The Impact of Macroprudential Housing Finance Tools in Canada: 2005-2010*

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Abstract

This paper combines loan-level data and household level survey data to analyze the impact of recent macroprudential policy changes in Canada on mortgage contract characteristics and mortgage demand for first-time home-buyers. We find that the LTV constraint has a significant impact on mortgage demand, while tools directed at the repayment constraint, such as amortization, are less effective at impacting demand. This is because they are on average not binding. Changes to amortization, however, do impact high wealth, low income individuals.

Keywords: macroprudential policy, household finance, microsimulation models
Bank classification: Financial system regulation and policies

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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 (including Canada) responded to imbalances in their domestic housing markets, in part by tightening household borrowing constraints.[1] 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 home buyer (FTHB) mortgage choices in Canada over a period of loosening and tightening macroprudential regulation. To summarize the aggregate impacts of macroprudential policy on borrower behavior and the dynamic responses of total credit we implement a microsimulation model of mortgage demand.

Macroprudential policy can directly impact household borrowing through wealth and income constraints. The macroprudential tools we analyze include changes to amortization and the loan-to-value (LTV) ratio. Changes to amortization impact households' monthly mortgage payments and therefore the income constraint. The longer households are able make fixed mortgage payments, the more they are able to borrow. Between 2006 and 2007 we observe an increase in allowable amortization from 25 to 40 years. This is followed by a tightening of 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 down payment requirement allows individuals to enter the housing market with less 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. This 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 covers the period 2005 to 2010 during which macroprudential tools were both loosened and tightened.[2] Institutional features of the Canadian mortgage environment – the fact that by law mortgage insurance is required on all high-loan-to-value ratio 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,[3] allowing us to assume credit is supplied elastically and that any impact from macroprudential policies are driven by demand and the effect of the policies on households'

[1] Argentina, Brazil, Columbia, Spain, and Peru have greater experience using macroprudential capital tools or liquidity-based tools. Switzerland is the first country to activate the Basel III counter-cyclical capital buffer.

[2] 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.

[3] Furthermore, there are substantial pre-payment penalties, limiting pre-payment risk, and mortgages are short-term (5 years), limiting refinancing until the renewal date.

borrowing constraint.

There are two main results from our analysis of the loan-level data, which is easier to interpret if we assume that households target a fixed mortgage payment. That is, households budget a fixed percentage of their income that goes towards housing in the same way that goes towards consumption, savings, etc. First, we find that 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 slackened the income constraint. Only a fraction of households take advantage of the longer allowable amortizations to lower the monthly payments associated with the larger loans at higher interest rates. This implies that the average household has a preference for a larger mortgage-to-income ratio, and therefore that 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. 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. 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.

Although our descriptive analysis of the observed choices of consumers during the loosening and tightening provides valuable insights, it is difficult to measure to 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 stochastic general equilibrium models generally have difficulty capturing.

The model imposes the following structure: there are a set of heterogeneous renters and home-

owners and every period a renter can qualify to become a home-owner if they have enough income and wealth to afford a house. This depends on their characteristics as well an exogenous process for their income, financial assets, regional house prices, and the macroeconomic environment. When the government changes access to mortgage insurance they affect the probability of renters qualifying to become home-owners 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 that 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 that enter the housing market. However, for FTHBs who have accumulated wealth, changes to the repayment constraint can also be substantial. For example, we find that a tightening of the LTV constraint from 100 to 95 leads to a 7.9% decrease in FTHBs. We observe a similar decrease following a tightening in the amortization from 35 to 25. The difference is responses is in the percentage of potential FTHBs. The impact of tightening the LTV is more than four times larger on even qualifying to purchase a starter home.

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 loan-to-value 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 one million dollar 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. Work at the IMF and BIS has focused more on the impact of macroprudential tools on bank-lending. See for example Cerutti et al. (2015) 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 (2010)). 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

[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) incorporate news shocks into the housing market model of Iacoviello and Neri (2010) and 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 off of a typical Taylor type rule. In terms of welfare, both Lambertini et al. (2013) and Angelini et al. (2012) show that there is no policy mix which simultaneously maximizes the utility of borrowers and savers in an economy. Consequently, the optimal policy depends upon the weights the macroprudential and monetary policy authorities place on different agents in the economy. All rational forward-looking DSGE models, however, have difficulty capturing the important non-linearities inherent in the financial frictions in mortgages.

about hypothetical policy changes (Harding (1996) and Gupta and Kapur (2000)). Compared to 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 - 2010. Section 4 presents the data. Section 5 presented the micro-econometric results based on the household-level data. Section 6 presents the microsimulation model and results on credit growth from macroprudential changes. Section 7 concludes.

2 Institutional Background

The 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 to lend to borrowers previously excluded from the mortgage market, thereby achieving the governments goal of increasing home-ownership. Mortgage insurance is provided by one public entity, CMHC, and two private entities. Since high-ratio mortgages are insured financial institutions do not face default risk.[5] Furthermore, there are steep pre-payment penalties in Canada, limiting lender pre-payment risk.

Conditioning mortgage access on mortgage insurance also allows the government to loosen and tighten access through insurance guidelines/rules."[6] See Schembri (2014) for an overview of the Canadian housing and mortgage system.

There were a number of important changes to mortgage insurance underwriting guidelines in the 1990s that led to a sharp increase in insured mortgage take-up. As a response to the 1991 recession, and to spur investment in housing, the maximum allowable LTV for an insured mortgage was increased in 1992 from 90% to 95% as a pilot program for first-time home-buyers (FTHBs). In May 1998, changes to legislation and regulation allowed for the finalization and extension of the 95% maximum allowable LTV to all home-buyers 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

[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 home-owners to have negative equity and walk away from their homes in this case.

