245,551	128,231	159,159	310,224
Mortgage	228,783	117,140	149,596	288,306
Income	87,389	46,108	58,915	103,897
rate-bond	1.29	0.74	0.76	1.77
I(detached)	0.65	0.48		
LTV	93.58	4.43	90.00	95.00
TDS	34.69	6.03	31.08	39.40
amortization (months)	375.68	83.29	300.00	480.00
I(FRM)	0.91	0.28		
Term(months)	59.99	12.85	60.00	60.00
I(FICO≥680)	0.78	0.41		
I(down payment=unconventional)	0.25	0.43		
	Sample: 2008/10/15-2010/04/18			
House price	288,225	141,584	190,867	360,675
Mortgage	267,405	129,158	178,858	334,533
Income	91,105	49,244	60,247	108,939
rate-bond	1.99	0.85	1.43	2.45
I(detached)	0.64	0.48		
LTV	93.08	3.75	90.00	95.00
TDS	35.25	6.36	31.32	40.27
amortization (months)	390.83	57.24	360.00	420.00
I(FRM)	0.87	0.34		
Term(months)	56.33	12.69	60.00	60.00
I(FICO≥680)	0.84	0.37		
I(down payment=unconventional)	0.24	0.43		

Note that on average, the time between application and closing is 45 days. For tightening episodes, both the application and closing dates are important since lenders typically provide a 90-day rate guarantee. Someone can therefore be pre-approved on January 1 and be guaranteed that contract until April 1. The mortgage tightening therefore applies immediately on the announcement day to borrowers without pre-approval and applies approximately 90 days later (implementation date) for those pre-approved under the old rules. Therefore, individuals with a closing date after the implementation date are considered affected by the change, and individuals with closing dates before the announcement are considered unaffected. Individuals who closed during the phase-in time are not considered affected if they applied before the announcement. For loosening, the announcement and implementation dates coincide. Individuals could borrow at the new terms once the loosening was announced.

From Table 1, we observe a noticeable increase in loan size over time, which is not surprising given the substantial increases in house prices. Incomes have also increased over time. LTV ratios appear relatively flat in Table 1; however, the amortization length and TDS ratios are increasing. The average age of an FTHB is 35. From Table 1 we see that the fraction of contracts that are fixed-rate mortgages is high, nearly 90%. The percentage of variable-rate mortgages, however, increases at the end of 2008 as the central bank cut interest rates and offered forward guidance that set expectations that rates would be low for some time.[14] Finally, we also present an indicator for whether the source of the down payment was unconventional. That is, if the source of down payment includes sweat equity, second lien, gifts, or flex-down (non-traditional sources). On average, these represent 25% of cases. Most down payments are from either private or registered savings plans.[15]

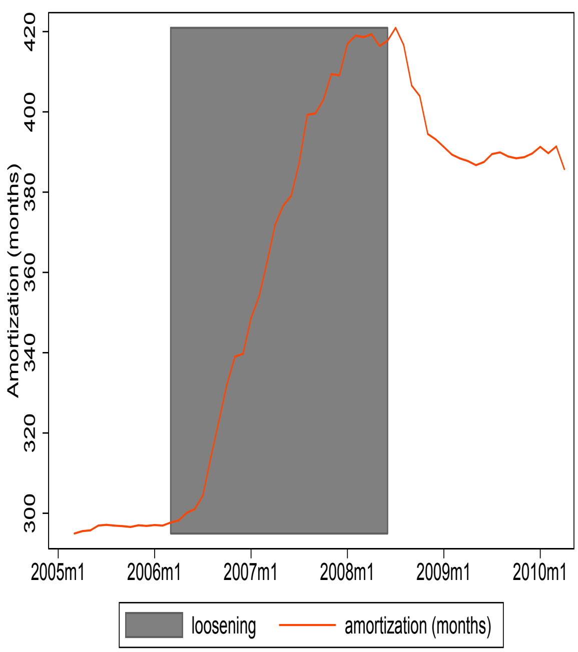
In Figure 1 and Figure 2 we graphically present the main variables of interest over the full sample for FTHBs. All dates are based on closing and not application. The contract variables of interest are amortization, LTV and TDS. Our main empirical analysis focuses only on fixed-rate contracts. Broadly speaking, there are three periods: the shaded area denotes a period of loosening; the period immediately following is a period of tightening; and the first year represents a period with no change in

[14]See Mendes and Murchinson (2014) for discussion of forward guidance in Canada.

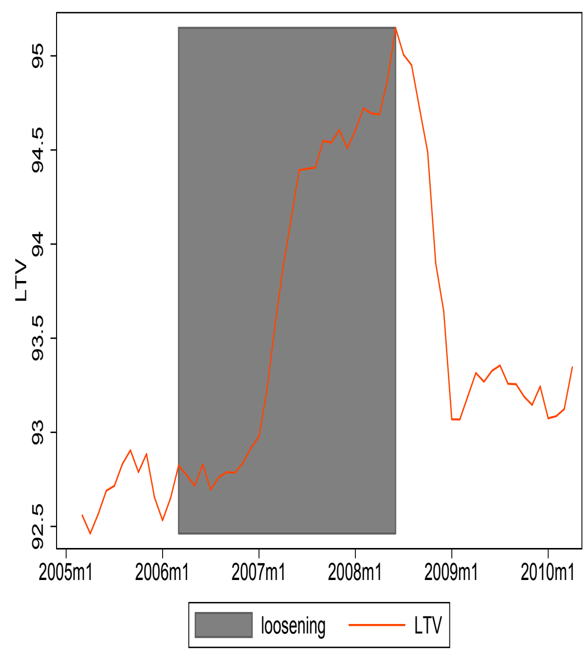
[15]The Canadian government has subsidized FTHBs by allowing them to withdraw savings from their retirement accounts tax-free up to a fixed amount, which during our sample was $20,000/person.

mortgage insurance guidelines. From the figures we can clearly observe an increase in amortization, LTV, and TDS during the loosening and a similar decrease during the tightening. Figure 2(b) captures only the monthly mortgage payment component of TDS. Mortgage payments between 2006 and 2008 are increasing even as amortization lengths are increasing, which loosens the income constraint. This is because monetary policy is tightening, which is making mortgages more expensive, and also because the wealth constraint is loosening and households are borrowing more.

Figure 1: Amortization length and LTV for FTHBs



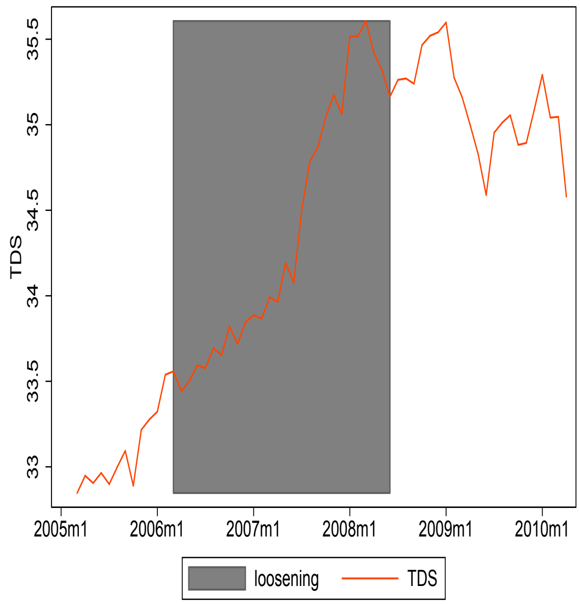
(a) Amortization



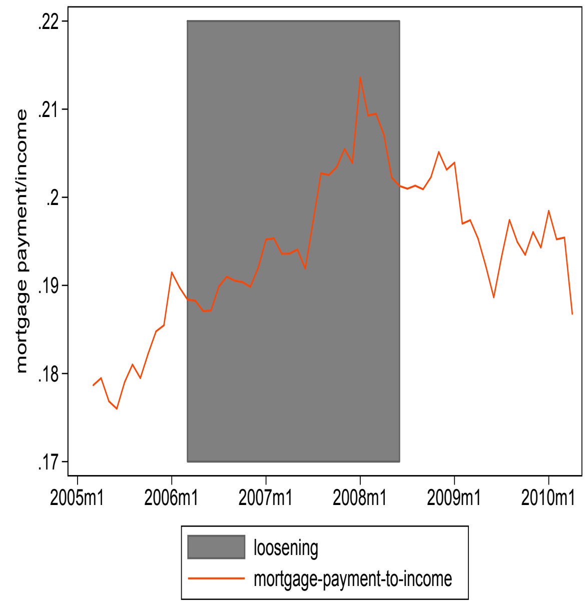
(b) LTV

Figure 3 shows the evolution of income. Interestingly, borrowers' average income increases during the loosening period but remains flat during the tightening. One reason for this could be that the well-documented increases in home prices forced people who would typically be outside the insurance space into the insured space in order to buy a house.

