How Does Mortgage Rate Refinancing Affect Consumer Spending and Debt Repayment? Evidence from Canadian Consumers*

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Abstract

We study the causal effects of mortgage rate refinancing on consumer spending and debt repayment during an expansionary and a contractionary monetary policy episode in Canada. Our identification takes advantage of the fact that the rates of short-term fixed-rate mortgages (FRMs) in the Canadian mortgage market have to be reset according to the prevailing market rates at predetermined time intervals. Our empirical strategy exploits this exogenous variation in the timing of mortgage rate resets. We document asymmetric responses of mortgage prepayment and of durable spending. We also find that borrowers actively repay their non-mortgage debt in both episodes. These results can be rationalized by the income effect of mortgage rate changes in conjunction with consumer expectations about future interest rates. As interest rates are on the rise in many countries, our findings help understand the responses of consumer spending and deleveraging to higher interest rates, especially in countries where short-term FRMs and adjustable rate mortgages are prevalent.

Keywords: Mortgage Rate Refinancing, Consumption, Deleveraging, Consumer Expectations, Monetary Policy.

JEL Codes: D12, D14, E43, E52, G21, R31.

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1 Introduction

During the global financial crisis, many central banks lowered short-term interest rates and engaged in large-scale asset purchases in an effort to stimulate the economy. One important channel through which these expansionary monetary policies are expected to work is their transmission to long-term rates, especially residential mortgage rates, so that households can have their mortgage payments reduced through refinancing and revitalize their spending. While the final assessment of these policies has yet to be made, ten years after the crisis, interest rates in major economies have started to rise. One consequence for the economies where adjustable-rate mortgages (ARMs, including variable-rate mortgages) and short-term fixed-rate mortgages (FRMs) dominate (e.g., Australia, Canada, Germany, Ireland, Japan, Korea, Spain and the U.K.) is that loans taken out during the extended low-rate period will have their rates reset to higher levels. Even in the United States, where long-term FRMs are most prevalent, ARMs account for a non-negligible market share and are subject to frequent rate resets. Understanding how monetary policy is transmitted to household spending through mortgage refinancing and whether the effects are symmetric during expansionary and contractionary monetary policy episodes, therefore, is of central interest for policy makers in many countries.

Notwithstanding the importance of this question, there is limited empirical evidence on the effects of mortgage rate refinancing, in particular, during contractionary monetary policy periods. In this paper, we provide a detailed analysis of the effects of exogenous mortgage rate changes through refinancing on consumer spending and debt repayment based on a comprehensive credit-bureau dataset. Our study is among the first to examine how consumers respond not only to mortgage rate decreases, but also to mortgage rate increases.[1]

Isolating the effects of a change in the mortgage rate on household spending and savings is challenging, because the timing of the refinancing is often chosen by borrowers, and refinancing outcomes depend on households' financial positions and creditworthiness. Studies of ARMs in the United States, as in Di Maggio et al. (2017), help address this identification concern to some extent, because ARMs experience automatic rate resets. The problem is that the ARM market accounts for a relatively small part of the overall U.S. mortgage market. Alternatively, one may explore the exogenous refinancing feature in countries dominated by short-term FRMs and ARMs, but the

[1] The only other study we are aware of that examines asymmetric responses of household debt and spending to mortgage rate changes is the concurrent work by Agarwal et al. (2019), who rely on a sample of Chinese credit card holders to estimate the responses of mortgage borrowers, relative to homeowners without mortgages, to monetary policy changes in China.

availability of high-quality consumer-level and loan-level data often poses a challenge for studying this question.[2]

We address these concerns by focusing on the Canadian mortgage market and relying on a comprehensive credit-bureau panel dataset that allows us to link mortgage loan-level data to consumer credit reports on more than one million Canadian borrowers. Our mortgage loan-level data form a large and representative sample, covering close to 20% of the loans in the Canadian mortgage market between 2009 and 2018. The loan-level dataset contains detailed information on mortgage origination and monthly updates on the payment, balance and delinquency of each account. We merge these records to the corresponding borrowers' characteristics and the reports on other credit accounts (auto loans, credit cards and lines of credit). The resulting dataset allows us to study mortgage payment adjustments as well as consumer spending and savings responses to mortgage rate changes at relatively high frequency.