[6] In Canada the government also has authority over mortgage securitization since CMHC is in charge of securitizing insured mortgages. CMHC introduced the NHA MBS program in 1987 and Canada Mortgage Bond (CMB) program in 2001. This paper abstracts from changes to securitization which could affect bank funding. There is also the possibility of private securitization, however, that market is nearly non-exist given the low-cost publicly available guaranteed funding (Mordel and Stephens (2015)).

allowable amortization length, LTV, debt-service-ratio, and re-introduced house price caps for mortgage insurance. We discuss some of these changes in detail 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, CMHC, and two private insurers. In the case of borrower default, lenders are protected by the insurer. In the case of borrower and insurer default, lenders have a government guarantee which 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.[7]

Although it has varied over time, the government has largely based it's mortgage insurance premiums on loan-to-value ratios and made access conditional on a maximum debt-service ratio and more recently a minimum credit score.[8] Mortgages in Canada are typically fixed-rate and the contract term is 5 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 this paper. The main rule changes were to the LTV constraint and the amortization length, the latter 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:

$$\frac{\text{loan}}{\text{house value}} \times 100 \leq \overline{LTV}, \tag{1}$$

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

[7] Since the Spring of 2012 risk management at CMHC is overseen by the Office of the Superintendent of Financial Institutions (OSFI) which is the banking regulator in Canada.

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

tool used by authorities to manage demand for household credit.

The TDS constraint is defined as follows:

$$\Big(\frac{\text{mortgage payment + other housing costs + other debt payments}}{\text{household income}}\Big) \times 100 \leq \overline{TDS}, \qquad (2)$$

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 years to 30 years in what was suppose to be a four month pilot program.[9] Soon after, on March 16, 2006, Genworth (one of two private insurers) increased its maximum amortization from 25 years to 35 years.[10] On June 28, 2006, CMHC allowed amortizations of 35 years.[11] 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 where Genworth increased its maximum amortization from 35 years to 40 years. CMHC also increased its maximum allowable LTV from 95 to 100, doing so on November 19, 2006. CMHC also increased its maximum amortization from 35 years 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 was with respect to amortization lengths for high-ratio mortgages, from 40 to 35 years, LTV ratios, from 100 to 95, and the imposition of a new TDS constraint of 45. The government also established a minimum credit score and loan documentation standards.

3.3 Expected impact of rule changes

The impact of changes to the income and wealth constraint 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:

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

[9]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.

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

[11]CMHC matched Genworth's insurance premiums.

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. Individuals who 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. We use a combination of individual-level data at mortgage origination as well as household-level survey data for balance sheet information.

4.1 Mortgage insurance data

Information on the mortgage contract, borrower and lender at the time of origination is collected by the public insurer (CMHC) for high-ratio mortgages (i.e., LTV greater than 20%). The information collected includes the interest rate, loan amount, house price, debt-service ratio, term, amortization, household income, credit score, and lender name.[12] On average 60% of contracts are new originations and 40% refinancing. We drop all refinancing and focus on the more homogenous set of new orginations in this paper. 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 not FTHBs and not the focus of our analysis. Table 1 presents summary statistics of the key variables for three sub-periods using the population of CMHC-insured FTHB residential purchases. All dollar values are in nominal CAD. The sub-periods 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. This is a period before the rapid loosening of insurance guidelines for fixed rate mortgages. The loosening period corresponds to February 25, 2006 to October 14, 2008. Over this period 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.[13] Over this period the government tightened amortization, LTV, and TDS constraints.[14] These 3 sub-periods

[12]Similar data has been used in Allen et al. (2014a) and Allen et al. (2014b) to study price dispersion in the Canadian mortgage market and the effect of bank mergers on interest rates, respectively.

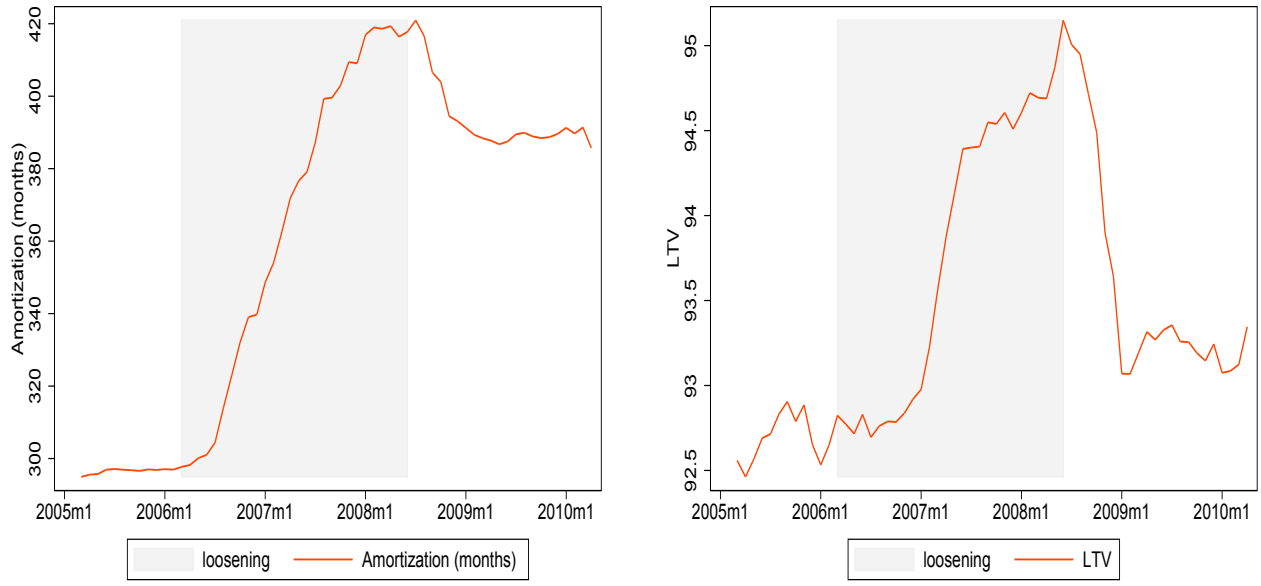
[13]We have data passed 2010. However, on April 19, 2010 the government changed the TDS formula for VRMs and for mortgages of terms longer than 5 years, which substantially impacts loan qualifying in an additional manner we have chosen not to study in this paper.

[14]There are also tightening for investment properties, which we exclude from our analysis given that we do not have data on these transactions per se.

form the basis for measuring the impact of macroprudential changes on mortgage demand.