Figure 2: Average TDS and monthly mortgage payment-to-income ratio for FTHBs

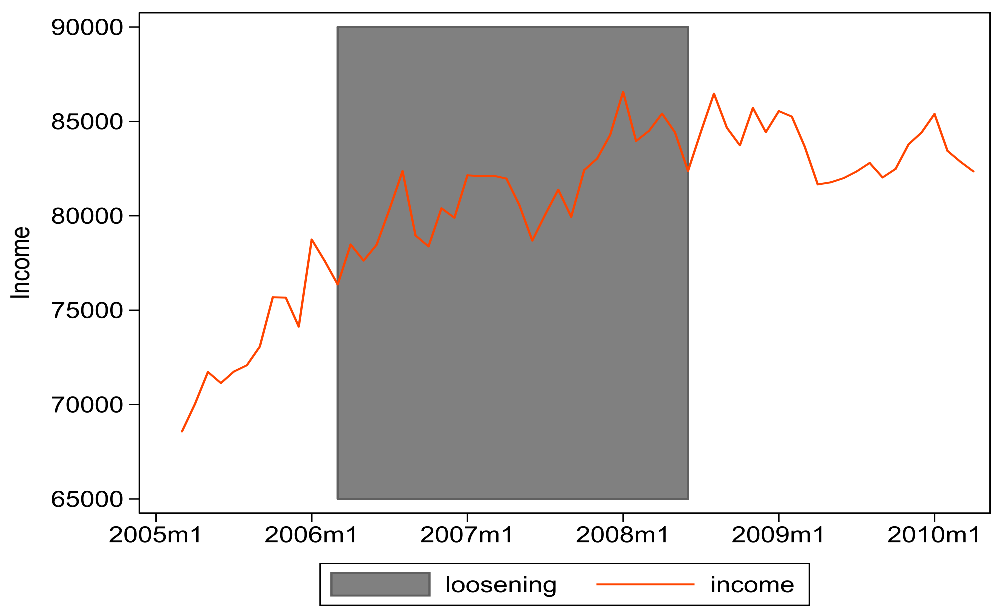


(a) TDS



(b) Mortgage-payment-to-income

Figure 3: Average household income for FTHBs



5 Data-driven analysis

Our empirical analysis focuses on the demand for credit and how both mortgage contract characteristics and borrower characteristics were affected by changes in mortgage insurance guidelines. We focus on FTHBs choosing five-year fixed-rate mortgages.

The main specification is equation (1) where y is our variables of interest: LTV ratio, amortization, TDS ratio, down payment-to-income ratio, monthly mortgage-payment-to-income ratio, house prices, loan size, household income, interest rates, credit score, and an indicator for whether the down payment was borrowed; and D_j is an indicator variable equal to 1 for the period under which mortgage insurance rule j is in place and 0 otherwise. We estimate equation (1) for two samples. First, where D_1 equals 1 during the loosening period from February 25, 2006 to July 8, 2008 and 0 from February 24, 2005 to February 24, 2006. Second, where D_2 equals 1 during the tightening period from July 9, 2008 to April 18, 2010 and 0 during the loosening period. In all specifications, we include month-of-year fixed effects interacted with location fixed effects (ν_m), where location is an FSA.[16] This allows us to control for location-specific seasonality (for example, housing demand might be different in Vancouver and Montreal across seasons due to weather) and unobservable differences in housing market conditions. Standard errors are clustered at the FSA level. For covariates we include borrower characteristics such as age and whether or not they used a broker, as well as property characteristics such as dwelling type and property age. We also include bank fixed effects (θ_b).

$$y_{it} = \alpha_0 + \beta X_{it} + \gamma_{j1} D_{jt} + \theta_b + \nu_m + \epsilon_{it}. \tag{1}$$

We present results for the loosening period (2006–2007) and the tightening period (2008–2010) in Table 2 and Table 3, respectively. Given that multiple tools were used in quick succession and most targeted all households in our data set, it is difficult to assign causation to any one particular tool. We therefore present the cumulative impacts and discuss the broad relationships between changes in macroprudential tools and household borrowing and explore specific mechanisms that are likely at play. We

[16] An FSA is a forward sortation area and is the first three letters of a Canadian postal code. There are more than 1,600 FSAs in Canada.

do allow the policy variable, D, to interact with log-income (demeaned) when looking at LTV and amortization. We do this to explore consumer heterogeneity in response to lending policies.[17] In Section 6 we impose more structure on the data and therefore discuss the impact of macroprudential tools on mortgage demand.

Our results highlight that most contract, borrower, and market characteristics respond to changes in mortgage guidelines. In addition, there is heterogeneity in impacts depending on income. For example, the marginal effect of loosening on LTV at the average income level is about 1.2%. At the same time, the fraction of borrowers with 5% equity or less increased by 4.1%. However, the impact is increasing in income. The increase in LTV for FTHBs with income one standard deviation below the mean is only 0.6%. Likewise, FTHBs with high income have a larger than average response to the loosening. This is because the relaxation of the wealth constraint allows high-income-low-wealth individuals to enter the housing market with smaller down payments, since they easily meet the income constraint. In contrast, we observe the probability of low-income individuals at the maximum LTV falling. This is because even though zero-down-payment mortgages are allowed during this period, households must still meet the income constraint, which is not feasible for some households. Note that about 17% of households took advantage of the zero-down product while it was offered.[18]

In column (3) of Table 2 we see that the cumulative impact of loosening is correlated with a 22.7% increase in the average amortization length and no heterogeneity by income. From column (4) we observe that as the maximum allowable amortization was increased from 25 years to 30, 35, and then 40 years, the percentage of borrowers at the maximum constraint fell. This is because nearly 97% of borrowers were at the constraint pre-loosening and not all borrowers choose the maximum allowable amortization following the relaxation of the constraint. Given that amortization plays an important role in the income constraint (and not the wealth constraint), this suggests that for at least some incoming FTHBs, the income constraint was not binding. Column (5) presents the cumulative impact of the loosening on the average TDS, which

[17] Ideally, we would also want to interact D with financial wealth. However, we do not have information on wealth other than the down payment at the time of purchase.

[18] Another reason for not choosing a zero-down mortgage includes a preference for a smaller mortgage (e.g., Brueckner (1994).)

was an increase of 4.4%. Column (6) presents the impact of the loosening on the average down-payment-to-income ratio. Given that 17% of FTHBs purchased with zero down, it should be surprising than the average down payment fell dramatically. Column (7) presents the impact of loosening on the average mortgage-payment-to-income ratio. The average cumulative impact was 10.5%. Why? House prices were rising substantially over the sample period, by 19.2% during the loosening period, and from column (11) we also see that interest rates were rising. From column (10) we also see that incomes increased by 11.8% during the loosening period. The result that mortgage payments increased, therefore, despite longer amortization and larger incomes is driven in large part by higher interest rates on larger loans. This suggests that borrowers were not income-constrained, but instead constrained by wealth.[19] This is because if households were truly constrained by income, mortgage payments should have remained flat as they took on longer amortizing mortgages. It also suggests that borrowers might not be overly sensitive to interest rates, at least relative to macroprudential policies.

Now consider the period of tightening mortgage insurance guidelines and the results in Table 3. The tightening of mortgage insurance guidelines affected the types of borrowers who could become FTHBs. House prices are continuing to rise but now monetary policy is being accommodating due to the global financial crisis. The lower interest rates allow FTHBs to take out larger loans for the same TDS constraint, even though the amortization constraint is being tightened by the government. However, what we observe is that the average TDS is unchanged from the loosening period and the mortgage-to-income ratio falls. This is because the new inflow of FTHBs have more non-mortgage debt than the previous cohort. They are constrained by their non-mortgage debt. They are also constrained by their savings. We observe a continued increase in the fraction of FTHBs at the maximum allowable LTV constraint even as households' down-payment-to-income ratio increases. This is especially true for high-income households. For income, the picture is more complicated. There are more households at the maximum allowable amortization, suggesting FTHBs are

[19] In contrast to rising contract interest rates, bank profit margins were falling, implying the cost of borrowing increased more than the average lending rate. The opposite is true during the tightening period, i.e., contract interest rates fell but margins increased. These results suggest that lending spreads are countercyclical, in line with the macroprudential tools.