What makes Canada an interesting case to consider is that the institutional characteristics of the Canadian mortgage market permit a clean identification of the causal effects of mortgage rate changes. Almost 80% of mortgages in Canada have a short term (usually 2 to 5 years) relative to the long amortization period (usually 25 to 30 years). The mortgage rate is fixed within the term, but has to be reset by the end of the term according to the prevailing mortgage rate when the mortgage contract is renewed. If the contract is renewed with the same lender, as is the case for most mortgages, the lender does not reassess the lending criteria such as loan-to-value (LTV) and debt-to-income (DTI) ratios. Moreover, due to the prevalence of penalties on full prepayment, most borrowers reset their mortgage rates exactly on schedule.

This institutional setting implies that the timing of a mortgage rate reset is predetermined by past contract choices, in particular, the duration of the previous term. This feature combined with the pronounced interest rate changes over time generates sizable mortgage rate reductions or increases upon reset that are exogenous with respect to the borrowers' spending and savings decisions, and do not depend on their financial positions or creditworthiness. The key to our identification strategy is to exploit the variation in the timing of mortgage rate resets. Intuitively,

[2]International evidence on the mortgage-rate-refinancing channel of monetary policy is provided by Jappelli and Scognamiglio (2018) for the case of Italy, La Cava et al. (2016) for the case of Australia, Floden et al. (2016) for the case of Sweden, and Agarwal et al. (2019) for the case of China. What distinguishes our work from these studies is the use of high-quality high-frequency panel data for a representative sample of Canadian mortgage borrowers, and the strategy of relying on exogenous variation in the timing of mortgage rate resets among borrowers holding the same type of contract. Moreover, the richness of our data allows us to study the dynamic responses of a wider range of outcome variables.

our empirical strategy compares the mortgage payment choices, the spending responses, and the savings patterns of similar borrowers who reset their mortgage rates at different points in time. We implement this strategy for FRMs with terms of 2, 3, 4, and 5 years before the resets, which account for 95% of our loan-level data.

We focus on mortgages that were scheduled to reset in two episodes: an expansionary monetary policy episode (2015.1-2017.1) and a contractionary monetary policy episode (2017.7-2018.9). These episodes correspond to the two major monetary policy shifts during our sample. As shown in Figure 1, the first episode was preceded by a secular decline in the prevailing mortgage rates. The two policy rate cuts in early 2015 further lowered the market rates. The second episode is characterized by a reversal of market rates, following closely the tightening of the policy rate. Our analysis is carried out separately for each mortgage term and episode. By comparing borrowers who hold the same-term mortgages but experience rate resets at different points in time, we are able to control for potential endogeneity due to the selection into mortgage terms.

We start by documenting the mortgage rate adjustment upon reset. We show that borrowers on average experienced rate reductions in the first episode with large variation across terms. Mortgages with previous terms of 2 and 5 years, for example, experienced rate reductions of 17 and 112 basis points, respectively. In the second episode, the rates of all shorter-term mortgages (2 to 4-year term) adjusted upward. In contrast, the 5-year term mortgages experienced a rate reduction on average because of the prolonged preceding period of declining rates. Given these exogenous changes in mortgage rates, we then examine mortgage payment choices and borrowers' spending and debt repayment responses.

Although mortgage rates are adjusted automatically upon reset, borrowers can choose the level of monthly payments when renewing their mortgage contracts. In the data, we observe contracted payments chosen by borrowers. To understand their choices, we construct a counterfactual payment schedule for each borrower that measures the automatic payment adjustment implied by a rate reset. By comparing the contracted payment and the counterfactual payment, we show that mortgage prepayment choices are asymmetric. Specifically, in the rate decrease episode, monthly payments may fall substantially upon reset, for example, on average by $100 (or 10 percent) per month for the 5-year term mortgages. Borrowers, however, do not fully cash out these interest savings, instead lowering their payments by about half of the potential savings and using the rest to prepay their mortgages. In the rate increase episode, as borrowers face the full burden of higher interest rates,

they simply choose the level of payments equal to the required amount, leaving the amortization schedule unchanged.

We complement these findings by documenting the heterogeneity in the payment choices across borrowers. When the rate decreases, borrowers with low credit scores, living in areas with low housing wealth, and below age 45 cash out more of their potential interest savings by scheduling the new payment closer to the maximum implied adjustment. When the rate increases, they make less voluntary prepayments. These findings are consistent with the view that liquidity constrained borrowers tend to cash out more of the interest savings and deleverage less in order to smooth their consumption.