It is important to note that on average, the time between application and closing is 30 days. For tightening episodes both the application date and closing date are important since, in Canada, lenders typically provide a 90-day rate guarantee.[15] Someone can therefore be pre-approved on January 1 and are guaranteed that contract until April 1. The mortgage tightening therefore applies immediately on the announcement day to borrowers without a 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 pre-announcement.

For loosening, the announcement and implementation date coincide. Individuals could borrow at the new terms once the loosening was announced. Individuals who applied before the announcement but closed after implementation could change the terms of the contract. This is rare, however, given that the loosening of the guidelines affected the budget constraint of individuals and probability of getting a mortgage. Borrowers able to qualify at the tougher conditions do not have an incentive to change the contract to a slacker, more expensive, one.



(a) Average amortization

(b) Average LTV

Figure 1: Amortization length and LTV for first-time home-buyers

From Table 1 we observe a noticeable increase in loan size over time, which is not surprising

[15] Unlike in the U.S., borrowers in Canada do not explicitly pay extra for rate guarantees between application and closing. Of course, all borrowers are most likely implicitly paying for rate guarantees via higher mortgage rates.

given the substantial increases in house prices. Incomes have also increased over time. LTVs appear relatively flat in Table 1, however amortization and TDS are increasing. The average age of a new home-owner is 35. On average we document that approximately two-thirds of FTHBs use a broker. Finally, we also present an indicator, for whether the source of the down-payment was unconventional. That is, 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.[16]

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 because of forward guidance by the central bank, the expectation was that rates were going to be low for some time.[17]

In Figures 1 to 2 we graphically present the main variables of interest over the full sample, 2005-2010 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 as these are the vast majority of contracts. Broadly speaking, there are three periods; the shaded area denotes a period of loosening. The period immediately following is a period of tightening. The first year represents a period with no change in 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 2006-2008 are increasing even as amortization lengths are increasing which loosens the income constraint. This is both because monetary policy is tightening, which is making mortgages more expensive, but also because the wealth constraint is loosening and households are borrowing more.

We also include figures showing the evolution of income (Figure 3) and credit scores (Figure 4). Interestingly, the average income of borrowers is increasing 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 (i.e. 20%+ down-payment) into the insured space in order to buy a house. In addition, we observe an increase in credit scores above the 680 threshold after the implementation of the minimum credit score standards in 2008.

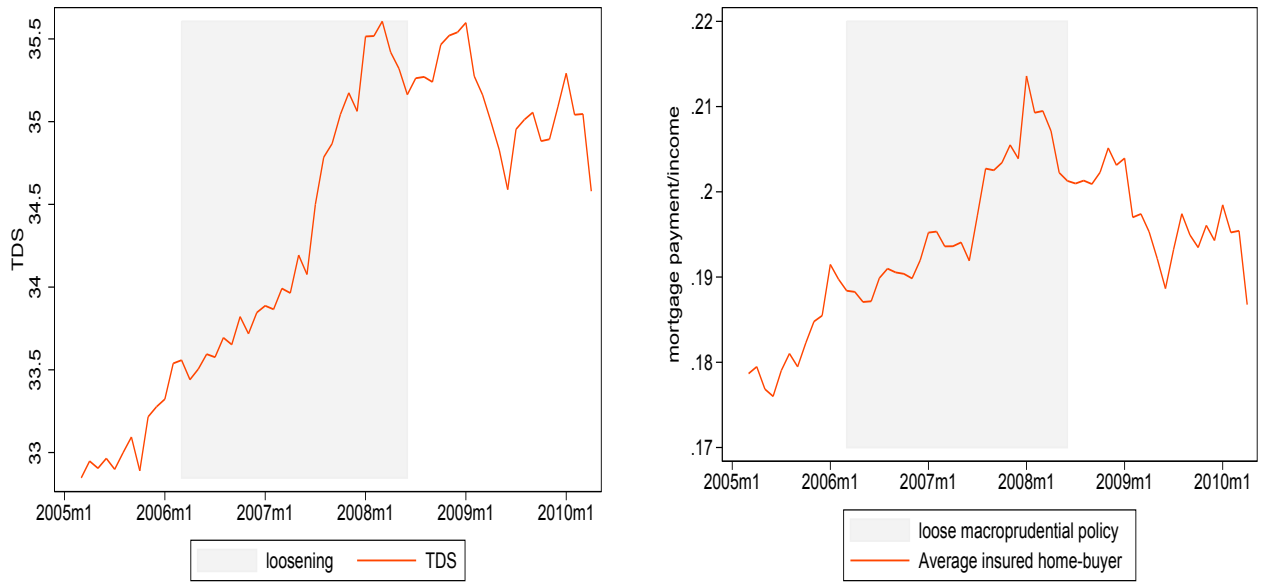
[16]The Canadian government has subsidized first-time-home-buyers by allowing them to withdraw savings from their retirement accounts tax free up to a fixed amount, which during our sample was $20,000 per person, or $40,000 for a couple.

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

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

The variable (rate-bond) represents an estimate of a lenders' profit margin. It's the contract rate minus the cost of funding, 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(broker=1) is an indicator variable equal to 1 if the borrower used a mortgage broker to intermediate the contract and 0 otherwise. 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 borrowers' down-payment was non-traditional, a gift, or sweat equity and 0 otherwise. All dollar figures are nominal.