Table 2: Impact of loosening macroprudential policy changes

This table shows the correlation between changes in macroprudential tools and mortgage contract characteristics for all new purchases. The coefficient *loose* is an indicator equal to 1 for the period February 25, 2006 to November 14, 2008 and 0 otherwise. The estimation sample is February 24, 2005 to November 14, 2008. The variables of interest are loan-to-value (LTV), $I(LTV \geq 95)$, log-amortization (AM), $I(AM \geq max)$ (equal to 1 if the chosen amortization is equal to or greater than the maximum allowable at the date of the contract and 0 otherwise), the log of the total debt-service ratio (TDS), the log of the down payment at origination to income ($\log(dp/inc)$), and the log of the monthly mortgage-payment-to-income ratio ($\log(mp/inc)$), log-house prices ($\log(HP)$), log-loan size ($\log(loan)$), demeaned log-income ($\log(inc)$), contract rate (rate), the likelihood of the household credit score being above 680 ($Pr(FICO \geq 680)$), and the likelihood of the down payment being borrowed ($I(borr.\ DP)$. Included are bank, FSA × month of the year fixed effects as well as controls for dwelling structure (type and age) and mortgage term. There are 150,459 observations. Robust standard errors clustered at the FSA level are in parentheses. Significance level is *** p<0.01, ** p<0.05, and * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	LTV	I(LTV≥95)	AM	I(AM≥max)	log(TDS)	$\log(\frac{dp}{inc})$	$\log(\frac{mp}{inc})$
loose	1.096***	0.041***	0.227***	-0.362***	0.044***	-0.393***	0.105***
	(0.030)	(0.004)	(0.002)	(0.005)	(0.001)	(0.009)	(0.003)
log(inc)	0.536***	0.025***	-0.023***	-0.062***			
	(0.052)	(0.007)	(0.002)	(0.005)			
loose×log(inc)	0.104*	0.029***	0.005	-0.049***			
	(0.058)	(0.007)	(0.003)	(0.006)			
Constant	95.61***	0.84***	5.67***	0.90***	3.52***	2.34***	-1.85***
	(0.171)	(0.020)	(0.009)	(0.017)	(0.008)	(0.046)	(0.017)
R^2	0.088	0.076	0.267	0.215	0.057	0.127	0.241

	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	log(HP)	log(loan)	log(income)	rate	Pr(FICO>=680)	I(borr. DP)
loose	0.192***	0.240***	0.118***	0.677***	0.007***	0.027***
	(0.007)	(0.007)	(0.004)	(0.004)	(0.003)	(0.003)
Constant	11.773***	11.803***	-0.247***	4.792***	1.186***	0.756***
	(0.020)	(0.020)	(0.018)	(0.025)	(0.017)	(0.019)
R^2	0.639	0.629	0.286	0.334	0.057	0.121

Table 3: Impact of tightening macroprudential policies changes

This table shows the correlation between changes in macroprudential tools and mortgage contract characteristics for all new purchases. The coefficient *tight* is an indicator equal to 1 for the period July 9, 2008 to April 18, 2010 and 0 otherwise. The estimation sample is February 25, 2006 to April 18, 2010. The variables of interest are loan-to-value (LTV), $I(LTV \geq 95)$, log-amortization (AM), $I(AM \geq max)$ (equal to 1 if the chosen amortization is equal to or greater than the maximum allowable at the date of the contract and 0 otherwise), the log of the total debt-service ratio (TDS), the log of the down payment at origination to income (log(dp/inc)), and the log of the monthly mortgage-payment-to-income ratio (log(mp/inc)), log-house prices (log(HP)), log-loan size (log($loan$)), demeaned log-income (log($income$)), contract rate (rate), the likelihood of the household credit score being above 680 ($Pr(FICO \geq 680)$), and the likelihood of the down payment being borrowed ($I(borr.\ DP)$. Included are bank, FSA × month of the year fixed effects as well as controls for dwelling structure (type and age) and mortgage term. There are 170,167 observations. Robust standard errors clustered at the FSA level are in parentheses. Significance level is *** p<0.01, ** p<0.05, and * p<0.1.

VARIABLES	(1) LTV	(2) I(LTV≥95)	(3) AM	(4) I(AM ≥ max)	(5) log(TDS)	(6) $\log(\frac{dp}{inc})$	(7) $\log(\frac{mp}{inc})$
tight	-0.761***	0.008***	0.027***	0.108***	0.002*	0.583***	-0.044***
	(0.023)	(0.003)	(0.001)	(0.003)	(0.001)	(0.00683)	(0.002)
log(inc)	0.529***	0.047***	-0.029***	-0.141***			
	(0.040)	(0.004)	(0.003)	(0.005)			
tight×log(inc)	0.248***	0.018***	-0.015***	-0.007			
	(0.049)	(0.006)	(0.003)	(0.006)			
Constant	96.943***	0.896***	5.903***	0.509***	3.565***	1.960***	-1.737***
	(0.150)	(0.019)	(0.009)	(0.018)	(0.008)	(0.0406)	(0.015)
R^2	0.075	0.071	0.138	0.135	0.049	0.162	0.228

VARIABLES	(8) log(HP)	(9) log(loan)	(10) log(income)	(11) rate	(12) Pr(FICO>=680)	(13) I(borr. DP)
tight	0.099***	0.116***	-0.004	-1.261***	0.048***	-0.037***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.002)	(0.003)
Constant	11.960***	12.039***	-0.149***	5.443***	1.196***	0.859***
	(0.017)	(0.018)	(0.017)	(0.025)	(0.016)	(0.019)
R^2	0.656	0.643	0.274	0.563	0.058	0.105

constrained. The average monthly-payment-to-income ratio, however, falls. This is driven by two facts. First, interest rates are falling as monetary policy is loosening. However, because of the amount of other debt households already hold, which is leading to a high TDS, and because of the LTV constraint, they cannot borrow as much as they would like.

A final comment on impact of tightening relates to average credit scores. In November 2008, the government established a minimum credit score and loan documentation standards at the same time it tightened the LTV and amortization constraints. The impact on the average credit score was immediate. The likelihood of the borrower having a credit score above 680 increased by 4.8%. Introducing tighter lending standards, therefore, did have an impact on the type of FTHBs entering the housing market. The average income of FTHBs remained the same; however, the fraction of FTHBs borrowing their down payment fell, suggesting that the increase in documentation requirements may have also tightened the wealth constraint.

6 Microsimulation Model

Although our descriptive analysis provides some suggestive evidence on the effect of macroprudential policy on household borrowing, it is lacking in several dimensions. Most importantly, it does not offer a succinct answer to the question: What is the impact of macroprudential policies on mortgage demand? In this section, we present a general overview of our microsimulation model, HRAM, extending the ideas presented in Faruqui et al. (2012).

Time is discrete, with a finite horizon given by T. Index time by

$$t \in \mathcal{T} = \{0, 1, 2, \ldots, T-1, T\}.$$

There is a discrete set of households, $\mathcal{I}$. Index each household by

$$i \in \mathcal{I} = \{1, 2, 3, \ldots, I-1, I\}.$$

A household i is defined as

$$i = \left(\Omega_i, \{X_{i,t}\}_{t=0}^{t=T}\right),$$

where Ω_i is a $J \times 1$ vector of fixed household characteristics, such as age, education, and geographic region, and $X_{i,t}$ is a $K \times 1$ vector of time-varying household variables, such as labor income and financial assets. Refer to an element in $X_{i,t}$ as $x^k_{i,t}$.

The nominal labor income of household i in period t is denoted by $x^Y_{i,t}$. Financial assets are denoted by $x^{FA}_{i,t}$, and housing assets by $x^{HA}_{i,t}$. The total financial resources available to household i at time t, which we refer to as a household's budget, is the sum of labor income (minus tax payments) and financial assets (with the return) less debt:

$$\underbrace{x^{FA}_{i,t} - x^D_{i,t} + x^C_{i,t}}_{\text{Asset, debt, consumption}} = \underbrace{x^Y_{i,t}(1-\tau) + x^{FA}_{i,t-1}\left(1 + R^{FA}_t\right) - x^D_{i,t-1}}_{\text{Available financial resources}} - \underbrace{x^{DP}_{i,t}}_{\text{Required debt payments}}$$

where τ is the tax rate on income, and R^{FA}_t is the return on financial assets, which is assumed to be exogenous.

6.1 First-Time Homebuyers

A three-stage approach is used to determine if a household, i, will be a FTHB in period t:

1. Determine whether a household is a potential FTHB, $p_{i,t} = 1$. Denote the complete set of potential FTHBs as $\mathcal{I}^P_t$.

2. Determine whether a potential FTHB qualifies for a mortgage, $q_{i,t} = 1$. Denote the complete set of qualified FTHBs as $\mathcal{I}^Q_t$.

3. Determine the down payment a household will make, and whether a qualified FTHB actually purchases a house, $b_{i,t} = 1$. Denote the final set of buying FTHBs as $\mathcal{I}^B_t$.