While these results inform us about the financial implications of mortgage rate refinancing, it is more important to understand its effects on the real economy through consumer spending and savings. For this purpose, we conduct a detailed consumer-level analysis of the responses of durable consumption, debt repayment, and delinquency. Our analysis shows asymmetric durable consumption responses: when the mortgage rate falls, auto spending rises; when the mortgage rate increases, auto spending does not change. In contrast, we find that borrowers actively pay down their revolving debt in both episodes. The reduction in credit card balances is about \$150 to \$270 (3.0 to 5.4 percent) in the rate decrease episode, and is about \$190 to \$220 (3.8 to 4.3 percent) in the rate increase episode. Borrowers also deleverage on their lines-of-credit debt by about \$500 to \$900 (1.7 to 3.2 percent) in the rate increase episode. On the other hand, we do find symmetric responses of delinquency on non-mortgage payments. The delinquency rates (of auto loans, credit cards and lines of credit) decline in response to lower mortgage rates, and rise when the rates increase.

Our results of the consumption responses to mortgage rate changes are broadly consistent with the conventional view that changes in mortgage rates represent income shocks (see e.g., Di Maggio et al. (2017)). However, the deleveraging of non-mortgage debt, in particular, in the rate increase episode raises the question of whether changes in mortgage rates affect consumer choices only through the income channel, since an increase in the mortgage rate does not provide extra liquidity for households to repay their debt. We provide suggestive evidence based on consumer expectation surveys that household expectations about future interest rates can explain the incentive to deleverage. Specifically, we show that (i) consumers expect future interest rates to be higher, especially when the current market rates are on the rise, (ii) consumers expect future

interest rates to continue rising, and (iii) in response to these expectations, they are most likely to pay down debt. These findings persist both in the nationally representative sample and in the restricted sample of all FRM borrowers.

Since our estimates are based on a representative sample of Canadian mortgage borrowers, we can recover the effect of mortgage rate refinancing on aggregate spending and aggregate saving. According to the back-of-the-envelope calculations, between 2015 and 2017, the additional auto spending generated by rate refinancing amounted to 1.5 billion dollars, or 1 percent of the aggregate new auto spending. Over the same period, the reduction in consumer debt through rate refinancing accounted for 3 percent of aggregate saving. In the rate increase episode (after mid 2017), however, both auto spending and aggregate saving due to rate refinancing weakened. They accounted for 0.1 percent and 2 percent of the aggregate auto spending and aggregate saving, respectively. When extending our analysis to the entire period of 2009-2018 for which microdata are available, we find time-varying aggregate spending and saving effects that are strongly correlated with the degree of mortgage rate adjustment.

Our study so far has focused on the effects of mortgage rate adjustment at the individual level. These adjustments arise from two distinct sources: the rigidity of mortgage contracts and the change in the prevailing mortgage market rates over time. In the last part of our analysis, we explore the implications of these two sources of variation for monetary policy. First, we conduct a counterfactual analysis that isolates the adjustment in the mortgage rate accounted for by current monetary policy actions from that accounted for by the secular trend in the prevailing mortgage rates. We show that, for longer-term mortgages, the bulk of mortgage rate adjustments is driven by the latter change, whereas for shorter-term mortgages, it is the current monetary policy actions that explain a large part of the rate adjustment at the individual level. This result suggests that the effect of mortgage rate refinancing on aggregate spending and saving cannot be attributed to current monetary policy actions alone.

Second, we revisit the recent literature on the path dependence of monetary policy. We show that past monetary policy actions may have changed the stock of mortgages through mortgage origination, and hence the number of mortgages refinanced today, making current monetary policy state dependent. For example, a cut in the policy rate today will be more effective if past policies have pushed down the mortgage rates and have encouraged more homeowners to take out mortgages. We provide evidence for this path dependence by estimating the effect of monetary policy shocks

on mortgage origination.

Relation to the Literature. Our paper contributes to the literature on the effects of interest rate changes on household balance sheets, consumption and default (see e.g., Di Maggio et al. (2017), Agarwal et al. (2019), Jappelli and Scognamiglio (2018), La Cava et al. (2016), Floden et al. (2016), Tracy and Wright (2016) and Fuster and Willen (2017)). The most closely related work is Di Maggio et al. (2017), who examine the effects of ARM resets on household consumption and debt repayment in the U.S. during the quantitative easing period. Unlike Di Maggio et al. (2017), we study a mortgage product that is widely adopted in many countries, namely, fixed-rate mortgages. Moreover, we study consumer choices not only in a rate decrease period, but in a period when market rates are rising.