	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
amortize (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
Borrower age (years)	35.24	10.23	27.00	41.00
I(broker)	0.70	0.46		
I(FICO≥680)	0.77	0.42		
I(downpayment=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
amortize (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
Borrower age (years)	35.04	10.26	27.00	41.00
I(broker)	0.68	0.47		
I(FICO≥680)	0.78	0.41		
I(downpayment=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
amortize (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
Borrower age (years)	35.63	10.56	27.00	42.00
I(broker)	0.68	0.47		
I(FICO≥680)	0.84	0.37		
I(downpayment=unconventional)	0.24	0.43		



(a) Average TDS

(b) Average payment to income

Figure 2: Average TDS and Monthly mortgage payment to income ratio for first-time home-buyers

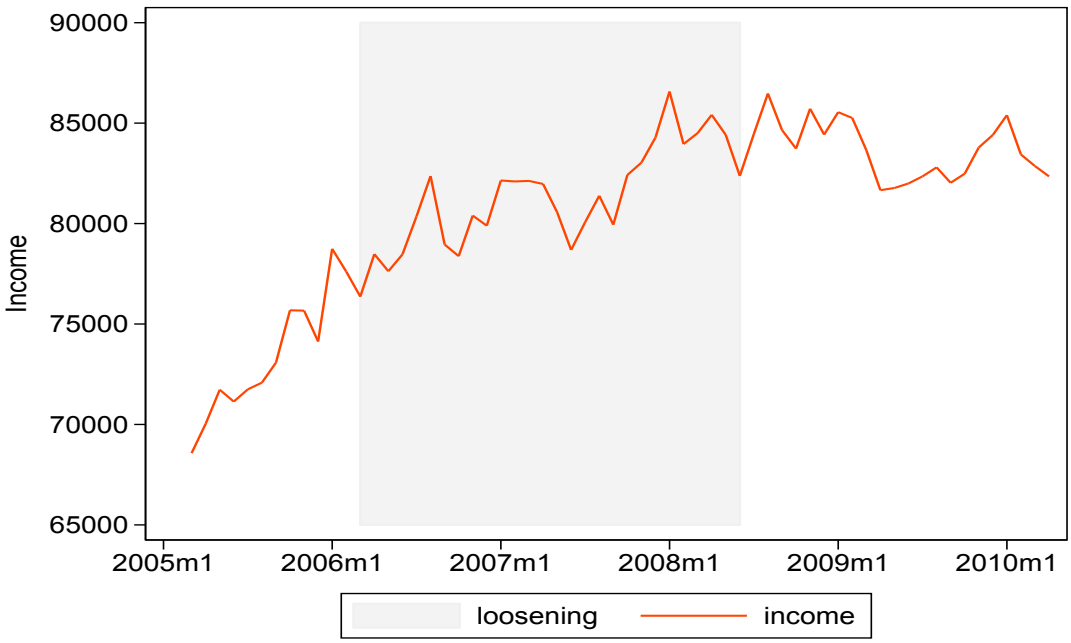


Figure 3: Average Household Income for first-time home-buyers

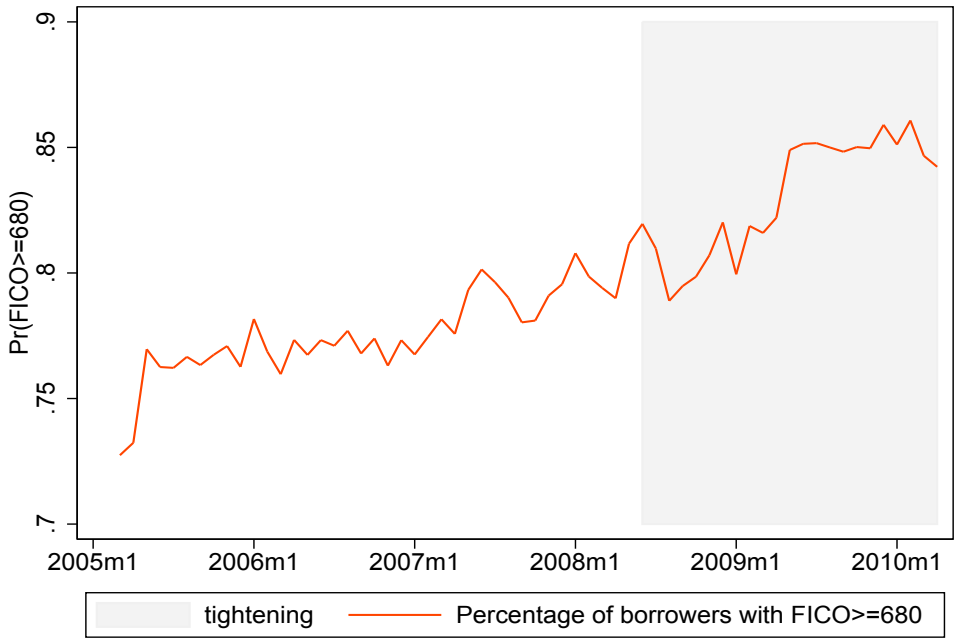


Figure 4: Average Pr(FICO $\geq$ 680) for first-time home-buyers

5 Descriptive analysis

Our empirical analysis focuses on the demand for credit and how the types of contracts household signed, as well as the types of households entering the housing market, were affected by changes in mortgage insurance guidelines. We focus on FTHBs choosing 5 year fixed-rate mortgages. This is over 90% of insured mortgages.

The main specification is equation (3) where Y is the dependent variable (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 one for the period under which mortgage insurance rule j is in place and 0 otherwise. We estimate equation (3) twice. First where D_1 equals one during the loosening period from February 25, 2006 to July 8, 2008 and 0 from February 24, 2005 to February 24, 2006. Second, D_2 equals one 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 as well as location (FSA)[18] fixed effects to control for seasonality and unobservable location effects, respectively. 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

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

as well as property characteristics such as dwelling type and property age. We also include bank fixed effects.

$$Y_{it} = \alpha_0 + \beta X_{it} + \gamma_{j1} D_{jt} + \theta_b + \nu_m + \epsilon_{it}. \tag{3}$$

We present results for both the loosening period (2006-2007) and the tightening period (2008-2010) in Tables 2 to 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. Table 2 summarizes the impact of the loosening relative to the pre-period (February 24, 2005 to February 24, 2006). Table 3 summarizes the impact of the tightening relative to the loosening period. We discuss the broad relationships between changes in macroprudential tools and household borrowing and explore specific mechanisms that are likely at play. 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 the changes in mortgage guidelines. For example, the cumulative impact of loosening is correlated with the average LTV ratio increasing by about 1.2%. At the same time, the fraction of borrowers with 5% equity or less increased by 4.3%. This latter statistic suggests that the fraction of FTHBs that were wealth-constrained increased during the loosening period. This is both a combination a households who took advantage of the zero down payment period (November 19, 2006 to 15 October 2008) and also an increase in households putting 5% down. About 22% of households took advantage of zero-down product while it was offered. The fact that not everyone purchases a house with zero down can be explained by a number of reasons. The first is that some households are constrained by the TDS constraint. Other reasons, however, include preferences for smaller mortgages (see for example Brueckner (1994)).