We now present each step in the process.

6.1.1 Potential FTHB

For a household to be a potential FTHB, three conditions must be met: (i) a household must not currently own housing assets, $x^{HA}_{i,t} = 0$, (ii) a household must be under 50 years old, and (iii) a household must be employed. If these three conditions are met, then $p_{i,t} = 1$.

6.1.2 Qualified FTHB

We next turn to which households qualify for a mortgage. The home ownership process is driven by a mortgage debt-service shock, which is a function of household income. At time t = 0, all households that do not yet own a house draw a one-time idiosyncratic shock for their gross mortgage debt-service ratio (GDS), ω_i^{GDS}, which is a function of household income:

$$\omega_i^{GDS} \sim N\left(\mu\left(x_{i,0}^Y\right), \sigma\right). \tag{2}$$

Note that we allow for dispersion at the individual household level. We calibrate the shock process for ω_i^{GDS} using the mortgage origination data.[20] This formulation assumes that a household has a deep underlying preference for the amount that it is willing to spend per month on its owner-occupied housing, akin to assuming that household i would like to allocate a constant fraction of its gross income to meet mortgage payments.

Given a household's GDS preference shock, the mortgage chosen by household i is given by

$$x_{i,t}^{MORT} = \omega_i^{GDS}\left[\frac{x_{i,t}^Y}{12}\right]\left[\frac{\left((1+r_t^5/2)^{1/6}-1\right)(1+r_t^5/2)^{T*2}}{(1+r_t^5/2)^{T*2}-1}\right], \tag{3}$$

where T is the amortization of the mortgage (measured in years) and r_t^5 is the nominal five-year fixed mortgage rate. Therefore, our assumption on debt servicing essentially determines the household's mortgage choice. For a given GDS shock, lower rates and longer amortization allow a household to take on a larger mortgage.

[20]We calibrate the GDS to the monthly mortgage-payment-to-income ratio. Formally a GDS includes heating costs and property taxes as well as 50% of condo fees in cases where the property is a condo. Our loan-level data do not have a GDS, but instead have the monthly mortgage payment and the TDS, which is the GDS plus other debt payments. We could calibrate the preference shock to the TDS but choose to calibrate the preference shock to the mortgage payment.

Modeling the down payment decision is more challenging. Given total household financial assets, the most valuable house that household i can purchase is

$$x_{i,t}^{HPMAX} = x_{i,t}^{MORT} + x_{i,t}^{FA}, \tag{4}$$

with the associated maximum down payment:

$$x_{i,t}^{DPMAX} = \frac{x_{i,t}^{FA}}{x_{i,t}^{MORT} + x_{i,t}^{FA}}. \tag{5}$$

Given these calculations, household i faces three qualifying constraints:

1. (*TDS: Income Constraint*) Total household debt-servicing must be below the TDS threshold:

$$\omega_i^{GDS} + \frac{x_{i,t}^{CDPAY}}{x_{i,t}^{Y}} \leq \overline{TDS}, \tag{6}$$

   where $x_{i,t}^{CDPAY}$ is payments by households due to consumer debt (i.e., non-mortgage debt), and $\overline{TDS}$ is the regulatory cap on insured mortgage highlighted in Section 3.

2. (*Down Payment Constraint*) The down payment by household i must be above the regulatory minimum:

$$x_{i,t}^{DPMAX} \geq DP^{MIN}. \tag{7}$$

3. (*Affordability*) Through a combination of down payment and servicing a mortgage, a household must be able to afford an entry-level house:

$$x_{i,t}^{HPMAX} \geq HP_{Reg_i,t}^{STARTER}, \tag{8}$$

   where $HP_{Reg_i,t}^{STARTER}$ denotes the price of a starter home at time t in the region in which household i lives. Note that later on, the affordability constraint will also limit the choice of down payment for some households, since some households will need to make a large enough down payment in order to afford a starter house in their region.

If equations (6) to (8) are satisfied, then we say that household i qualifies for a mortgage of size $x_{i,t}^{MORT}$ and $q_{i,t} = 1$. We denote the set of households that qualify for a mortgage as $\mathcal{I}_t^Q$.

6.1.3 Buying FTHBs and Down Payment Decision

Given the set of households that qualify for a mortgage, $\mathcal{I}_t^Q$, we next determine which households purchase a house in period t, as well as the down payment used to purchase the house. This is a complex problem, since there are many factors behind a homebuying decision, such as those related to family planning or employment opportunities. Furthermore, the down payment decision is complicated by the fact that some households may choose to not use all of their financial assets for the down payment. To simplify this decision, we partition the set of possible down payments into four categories:

$$\mathcal{DP} = \{0\%, 5\%, 10\%, 20\%\}.$$

Given our loan-level data, this is a reasonable assumption. Allen et al. (2014b) show that the nonlinearity of mortgage insurance pricing leads to bunching at these levels.

To simplify the homebuying decision, we make the homebuying and down payment decision a function of income and the minimum down payment that a household can afford. Formally, we assume that for each period t, every household i in $\mathcal{I}_t^Q$ receives a shock from the uniform distribution, $\varepsilon_{i,t}^{dp_k} \sim U[0,1]$, for each down payment dp_k in $\mathcal{DP}$ that is below $x_{i,t}^{DPMAX}$. For example, if $x_{i,t}^{DPMAX} = 8\%$, then household i would receive two shocks: $\varepsilon_{i,t}^{0}$ and $\varepsilon_{i,t}^{5}$. A household then purchases a house with down payment dp_k if

$$\varepsilon_{i,t}^{dp_k} \geq Z_t \overline{\theta}\left(dp_k, x_{i,t}^{Y}\right). \tag{9}$$

If equation (9) holds for more than one dp_k, then the household makes the larger down payment. The variable Z_t is an aggregate shock that captures movements in housing demand that are not due to changes in mortgage qualification.

The calibration of $\overline{\theta}$ is the central part of the model where the structure speaks to the data. While the details are discussed in Section 6.2, the idea is that we discretize household income and perform a one-step generalized method of moments (GMM) calibration to match the joint distribution of income and down payments from the mortgage originations data shown in Table 6 and Table 7.

Due to the limited size of the household-level survey data, we limit the homebuying decision to only income and wealth (via the down payment). While this does not capture all of the potential factors influencing housing demand, such as age, eduction, etc., income and wealth do go are quite effective in capturing these factors. For instance, we have found in our calibration that higher-income and higher-wealth renters are more likely to become owners, which partially captures the effects of age.

Last, macro factors that might influence housing demand from unconstrained households can shift demand via the aggregate factor Z_t. The path of aggregate variables, such as house prices, interest rates and income variables is constructed in Section 6.2 to be consistent with the actual path of these variables.

6.2 Calibration

The calibration uses loan-level transaction data from CMHC to identify those households most likely to become FTHBs in the household-level survey data. Table 4 summarizes the exercise. We start by identifying a set of potential FTHBs (Section 6.1.1). Second, there is a GDS preference shock that determines the amount of housing that would be assigned, which must be at least the minimum regional housing price to qualify (Section 6.1.2). Finally, there is the probability of purchasing a house (Section 6.1.3). The set of potential FTHBs is taken from a household survey, discussed below. This provides information on financial assets as well as detailed information about the characteristics of potential borrowers, including income, which is required to match the loan-level data. The GDS shock is used to find qualifying households among the set of renters identified in the first step, and to determine an amount of housing that would be assigned. These are chosen to match the joint distribution of income and mortgage-payment-to-income ratio of FTHBs in the loan-level data. The GDS draw must give an amount of housing that is greater than the minimum for that region. Finally, the probability that a qualifying individual purchases a house is determined by the joint distribution of that individual's income and down payment (or conversely, the LTV ratio). We discuss each step in more detail.

Table 4: Use of microdata in the calibration strategy

Data set	Uses	GDS shocks and Pr(purchasing)
Loan-level mortgage insurance data (CMHC)	Benchmark to help describe FTHBs	Determine moments for joint distributions
Household survey data	Used in HRAM	Match moments in the mortgage insurance data
	Determines financial assets & income of FTHBs	Joint distributions of GDS and income, and down payment and income

6.2.1 Household survey data and the set of potential FTHBs

In the first step, households are identified as potential FTHBs if they have sufficient wealth and income, and meet the criteria described in Section 6.1.1: that they do not currently own housing assets, are under 50 years old, and are employed.

The set of potential FTHBs is constructed using the household-level data summarized in Table 5 and taken from the *Canadian Financial Monitor* (CFM) survey, conducted quarterly by Ipsos-Reid since 1999. The survey is of approximately 12,000 households per year and includes detailed information on assets and liabilities as well as socio-demographic information. Crucially, the survey includes homeowners and renters. Home ownership is around 68%. The household-level data initialize the households in the model, so that the distribution of home ownership, income, and financial assets matches the distribution observed in the data.[21] Whether a household that is currently renting can qualify for a mortgage will depend upon the household's income (whether the household can afford the monthly payment) and wealth (whether the household can afford the minimum down payment).

We provide summary statistics for two data sets, the first for 2005 and the second an average over 2007–2008. In our policy experiments we use the first data set for the loosening scenarios, with FTHBs calibrated to the CMHC loan-level data from the pre-loosening period of 2005. We then measure the impact of loosening relative

[21] Specifically, we populate the households in the model with households from the survey data. We then replicate households according to their survey sample weights (replicated households will receive different idiosyncratic GDS shocks). Thus, we have a set of potential FTHBs who should be rich enough to match the heterogeneity in the data. Importantly, we are using the data on financial assets and household income from the survey to determine if a household can make a sufficiently large enough down payment and afford an entry-level home in order to qualify for a mortgage. In contrast, the loan-level data do not include household financial assets.

to a counterfactual benchmark case where macroprudential rules are not changed. Similarly, we use the second data set as the data for the tightening scenarios, with FTHBs calibrated to the CMHC loan-level data from the pre-tightening period of 2007–2008, to measure the impact of tightening. The impact of the tightening is also measured relative to a counterfactual benchmark case where macroprudential rules are not changed.

In the household-level survey data, the average potential FTHB had an average income of $65,779 in 2005 and $67,614 between 2007 and 2008. Financial assets are heterogeneous, and determine how binding the wealth constraint is for those buying a house. The average potential FTHB in 2005 had $55,193 in 2005, which is more than the 75th percentile, due to positive skewness. Between 2007 and 2008, potential FTHBs had, on average, financial assets of $29,225, and again, this is more than the 75th percentile.[22]

Table 5: Household variables used in HRAM from CFM household survey data

This table provides summary statistics on the main variables in HRAM. The variables are for those households that qualify to purchase a house, not all potential households. $x^{Y}_{i,t}$ is gross household income; ω^{age}_{i} is the head-of-household age; $x^{FA}_{i,t}$ is total financial assets; and $x^{CDPAY}_{i,t}$ is the consumer debt-to-income ratio. Outside of the survey data, we calibrate the mean interest rate to the five-year average discounted fixed-rate mortgage (R^5) and provincial house prices to the average resale price based on Canadian Real Estate Association data (HP).

Variables	2005				2007-2008			
	mean	sd	p25	p75	mean	sd	p25	p75
$x^{Y}_{i,t}$ \$)	65,779	31,555	40,000	82,500	67,614	29,545	47,500	85,000
ω^{age}_{i}	37.2	7.9	28	42	35	7.9	28	42
$x^{FA}_{i,t}$ (\$)	55,193	95,746	14,150	48,250	29,224	58,254	1,500	27,550
$x^{CDPAY}_{i,t}$ (%)	0.97	8.91	0	6.34	4.32	6.5	0	8.54
HP (\$)	172,633	79,865	113,634	214,317	203,421	85,062	141,532	247,175
R^5 (%)	4.93	0.45	4.63	5.31	5.50	0.30	5.39	5.63

[22]The average assets are substantially lower in the second period because during this period, the down payment required to purchase a house went from 5% to 0%. While the financial crisis may have reduced household financial assets, this only became more pronounced in 2008Q4, and would not explain the drop in the 2007–2008 period relative to 2005. The fact that the mean of financial assets is more than the 75th percentile highlights the positive skewness in financial assets and that there are some affluent households who could easily afford a house but instead choose to rent.

6.2.2 Matching loan-level and household-level data

The second step is to use the joint distribution of mortgage payments (GDS) and income in the loan-level data to find matching potential homeowners in the household-level survey data. Table 6 and Table 7 show the breakdown of parameters that are determined from the CMHC loan-level data, to be used in the calibration for their respective exercises. As with the household-level data, there are two periods: the pre-loosening period of 2005 (Table 6), and the pre-tightening period of 2007–2008 (Table 7). We determine the relative frequency distribution of FTHBs for 11 income classes,[23] as well as for each income class, average mortgage-payment-to-income ratios, and the distribution of these FTHBs across key down payment categories.[24] Each of these income classes in the set of potential FTHBs in the survey data, therefore, receives an average GDS (mortgage-payment-to-income) ratio corresponding to what is presented in the table. The average mortgage-payment-to-income ratio with respect to income is somewhat hump-shaped; however, borrowers in the highest income category have lower ratios than the low-income borrowers, on average. In addition to matching the within-income-category average mortgage-payment-to-income ratio, we also match the between-dispersion in mortgage-payment-to-income ratios for each of our two periods. That is, the σ in equation (2). For 2005 we calibrate σ to 5.3 and for 2007–2008, we calibrate σ to 5.5.

The third and final step is to use the joint distribution of income and down payment for FTHBs in the loan-level data to determine the probability of a potential match in the household-level survey data of buying a house. Table 6 and Table 7 provide this information as well. We calibrate the LTV choices to three options in the pre-period and to four options in the loosening period. The fourth option is a 100% LTV choice available only during this period. The majority of borrowers have a 95% LTV. On average, 13.4% of borrowers in the population have 0% down. This is because 16.8% of borrowers in the insured space have 100% LTV mortgages and here we are adding FTHBs in the uninsured space to the calibration. We know very

[23] These income classes correspond closely to the survey buckets that are used for the CFM survey, but take advantage of data on individual earners in two-income households, where possible.

[24] The empirical distribution of down payment ratios is highly clustered around key ratios that define the laddered increases in mortgage insurance premium rates.

Table 6: Loan-level data calibration: 2005

Calibration variables for HRAM. Potential FTHBs are drawn from CFM based on whether their income, mortgage-payment-to-income ratio (mp/inc), and LTV ratio characteristics match those in the loan-level data. Income is gross nominal household income. The distribution of LTV by income is based on the loan-level data. The fraction of FTHBs with an LTV of less than 80, i.e., outside of the insurance space, is based on CFM. The cross-sectional dispersion in mp/inc (σ in equation (2)) is 5.3.

Income category	Frequency	mp/inc		LTV	
($)	(%)	mean	95%	90%	80%
0-24,999	0.8	17.8	58	26	16
25,000-34,999	4.5	17.9	53	29	19
35,000-44,999	9.8	18.2	50	31	19
45,000-54,999	14.5	18.0	49	32	19
55,000-59,999	8.0	17.8	48	32	19
60,000-69,999	14.9	17.6	46	34	19
70,000-84,999	18.9	17.2	49	35	17
85,000-99,999	12.2	16.4	43	34	22
100,000-119,999	8.7	15.2	40	37	23
120,000-149,999	4.8	14.0	36	38	25
150,000+	2.9	10.9	33	36	31

little about these borrowers, except that on average during the sample period they represent about 20% of FTHBs.

Potential FTHBs can usually qualify in more than one LTV category. Because there is a strong tendency for a household's LTV qualifying range to be constrained mainly at the lower end (i.e., a household can qualify at all LTV levels from 100% down to a certain level, but not below), the assignment of FTHBs to LTV categories proceeds iteratively, from low to high levels of LTV. The result of this iterative procedure is a pool of potential FTHBs in the household-level survey data that is representative of the FTHBs found in the CMHC loan-level data.

Note that while matching the joint distribution of income and down payment, we also match the unconditional income distribution. That is, we ensure that the fraction of FTHBs in each of the 11 income categories matches what we observe in the mortgage origination data. The frequencies are given in column (2) of Table 6 for the 2005 calibration and column (2) of Table 7 for the 2007–2008 calibration.

Table 7: Loan-level data calibration: 2007 to 2008

Calibration variables for HRAM. Potential FTHBs are drawn from CFM based on whether their income, mortgage-payment-to-income ratio (mp/inc), and LTV ratio characteristics match those in the loan-level data. Income is gross nominal household income. The distribution of LTV by income is based on the loan-level data. The fraction of FTHBs with an LTV of less than 80, i.e., outside of the insurance space, is based on CFM. The cross-sectional dispersion in mp/inc (σ in equation (2)) is 5.5.