The second constraint faced by FTHBs is the income constraint. This is more complicated than the wealth constraint. There is the impact of interest rates, income, and regulatory constraints on amortization and the total debt service ratio. In column (3) we see that the cumulative impact of loosening is correlated with a 22.7% increase in the average amortization length. From column (4) we observe that as the maximum allowable amortization was increased from 25 years to 30, 35, and then 40, 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. In section 6 we quantify the impact. Column (5) present the cumulative impact of the loosening on the average TDS, which was an increase of 4.5%. Column (6) presents the impact of the loosening on the average down payment to income ratio. Given that 22% 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 average mortgage payment to income ratio. The average cumulative impact was 10.6%. Why? House prices were rising substantially over the sample period, by 19.4% 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 12% 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. 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 impacted 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 allows 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 increases. For income the picture is more complicated. There are more households at the maximum allowable amortization, suggesting FTHBs are 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 they already hold, which is leading to a high TDS, and because of the LTV constraint households, cannot borrow as much as they would like.

A final comment on impact of tightening relates to average credit scores. In November of 2008 the government established a minimum credit score and loan documentation standards at the same time they tightened the LTV constraint and amortization constraint. The impact on the average credit score was immediate. The likelihood of the borrower having a credit score above 680 increased by 4.8%. As we saw from Figure 4 average scores increased substantially following the tightening. 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

[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 counter-cyclical, in line with the macroprudential tools.

documentation requirements may have also tightened the wealth constraint.

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 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 ($\log(dp/income)$), and the log of the monthly mortgage payment to income ratio ($\log(m.pay/income)$), log-house prices ($\log(HP)$), log-loan size ($\log(loan)$), log-income ($\log(income)$), contract rate (rate), the likelihood of the household credit score is above 680 ($Pr(FICO \geq 680)$), and the likelihood of the down-payment being borrowed ($I(borrowed\ DP)$. Included are bank, FSA and 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	LTV	I(LTV≥95)	AM	I(AM≥max)	log(TDS)	log(dp/inc)	log(mp/inc)
loose	1.153***	0.043***	0.227***	-0.380***	0.045***	-0.392***	0.106***
	(0.028)	(0.003)	(0.002)	(0.005)	(0.001)	(0.009)	(0.003)
Constant	95.503***	0.823***	5.694***	0.872***	3.529***	2.322***	-1.846***
	(0.177)	(0.021)	(0.009)	(0.017)	(0.008)	(0.048)	(0.017)
R^2	0.085	0.075	0.271	0.237	0.058	0.127	0.241

	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	log(house price)	log(loan)	log(income)	rate	Pr(FICO>=680)	I(borrowed. DP)
loose	0.194***	0.243***	0.120***	0.695***	0.007***	0.028***
	(0.007)	(0.007)	(0.004)	(0.004)	(0.003)	(0.003)
Constant	11.787***	11.820***	11.023***	4.865***	1.191***	0.767***
	(0.020)	(0.020)	(0.018)	(0.026)	(0.017)	(0.020)
R^2	0.640	0.629	0.287	0.354	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 *loose* is an indicator equal to 1 for the period February 25, 2006 to November 14, 2008 and 0 otherwise. 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 ($\log(dp/income)$), and the log of the monthly mortgage payment to income ratio ($\log(m.pay/income)$), log-house prices ($\log(HP)$), log-loan size ($\log(loan)$), log-income ($\log(income)$), contract rate (rate), the likelihood of the household credit score is above 680 ($Pr(FICO \geq 680)$), and the likelihood of the down-payment being borrowed ($I(borrowed\ DP)$. Included are bank, FSA and 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	LTV	I(LTV≥95)	AM	I(AM≥max)	log(TDS)	log(dp/inc)	log(mp/inc)
tight	-0.771***	0.007***	0.027***	0.107***	0.002**	0.586***	-0.044***
	(0.023)	(0.003)	(0.001)	(0.003)	(0.001)	(0.007)	(0.002)
Constant	96.850***	0.876***	5.920***	0.474***	3.566***	1.945***	-1.735***
	(0.155)	(0.019)	(0.009)	(0.018)	(0.008)	(0.042)	(0.015)
R^2	0.071	0.070	0.139	0.143	0.049	0.162	0.229

	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	log(house price)	log(loan)	log(income)	rate	Pr(FICO>=680)	I(borrowed. DP)
tight	0.099***	0.117***	-0.005	-1.265***	0.048***	-0.037***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)
Constant	11.963***	12.044***	11.116***	5.521***	1.195***	0.880***
	(0.017)	(0.018)	(0.017)	(0.025)	(0.016)	(0.019)
R^2	0.656	0.643	0.274	0.595	0.058	0.105

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 $x_{i,t}^k$.

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

$$\underbrace{x_{i,t}^{FA} - x_{i,t}^{D} + x_{i,t}^{C}}_{\text{Asset, debt, consumption}} = \underbrace{x_{i,t}^{Y}(1-\tau) + x_{i,t-1}^{FA}\left(1 + R_t^{FA}\right) - x_{i,t-1}^{D}}_{\text{Available Financial Resources}} - \underbrace{x_{i,t}^{DP}}_{\text{Required Debt Payments}}$$

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

6.1 First-Time Home-Buyers

A three-stage approach is used to determine if a household 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 FTHB as $\mathcal{I}_t^P$.

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

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

We now present each step in the process.

6.1.1 Potential FTHB

In order for a household to be a potential FTHB three conditions must be met: (i) a household must not currently own household assets, $x_{i,t}^{HA} = 0$, (ii) a household must be under fifty 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 can 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 who do not yet own a house, $x_{i,0}^{HA} = 0$, draw a one-time idiosyncratic shock for their gross mortgage debt-service ratio (GDS), ω_i^{GDS}, which is a function of household income:

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

Note that we allow for dispersion at the individual household level. We will 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 they are willing to spend per month on their owner-occupied housing, akin to assuming that household i would like to allocate a constant fraction of their gross income to meeting mortgage payments.