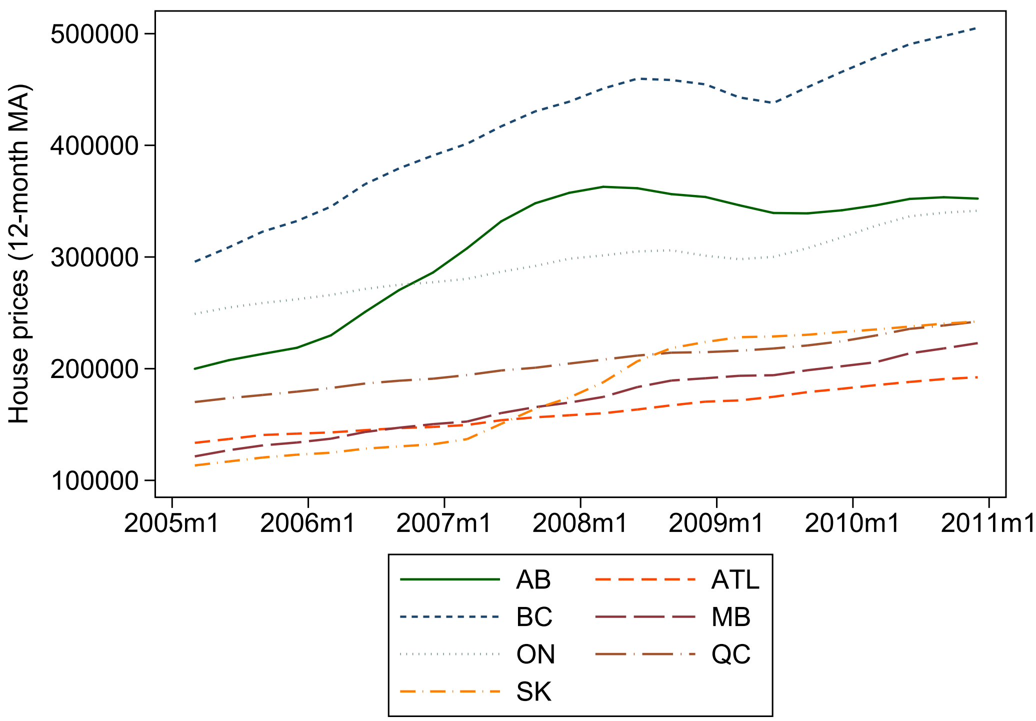
Income category	Frequency	mp/inc	LTV			
($)	(%)	mean	100%	95%	90%	80%
0-24,999	0.5	18.1	9.9	49	25.1	16
25,000-34,999	2.8	18.2	12	45.7	23.4	19
35,000-44,999	7.3	18.9	14.5	41.4	25.1	19
45,000-54,999	11.7	18.9	14.5	39.3	27.2	19
55,000-59,999	6.8	18.7	14.7	39.8	26.4	19
60,000-69,999	14.5	18.6	14.9	39.1	27	19
70,000-84,999	19.0	18.1	14.4	40.2	28.4	17
85,000-99,999	14.2	17.6	13	37.6	27.5	22
100,000-119,999	11.3	16.6	12.2	36.7	28.0	23
120,000-149,999	7.2	15.3	10.7	34.9	29.4	25
150,000+	4.7	12.7	8.3	30.6	30	31

6.3 Housing Market

So far we have discussed the demand for mortgage credit, with little discussion of the housing or rental markets. This is because once renters have sufficient income and wealth to purchase a starter home in their neighborhood, they will do so, subject to an idiosyncratic shock. The decision to rent is implicitly the complement of the decision to enter the housing market (abstracting from the household formation decision). Renters who qualify to enter the market but do not receive the idiosyncratic shock continue to rent. In this respect, an explicit modeling of the rental decision is not essential for addressing the issues at hand. The price of housing, however, which is determined exogenously from the model, plays an integral role, since it is an input in deciding which households can enter the market.

We calibrate the minimum house price for market entry using provincial house price data. Specifically, we use the average resale price based on the Canadian Real Estate Association (CREA) housing price data. Between the two periods, house prices increase from just under $173,000 to just over $203,000. From Figure 4, which presents the 12-month moving average of house prices in six provinces plus the average across the Atlantic provinces, however, we see that there is substantial variation across provinces, which motivates our calibration. The average house price in British Columbia is more than twice that of several provinces. Also outside of the household data are interest rates. Over the sample period, the average typical interest rate on a five-year fixed-rate mortgage increased from 4.93% to 5.50%.

Figure 4: Canadian house prices



6.4 Results

We perform two sets of experiments. For the first set, we calibrate HRAM to a base case using data from 2005. This captures the period prior to the sequence of macroprudential loosenings highlighted in Section 3. We then quantify the impacts of the loosening of the rules for insured mortgages on FTHBs. In the second set of experiments we calibrate HRAM to data from the loose period (2007–2008). This second set of experiments allows us to quantify the implications of macroprudential tightening on the set of FTHBs who were able to take advantage of the most generous mortgage terms in our sample. For the experiments, we assume that, for potential FTHBs in a given down payment and income category, the GDS shock that each household receives and the probability of buying a house are both unchanged from the relevant baseline scenario (no rule change) to the rule-change scenario. However, because the pool of potential FTHBs itself changes in size as the rule change alters the extent of household qualification, across all down payment and income categories, the number of FTHBs will change.

Thus, the impacts can occur on both the extensive and intensive margins. The extensive margin encompasses households that are newly included or excluded from the set of FTHBs as a result of a change in macroprudential rules; the intensive margin can be affected because with the GDS shock held constant, the mortgage size increases as the amortization period increases, and vice versa. In either case, the results can be interpreted as responses to how income and wealth constraints have changed with the new rule(s).

We first experiment with the impact of loosening on mortgage demand. For this case, we first calibrate the baseline FTHBs to the 2005 loan-level data. For the relaxation of the down payment to 0%, we assume that the probability of buying at 0% is the same for potential FTHBs who qualify at 0% as for those who qualify at a 5% down payment, with the latter probability determined in the baseline calibration. When we do this experiment, we assume that households that qualified under the tighter policy still qualify under the looser policy.[25]

For the loosening experiments, we consider four different amortization changes. The variables in the first three rows in Table 8 were implemented in 2006, whereas the fourth row combines these into a hypothetical one-time policy move. We report three outcomes of the model: (i) the change in the percentage of qualified households, (ii) the change in the percentage of FTHBs, and (iii) the change in FTHB mortgage debt.

[25]Note that otherwise, due to our assumption that households have a fixed GDS (meaning that a loosening of the amortization implies that a household purchases a larger house), it arises that some households would not be able to afford the down payment for the larger house. Since this is not an intended effect in the exercise, we essentially relax the fixed-GDS assumption for some baseline FTHBs, where necessary. Note that this gives an extensive margin effect that is the same as it would be if the preference shock specified a fixed mortgage amount instead.

The difference between the changes in the number of households that qualify and the households that purchase is a function of our calibration. If there was no calibration to the loan-level data, a greater number of households in lower income categories would be assigned as FTHBs in the model. These potential FTHBs, however, would in reality have less tendency to purchase a house, which may reflect preferences that the calibration helps to reflect. Recall the probability of buying a house is given by condition (9). The first result is that a relaxation in the amortization from 25 to 30 years leads to a 4.5% increase in FTHBs and an 11.3% increase in mortgage demand. The second relaxation was amortization from 30 to 35 years, conditional on the first change in amortization having already happened. The increase in demand is smaller in this case, with an increase in entry of 2.7% and an increase in demand of 7.5%. The smaller impact is because of the smaller percentage increase in amortization and because of the nonlinear effects of amortization on mortgage payments. The third row shows that further loosening had an even smaller effect—a 2% increase in entry and an increase in demand of 5.4%. The fourth row measures the impact of changing the amortization from 25 to 40 years in one step rather than sequentially. The impacts on entry and demand are nearly identical to the sequential changes.

The fifth row in Table 8 considers the impact of keeping the amortization fixed at 40 years and changing the LTV from 95 to 100. This change was made in November 2006 by the government, and as we saw in Section 5, there was a 17% uptake in zero-down-payment mortgages. We observe a 129.7% increase in FTHBs and a 137.4% increase in mortgage demand. Clearly this is an overestimation of what we observe in the data. When we examine the impact of tightening from 100 to 95, we see that the impact is not symmetric. When we allow FTHBs to enter with zero savings, the only constraint is the income constraint. Many individuals therefore qualify to enter. Not everyone, however, enters the market. This is likely because there are preferences for renting that the model does not capture. That said, this exercise suggests more entry than what we observed in Section 5. This is because we are not capturing behavioral features, such as aversion to having zero equity or aversion to debt by some households, which these results clearly imply are important given the very large pure-qualification effect.