Given a households GDS preference shock, the mortgage chosen by household i is given by :

$$x_{i,t}^{MORT} = \omega_i^{GDS}\left[\frac{x_{i,t}^{Y}}{12}\right]\left[\frac{\left(\left(1+R_t^5/2\right)^{1/6}-1\right)\left(1+R_t^5/2\right)^{AMT*2}}{\left(1+R_t^5/2\right)^{AMT*2}-1}\right] \tag{4}$$

where AMT is the amortization of the mortgage (measured in years) and R_t^5 is the 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.

Modelling the down-payment decision is more challenging. Given total household financial

[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 the case the property is a condo. Our loan-level data does not have a GDS, but instead has 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.

assets, the most valuable house that household i can purchase is

$$x_{i,t}^{HPMAX} = x_{i,t}^{MORT} + x_{i,t}^{FA}, \tag{5}$$

with the associated maximum down payment:

$$x_{i,t}^{DPMAX} = \frac{x_{i,t}^{FA}}{x_{i,t}^{MORT} + x_{i,t}^{FA}}. \tag{6}$$

Given these calculations, household i faces three qualifying constraints:

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

$$\omega_i^{GDS} + \frac{x_{i,t}^{CDPAY}}{x_{i,t}^{Y}} \leq \overline{TDS} \tag{7}$$

   where $x_{i,t}^{CDPAY}$ are payments by households due to consumer debt (i.e. non-mortgage debt), and $\overline{TDS}$ is a regulatory cap on a households total-debt-service ratio to qualify for a (insured) mortgage.

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

$$x_{i,t}^{DPMAX} \geq DP^{MIN}. \tag{8}$$

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

$$x_{i,t}^{HPMAX} \geq HP_{Reg_i,t}^{STARTER}, \tag{9}$$

   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 (7) to (9) 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 who qualify for a mortgage as $\mathcal{I}_t^Q$.

6.1.3 Buying FTHB and Down Payment Decision

Given the set of households who qualify for a mortgage, $\mathcal{I}_t^Q$, we next determine which households actually purchase a house in period t, and the final choice of down payment and house value. This is complex problem, since households may choose not to use all of their financial assets for the

down-payment. To do this 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.

We assume that the probability that a qualified household will buy a house with down payment dp_k depends upon a household's maximum possible down payment as well as household income:

$$prob\left(dp_{i,t} = dp_k\right) = p\left(dp_k, x_{i,t}^{Y}, x_{i,t}^{DPMAX}\right) \tag{10}$$

If $dp_k > x_{i,t}^{DPMAX}$, then $p\left(dp_k, x_{i,t}^{Y}, x_{i,t}^{DPMAX}\right) = 0$. For the other probabilities we perform a one-step GMM calibration to match the joint distribution of income and down payments that are provided in Table 6. Given that HRAM is a microsimulation model, to capture decision-making we assume potential FTHBs choose a down payment (LTV) that matches the distribution we observe in the transactions data. Note that not all households who qualify will ultimately buying a house. Denoting the set of households who buy a house with down payment k as $\mathcal{I}_t^{B,dp_k}$. The total number of first-time home-buyers is then given by

$$\mathcal{I}_t^{B} = \bigcup_k \mathcal{I}_t^{B,dp_k}.$$

6.2 Calibration

The calibration combines the loan-level transactions data from CMHC with household level survey data. Table 4 summarizes the exercise. We start with a set of potential FTHBs (section 6.1.1). Second, there is a GDS preference shock which determines whether one qualifies (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 step 1. These are chosen to match the joint distribution of income and mortgage-payment-to-income ratio of FTHBs in the loan-level data. Finally, the probably that a qualifying individual purchases a house is determined by the joint distribution of their income and down-payment (or equivalently the LTV ratio). We discuss each step in more detail.

The set of potential FTHBs is constructed using the household level data summarized in Table 5. The household level data is from the *Canadian Financial Monitor* survey, conducted quarterly by Ipsos-Reid since 1999. The survey is of approximately 12,000 households per year and includes

Table 4: **Use of micro-data in the calibration strategy**

Potential set of FTHB	GDS Shocks	Probabilities of Purchasing
Populated using household survey data	Match moments using mortgage insurance data	Match moments using mortgage insurance data
Determines Financial Assets and Household Income	Joint dbn of GDS and Income for FTHB	Joint dbn of down payment and income for FTHB

detailed information on assets and liabilities as well socio-demographic information.[21] Crucially, the survey includes home-owners and renters. Home-ownership is around 68%. The household level data initializes the households in the model, so that the distribution of home-ownership, income, and financial assets matches the distribution observed in the data.[22] Whether a household who is currently renting can qualify for a mortgage will depend upon a household's income (whether a household can afford the monthly payment) and a household's wealth (whether a household can afford the minimum down payment). We provide two sets of summary statistics, the first for 2005 and the second an average over 2007-2008. In our policy experiments we want to use the first case as the calibration to measure the impact of loosening. We want to use the second case to calibrate households who purchased homes during the loosening period and measure the impact of tightening. Finally, outside of the survey data, we calibrate the mean interest rate to the 5-year average discounted fixed rate mortgage and provincial house prices to the average resale price based on CREA data.

The second step is to use the the joint distribution of mortgage payments (GDS) and income in the loan-level data to find matching potential home-owners in the households survey data. Table 6 decomposes the information as it is used in the calibration exercise(s). As with the household data, there are two periods, the pre-period and loosening period. For 10 income classes we have average mortgage-payment-to-income ratios.[23] For each of these income classes in the set of potential FTHBs in the survey data, therefore, they receive an average GDS (mortgage-payment-to-income) corresponding to what is presented in the table. The mortgage-payment-to-income ratios are somewhat hump shaped, however the highest income borrowers have much lower ratios than the low income borrowers.