Table 8: Impacts of loosening policy from the structural model

Experiment		Δ in # of Qualified Households (%)	Δ in # of FTHBs (%)	Δ in FTHB Mortgage Debt (%)
Loosening: Calibrated to 2005 data				
LTV	Amortization			
95	25 to 30 yrs	6.5	4.5	11.3
95	30 to 35 yrs	4.4	2.7	7.5
95	35 to 40 yrs	3.1	2.0	5.4
95	25 to 40 yrs	12.9	9.0	24.7
95 to 100	40 yrs	166.9	129.7	137.4
HP ↑ 2005 to 2006	unchanged	-6.2	-4.1	-2.5
HP ↑ 2005 to 2008	unchanged	-9.7	-6.7	-4.2
Tightening: Calibrated to 2007–2008 data				
LTV	Amortization			
95	40 to 35 yrs	-3.5	-2.1	-5.3
95	35 to 30 yrs	-4.8	-3.6	-7.2
95	30 to 25 yrs	-7.3	-5.1	-10.4
100 to 95	40 yrs	-51.5	-7.9	-8.1

The last two rows in the loosening panel consider the impact of house prices on FTHBs. In the model, prices do not respond endogenously to macroprudential rule changes. This experiment shows that if we allow house prices to increase to match the actual price increase observed between 2005 and 2007–2008, this would offset approximately 75% of the increase in affordability allowed by loosening the amortization from 25 to 40 years.

For the tightening, we calibrate the model to the 2007–2008 loan-level data. This was a period when rules had been substantially loosened, and a tightening from this period would likely have put restrictions on FTHBs who entered with 0% equity and 35- to 40-year amortization. We consider four experiments. The first three are a tightening of the maximum allowable amortization, while the last is a tightening of the maximum allowable LTV from 100 to 95. A tightening of amortization from 40 to 35 years leads to a small reduction in FTHBs and mortgage demand. A tightening from 35 to 30 years leads to a 3.6% reduction in FTHBs entering the market and a

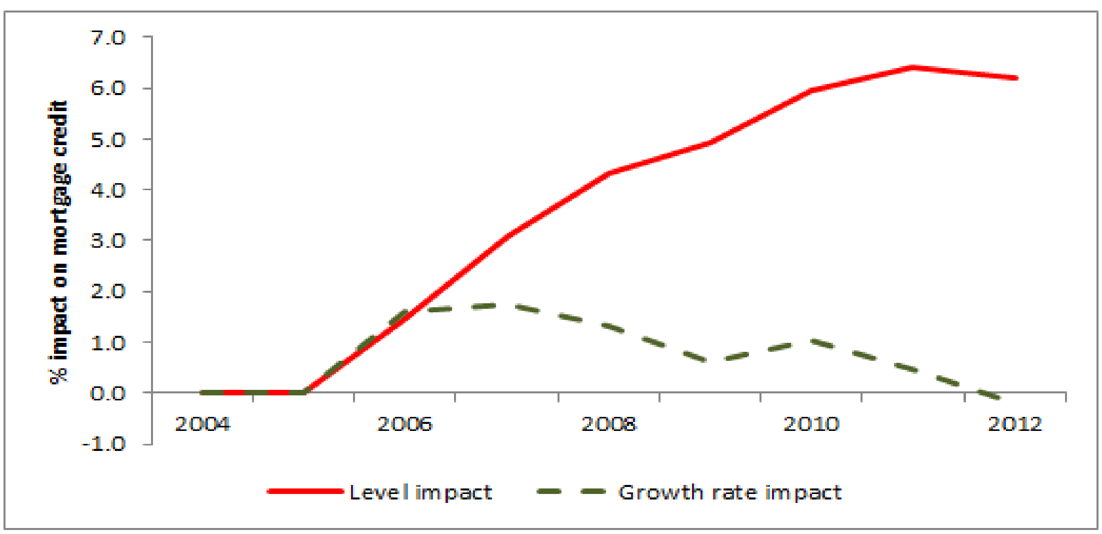
7.2% reduction in the demand for credit. This change in amortization, like a change from 30 to 25 years, has similar impacts on mortgage demand to a change in LTV. The change in LTV from 100 to 95 has a 7.9% decrease in FTHBs and an 8.1% decrease in credit. Notice that the fraction of households that qualify falls more dramatically for a relatively smaller proportional change in the LTV—the impact also appears to be more on the extensive margin, through the change in qualification, rather than the intensive margin of average mortgage sizes. In Section 5 we argued that the wealth constraint was the most binding—this is where that constraint appears. Once the 100% LTV mortgages are removed, households can no longer qualify with zero equity. Given our calibration exercise in Table 7, and equation (9) that maps income and LTV into purchasing probabilities, only 13.4% of the population of baseline FTHBs had zero down (16.8% of the high-LTV FTHBs), and the impact on total credit from the LTV change is 8.1%.

Finally, in addition to measuring the responses of FTHBs to hypothetical changes to income and wealth constraints, one can assess the impact of the combined changes in constraints over time. In Figure 5, we present the full path of credit growth in Canada, starting with the 2006 loosening of amortization and including all the tightening between 2008 and 2010. Here, total credit is the sum of x_i^D, or the sum of mortgage credit and other household credit. The impact on total credit growth is immediate upon loosening and tightening. Loosening leads to an increase in total credit while tightening leads to a contraction.

A key assumption in the calculation of cumulative effects pertains to the persistence of the individual rule-change effects. Figure 5 reflects the assumption that extensive margin effects are transitory one-off effects, which should, on balance, have a net effect of roughly zero on mortgage credit growth over the long term. This is because the loosening of rules should largely create a pull-forward effect, as households that had an underlying intention/preference to enter the housing market, independent of prevailing macroprudential rules, are able to enter sooner in the loosened periods. The tightening period beginning in 2008 eventually returned both the maximum amortization and LTV levels to their original pre-2006 states, at 25 years and 100%. With the exception of some households that might never have been able to enter the housing market, had it not been for the loosened period, most of the extensive margin effects would amount to a shifting of FTHB entry from later periods into earlier periods. In other words, most of these FTHBs who entered would have eventually increased their financial assets or income sufficiently to enter the market, even without the looser period.

The intensive margin effects, in contrast, are more likely to have persisted for the entire period that they were in place.[26] That is, throughout the period that a 40-year amortization was allowed, some FTHBs would continue to take out 40-year amortizations. Rather than being a shift in demand from one period to another, the distribution of mortgage characteristics should experience a sustained shift, as long as the new rules are held in place. The combination of these transitory and sustained effects gives the cumulative impact in Figure 5, levelling out at a 6% increase in the level of mortgage credit by 2012. Although this level increase will diminish over time, as the stock of longer-amortization mortgages are paid off, one could argue that the household debt-to-income level is higher than it otherwise would have been without this period of looser rules. So while the impacts of macroprudential rule changes have been difficult to determine in many settings, our simulations suggest that these changes may have been important and lasting.

Figure 5: Impact of macroprudential loosening and tightening on credit growth



[26]The intensive margin effect is approximately the difference between the total percentage effect on FTHB mortgage credit and the percentage effect on the number of FTHBs.

6.5 Discussion

The results of the experiments suggest that wealth constraints are more effective than income constraints at affecting mortgage demand, particularly on the extensive margin, for a given proportional change and the given starting points of policy parameters (95% maximum LTV and maximum 25-year amortization for insured mortgages). Income constraints, however, are just as effective as wealth constraints for high-wealth homebuyers. The focus of the empirical analysis and the model, however, is on mortgage demand, and ignores some aspects of the general market for housing as well as potential supply effects. In this section we discuss how market participants other than buyers might react to macroprudential policy, affecting the interpretation of our results.

We are currently abstracting from the response of lenders in the model. As a response to tighter macroprudential regulation, for example, there are two potential responses that could lead to lower rates. First, tightening can reduce the borrowers' risk, which could lead lenders to reduce rates. Given that financial institutions do not face default risk in this market, this seems unlikely. Second, since tightening can lead some potential buyers to be disqualified from accessing mortgage insurance, financial institutions might respond by easing rates (moral hazard), subject to the mortgage still being profitable. This could be a response to a tightening of amortization, since amortization and rates are alternatives that could be adjusted in order for a household to meet the income constraint. Interest rates and LTV, however, are not substitutes, therefore we would not expect financial institutions to lower rates in response to a tightening of the LTV. In both instances, the macroprudential policy will be less effective. In the context of our results, the impact of tightening the income constraint will be smaller than what we estimate.

Another feature not captured in HRAM is the market response in terms of prices. An increase in demand would induce price increases, as sellers could increase asking prices, and home-builders would not be able to fully respond in the short term due to the lags involved in residential investment—reflecting the general interaction of a shift in demand, holding the short-term supply curve constant. While this could partially offset any improvement in affordability from a loosening, it might have less effect on the intensive margin of the amount of mortgage debt required by FTHBs—

they would still require more debt, regardless of exactly how much more housing they could purchase. Indeed, if supply were perfectly inelastic, any change in rules would have no effect on qualification, and would only change the equilibrium prices and mortgage debt implied by these prices. Thus, this issue amounts to understanding the elasticity of supply over a desired horizon.