The third and final step is to use the joint distribution of income and down payment for FTHBs

[21] This data has been used by Bank of Canada staff in a number of research papers, including Allen et al. (2015) and Chen et al. (2015), and used extensively in the Bank of Canada's publication *Financial System Review* to analyze risks to the Canadian household sector. It has also been used externally to the Bank of Canada, for example, by Foerster et al. (2014) to study the role of financial advice on household portfolio choices.

[22] Specifically, we populate the households in the model with households from the survey data. We then replicate households according to their survey sample weights (note that replicated households will receive different idiosyncratic GDS shocks). Thus, we have a set of potential first-time home buyers that 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 data in order 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.

[23] Specifically we use the survey buckets that are used for the CFM survey.

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

This table provides summary statistics on the main variables in HRAM. Income is gross household income. The variables are for those households who qualify to purchase a house and not all potential households. [a] CD/inc is consumer debt to income ratio. Outside of the survey data, we calibrate the mean interest rate to the 5-year average discounted fixed rate mortgage and provincial house prices to the average resale price based on CREA data.

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

in the loan data to determine the probability of a potential match in the household survey data of buying a house. Table 6 provides 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 only available during this period. The majority of borrowers have a 95 LTV. On average 14% of borrowers in the population have 0% down. This is because 22% of borrowers in the insurance space have 100 LTV mortgages and here we are adding FTHBs in the uninsured space to the calibration. We know very little about these borrowers, except that on average during the sample period they represent about 20% of FTHBs.

The mortgage insurance transactions data is then used to calibrate the the GDS process and the buying probabilities. To do this we split income into ten income categories.[24] For the GDS shock we match the mean GDS for each income category, presented in Table 6. For the buying probability, we choose the probabilities to match the joint distribution of income and down payment, also in Table 6. Finally, we calibrate the mean interest rate to the 5-year average discounted fixed rate mortgage and provincial house prices to the average resale price based on CREA data.

6.3 Results

We perform two experiments. In the first experiment we calibrate HRAM to a base case using data from 2005. This captures the period prior to the sequence of macroprudential loosening highlighted is section 3. We then quantify the impacts of the loosening of the rules for insured mortgages on FTHBs. In the second experiment we calibrate to data from the loose period (2007-2008) and then quantify the impacts of the tightening policy. This second experiment allows us to quantify the implications of macroprudential tightening on the set of FTHBs who took advantage of the most generous mortgage terms in our sample. For the experiments we assume that the GDS shock that each household receives and the probability of buying a house by down payment and income are

[24]Specifically we use the survey buckets that are used for the CFM survey

Table 6: Loan-level data calibration

Calibration variables for HRAM. Potential FTHBs are drawn from CFM based on whether their income, mortgage payment-to-income (mp/inc), and LTV characteristics match those in the loan level data. Income is gross 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. Income is nominal.

	2005				2007-2008				
Income category ($)	mp/inc	LTV			mp/inc	LTV			
	mean	95%	90%	80%	mean	100%	95%	90%	80%
0-24,999	17.8	0.58	0.26	0.16	18.1	0.099	0.49	0.251	0.16
25,000-34,999	17.9	0.53	0.29	0.19	18.2	0.12	0.457	0.234	0.19
35,000-44,999	18.2	0.50	0.31	0.19	18.9	0.145	0.414	0.251	0.19
45,000-54,999	18.0	0.49	0.32	0.19	18.9	0.145	0.393	0.272	0.19
55,000-59,000	17.8	0.48	0.32	0.19	18.7	0.147	0.398	0.264	0.19
60,000-69,999	17.6	0.46	0.34	0.19	18.6	0.149	0.391	0.27	0.19
70,000-84,999	17.2	0.49	0.35	0.17	18.1	0.144	0.402	0.284	0.17
85,000-99,999	16.4	0.43	0.34	0.22	17.6	0.13	0.376	0.275	0.22
100,000-119,000	15.2	0.40	0.37	0.23	16.6	0.122	0.367	0.280	0.23
120,000-149,999	14.0	0.36	0.38	0.25	15.3	0.107	0.349	0.294	0.25
150,000+	10.9	0.33	0.36	0.31	12.7	0.083	0.306	0.30	0.31

both unchanged; thus the impacts are primarily moving through the impact of qualification. That is, the impacts are on the extensive margin and therefore the results can be interpreted as responses to movements in the income and wealth constraints.

We first experiment with the impact of loosening on mortgage demand. For this case we first calibrate the model to the 2005 loan-level and household survey data. For the relaxation of the down payment to zero percent, we assume that the probability of buying at zero percent is the same as the calibrated probabilities for 5% down payment. When we do this experiment, we assume that households that qualified under the tighter policy still qualify under the looser policy.[25]

We first consider three different amortization changes, the first two rows in Table 7 were implemented in 2006 whereas the third row considers an alternative, more drastic one-time policy move in amortization and it's hypothetical impact on FTHBs. 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. The difference between the number of households that qualify and the households that purchase is a function of our calibration. Individuals that qualify are originating from the lowest income categories once the income constraint is relaxed. Some of these potential FTHBs, however, choose not to purchase a house given the required LTV. Recall that the probability of buying a house is given by equation (10). The first result is that a relaxation in the amortization from 25 to 30 years leads to a 4.4% increase in FTHBs and an

[25]Note that due our assumption that households have a fixed GDS, a loosening of the amortization implies households purchase a larger house, and some households may not be able to afford the down payment for the larger house.

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, entry of 2.6% and an increase in demand of 7.5%. The smaller impact is both because of the smaller percentage increase in amortization and because of the nonlinear effects of amortization on mortgage payments. The third row measures the impact of changing the amortization from 25 to 35 years in one step rather than sequentially. The impacts on entry and demand are nearly identical to the sequential changes.

The fourth row in Table 7 considers the impact of relaxing the amortization from 35 to 40 years and 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 22% take-up in zero down payment mortgages. We observe a 135% increase in FTHBs and a 150% increase in mortgage demand. Clearly this is an over-shooting of what we observe in the data. When we examine the impact of tightening from 100 to 95 we will 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, we have more entry that what we observed in section 5. This is likely because we are not capturing behavioral features, such as aversion to having zero equity or aversion to debt by some households.