The model abstracts from other factors as well, including the possible effects from rule changes on expected housing returns. A loosening could prompt a pull-forward of demand not only because of easier conditions for qualification, but also in anticipation that demand, and thus house prices, will be stronger going forward. Conversely, a tightening could at least temporarily influence sellers to accept lower-than-otherwise prices in the belief that demand would weaken. While this could contribute to the impacts from the rule changes, it would likely amount to one-off effects that would roughly net-out to zero over time; any pull-forward would not indefinitely continue to accumulate, and would certainly not continue once the amortization and LTV rules had returned to their original pre-2006 states. Nevertheless, to the extent that such factors could obscure the estimation of the effects of interest, i.e., on wealth and income constraints, and on mortgage debt levels, they would still be important.

Although an endogenous explanation for house prices is beyond the scope of the model, the model irrespectively provides insight into the possible impacts of macroprudential rules. The potential benefits of a loosening on affordability could be at least partially lost through market overheating; however, this would be conditional on the elasticity of supply over a given time horizon, thus rule changes interact with the ability of housing supply to respond to increased demand. Rapid loosening could be more likely to induce house price increases if the expansion in demand outpaces supply, so as to not achieve the intended benefits for affordability, at least in the short term. Over a longer time horizon, of course, the elasticity of supply should increase.

In the opposite case of a rule-tightening, though, any endogenous effect on house prices would serve to mitigate the negative affordability impact. This should diminish the concern about negative side effects from measures implemented to counteract mushrooming household debt. In either case, the relative elasticities of short-term versus long-term supply are worthy of consideration.

7 Conclusion

This paper analyzes the impact of key macroprudential housing finance rule changes in Canada on household borrowing behavior and mortgage credit. From changes in consumer demand, we find that LTV constraints, which work through the wealth channel, are effective housing finance tools. Given that the average household is able to meet changes in cash flow, we conclude that, at least with the types of changes we observe to amortization, that changes directed at household repayment constraint are less effective. Households are attracted to these products, however, they are not binding.

An important contribution of this paper is the use of microsimulation modeling to capture the interactions of multiple policy tools and the non-linearities in consumer responses. This model imposes some structure on how we interpret the data while still being highly flexible in capturing nonlinear responses that more traditional, rational forward-looking dynamic stochastic general equilibrium models generally have difficulty capturing. The model allows us to map the impact of a policy change on the percentage of FTHBs who enter the market and their demand for credit. The results of our microsimulation model suggest that the wealth constraint has the largest impact on the number of FTHBs who enter the housing market and amount of debt that they hold. However, the impact of changes in amortization, which affect the income constraint, do affect high-wealth households.

A caveat of our results is that we have taken as given that lenders are able to change the supply of credit exogenously in response to changes in macroprudential policy. This appears reasonable, given that banks do not face default risk in the Canadian (insured) mortgage market. However, if there is a tightening, banks might react strategically to price mortgages in a way that partially offsets changes in macroprudential policies. More importantly, we do not capture general equilibrium effects. A relaxation of mortgage insurance guidelines leads to entry of FTHBs, which can lead to house price appreciation, which leads to further entry and greater house price appreciation. This can affect both current and future mortgage demand in a way that is not captured in the model.

References

Allen, J., R. Clark, and J. F. Houde (2014a). The effect of mergers in search markets: Evidence from the Canadian mortgage industry. *American Economic Review 104*, 3365–3396.

Allen, J., R. Clark, and J. F. Houde (2014b). Price dispersion in mortgage markets. *Journal of Industrial Economics 62*, 377–416.

Allen, J., R. Clark, and J.-F. Houde (2015). Macroprudential housing policies and borrowing constraints. Mimeo.

Anenberg, E. and P. Bayer (2013). Endogenous sources of volatility in housing markets: The joint buyer-seller problem. NBER working paper No. 18980.

Angelini, P., S. Neri, and F. Panetta (2012). Monetary and macroprudential policies. Mimeo.

Brueckner, J. (1994). The demand for mortgage debt: Some basic results. *Journal of Housing Economics 3*, 251–262.

Cerutti, E., S. Claessens, and L. Laeven (2016). The use and effectiveness of macroprudential policies: New evidence. Forthcoming *Journal of Financial Stability*.

Crawford, A. (2015). Building stable mortgage markets: Lessons from Canada's experience. *Journal of Money, Credit and Banking 47*, 81–86.

Davis, M. and J. Heathcote (2005). Housing and the business cycle. *International Economic Review 46*, 751–784.

Faruqui, U., X. Liu, and T. Roberts (2012). An improved framework for assessing the risk arising from elevated household debt. Bank of Canada *Financial System Review* (June).

Fuenzalida, M. and J. Ruiz-Tagle (2011, 06). Household Financial Vulnerability. In *Financial Stability, Monetary Policy, and Central Banking*, Volume 15 of *Central Banking, Analysis, and Economic Policies Book Series*, Chapter 10, pp. 299–326. Central Bank of Chile.

Galati, G. and R. Moessner (2012). Macroprudential policy — A literature review. *Journal of Economic Surveys 27*, 846–878.

Godoy de Araujo, D., J. B. Barroso, and R. Gonzalez (2015). Loan-to-value and housing loans: Effects on constrained borrowers. Mimeo.

Gorman, W. (1964). Professor Friedman's consumption function and the theory of choice. *Econometrica 32*, 189–197.

Gupta, A. and V. Kapur (2000). Microsimulation in government policy and forecasting. North-Holland: Amsterdam.

Han, L., C. Lutz, and B. Sand (2016). The effects of macroprudential mortgage insurance regulation during a housing boom: Evidence from Canada. Mimeo.

Harding, A. (1996). Microsimulation and public policy. North-Holland: Amsterdam.

Herrala, R. and K. Kauko (2007). Household loan loss risk in Finland — estimations and simulations with micro data. Bank of Finland Research Discussion Paper No. 5/2007.

Igan, D. and H. Kang (2011). Do loan-to-value and debt-to-income limits work: Evidence from Korea. IMF Working Paper No. 11/297.

IMF (2013). Key aspects of macroprudential policy-background paper. International Monetary Fund, June.

Johansson, M. and M. Persson (2006). Swedish households' indebtedness and ability to pay — a household level study. Sveriges Riksbank.

Kuttner, K. and I. Shim (2013). Can non-interest rate policies stabilize housing markets? Evidence from a panel of 57 countries. NBER Working Paper No. 19723.

Lambertini, L., C. Mendicino, and M. Punzi (2013). Leaning against boombust cycles in credit and housing prices. *Journal of Economic Dynamics and Control 37*, 1500–1522.

Mendes, R. and S. Murchinson (2014). Should forward guidance be backward-looking? *Bank of Canada Review* (Autumn).

Mordel, A. and N. Stephens (2015). Residential mortgage securitization in Canada: A Review. Bank of Canada *Financial System Review* (December).

Schembri, L. (2014). Housing finance in Canada: Looking back to move forward. *National Institute Economic Review 230*, R45–R57.

Appendix

Table 9: Macroprudential housing finance tool announcements and implementation

This table highlights the most important macroprudential changes since 1992. Some changes were imposed by the federal government. Others (loosening) were requested by the insurers and not denied by the government. * restricted to FTHBs. ‡ LTV of 95 remained for house prices above regional price caps. † for variable rate mortgages. ^{a} TDS calculation based on modal five-year fixed posted rate of the Big 6 banks. ** restricted to house prices over $1 million. *** restricted to new insured mortgages for the portion of the house price between $500,000 and $1,000,000.

			Action				
Year	Announce	Implement	max ltv	max amortize	max ltv (refi)	max ltv(invest)	max tds
1992	Jan	Jan	90 to 95*				
1998	31 Mar	11 May	90 to 95‡				
2003	19 Sep	22 Sep					
2005	27 Jul	12 Aug	90 to 95†				
2006	25 Feb	25 Feb		25 to 30			
2006	28 Jun	28 Jun		30 to 35			
2006	19 Nov	19 Nov	95 to 100	35 to 40			
2007	21 Sep	21 Sep			90 to 95		
2008	9 July	15 Oct	100 to 95	40 to 35			45
2010	16 Feb	19 Apr			95 to 90	95 to 80	45^{a}
2011	17 Jan	18 Mar		35 to 30	90 to 85		
2012	21 Jun	9 Jul	95 to 80**	30 to 25	85 to 80	44	
2015-2016	11 Dec ‘15	16 Feb ‘16	95 to 90***				