For the tightening we calibrate the model to the 2007-2008 data. This was a period of substantial loosening, therefore a tightening from this period will necessarily put restrictions on FTHBs who entered with zero percent equity and 35-40 year amortizations. We consider four experiments. The first three are tightening of the maximum allowable amortization. The last experiment 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 ten-year tightening, from 35 years to 25 years leads to a 7.8% reduction in FTHBs entering the markets and a 16.7% reduction in the demand for credit. This change in amortization, like a change from 40 years to 25 years which is even more substantial, both have larger impacts on mortgage demand than 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 who qualify falls much more dramatically. 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 6 only 14% of the population of FTHBs have zero down (22% of the high-LTV FTHBs) and equation 10 which maps income and LTV into purchasing probabilities, the impact on total credit is 8.1%.

Finally, in addition to measuring the responses of FTHBs to hypothetical changes to income and wealth constraints, HRAM can be used to assess the impact of the combination of 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.

Table 7: Impacts of loosening policy from the structural model

Experiment	Change in # of Qualified Households (%)	Change in in # of FTHBs(%)	Change in FTHB Mortgage Debt (%)
Loosening: Calibrated to 2005 data			
Amortization increase 25 to 30	6.5	4.4	11.3
Amortization increase 30 to 35	4.2	2.6	7.5
Amortization increase 25 to 35	10.2	6.9	19.0
Amortization increase 35 to 40 and LTV increase 95 to 100	164.8	135.0	149.9
Tightening: Calibrated to 2007-2008 data			
Amortization decrease 40 to 35	-3.4	-2.1	-5.3
Amortization decrease 35 to 25	-11.2	-7.8	-16.7
Amortization decrease 40 to 25	-14.0	-9.6	-21.0
LTV decrease 100 to 95	-51.4	-7.9	-8.1

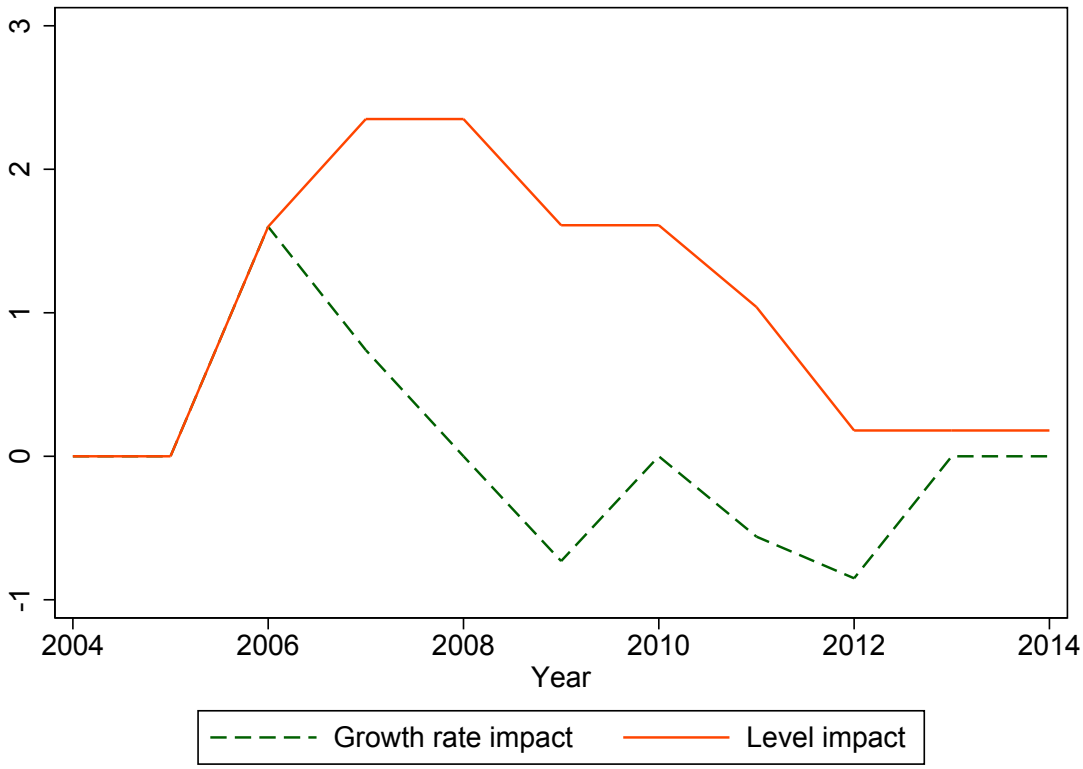


Figure 5: Impact of Macroprudential Loosening and Tightening on Credit Growth in Canada

7 Conclusion

This paper analyzes the impact of key macroprudential housing finance rule changes in Canada on household borrowing behaviour 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 modelling 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 that 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 that enter the housing market and amount of debt that they hold. However, the impact of changes in amortization, which impact the income constraint, do impact 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. Policy-makers should be cautious of this possibility and future work should model it. 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 impact both current and future mortgage demand in a way that is not captured in the model.

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Appendix

7.1 Data

Table 8: 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 first-time home-buyers. ‡ LTV of 95 remained for house prices above regional price caps. † is for variable rate mortgages. [a]: TDS calculation based on modal 5 year fixed posted rate of the Big 6 banks. ** restricted to house prices over one million dollars. *** restricted to new insured mortgages for the portion of the house price between $500,000-$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***				

Table 9: Variable Definitions

Variable	Definition
Income	Total amount of the borrower(s) salary, wages, and income from other sources
TDS	Ratio of total debt service to income
Loan amount	Dollar amount of the loan excluding the loan insurance premium
Premium	Loan insurance premium
Purpose	Purpose of the loan (purchase or refinance)
LTV	Loan amount divided by lending value
LTI	Loan amount divided by Income
Rate	Interest rate of the actual mortgage
Qualifying Rate	Rate at which borrower must qualify
Term	Represents the term over which the interest rate applies to the loan
Amortization	Represents the period the loan will be paid off
Interest type	Fixed or adjustable rate
CREDIT	Summarized application credit score (minimum borrower credit score).
Dwelling type	4 options that define the physical structure