Our work is also related to the literature on consumption responses to income shocks (see e.g., Agarwal and Qian (2014), Agarwal et al. (2007), Johnson et al. (2006), Parker et al. (2013), Kaplan and Violante (2014), Misra and Surico (2014), and Shapiro and Slemrod (2003)). In particular, our findings are consistent with Baugh et al. (2018), who document asymmetric consumption responses to positive and negative anticipated cash flows. Previous studies on the effects of changing mortgage rates tend to interpret mortgage rate shocks as income shocks, but our finding of household deleveraging during the rate increase episode suggests that mortgage rate shocks may affect household behavior also through other channels.

Drawing on the recent housing boom-bust cycle, a strand of the literature has emphasized the role of housing wealth and household leverage in affecting consumption behavior (see e.g., Mian and Sufi (2011, 2014), Mian et al. (2013), Cloyne et al. (2019), Aladangady (2017), Guren et al. (2018), Berger et al. (2018a) and Kaplan et al. (2017)). While this existing literature has focused on the role of house prices in driving housing wealth, we highlight the contribution of debt repayment financed by lower borrowing costs to home equity accumulation. We also emphasize the heterogeneity in the deleveraging behavior arising from liquidity constraints.

Our paper also contributes to the recent literature on the transmission of expansionary monetary policy shocks through the mortgage refinancing channel, and on the effects of government debt relief programs implemented in economic downturns (see e.g., Beraja et al. (2018), Wong (2016), Greenwald (2017), Chen et al. (2018), Cloyne et al. (2018), Hurst and Stafford (2004), Bhutta and Keys (2016), Ganong and Noel (2016), Agarwal et al. (2017), Ehrlich and Perry (2017), Karamon et al. (2017) and Abel and Fuster (2018)). Relative to these strands of work, we examine the

monetary policy transmission in both expansionary and contractionary periods. Moreover, we highlight that the strength of the refinancing channel can vary over time due to the rigidity of mortgage contracts.

Our findings based on an institutional setting with exogenous refinancing also inform the discussion in the literature about the role of alternative mortgage features in affecting the transmission of monetary policy (see e.g., Campbell et al. (2018)). The exogenous-refinancing feature we study is a double-edged sword. In economic downturns, the number of mortgages refinanced is likely to be higher than in a similar economy with endogenous refinancing, because in the latter economy, households' ability to refinance is constrained by declining house prices and tightened lending standards. This severely weakens the monetary policy transmission through the refinancing channel (see e.g., Beraja et al. (2018) and DeFusco and Mondragon (2018)). On the other hand, exogenous refinancing directly exposes borrowers to both increases and decreases in monetary policy rates.

Finally, our work contributes to a growing literature on the path dependence of monetary policy, including recent work by Berger et al. (2018b) and Eichenbaum et al. (2018). While these two papers study the U.S. mortgage market where monetary policy actions can affect both the stock of mortgages and the propensity to refinance, we focus on the Canadian mortgage market where the propensity to refinance is predetermined. This allows us to characterize path dependence by estimating the effect of current monetary policy shocks on mortgage originations.

The remainder of the paper is organized as follows. Section 2 discusses the institutional features of the Canadian mortgage market that facilitate our identification, and describes the credit-bureau data used in our analysis. Section 3 outlines our empirical strategy, and Section 4 presents the results of mortgage loan-level adjustments upon reset. Section 5 examines borrower-level responses and provides new evidence from consumer expectations surveys that helps to explain our findings. Section 6 presents the back-of-the-envelope-calculations for the effect of mortgage rate resets on aggregate auto spending and aggregate saving rates. Section 7 examines the implications of mortgage rate refinancing for monetary policy. Section 8 provides further evidence and robustness analysis for the baseline results in Sections 4 and 5. Section 9 concludes.

2 Institutional Setting and Data

2.1 Canadian Mortgage Market

The Canadian mortgage market has several interesting institutional features. First, mortgage contracts have short terms and long amortization periods. The vast majority of mortgages in Canada are FRMs, corresponding to almost 80% of the overall market. For these mortgages, a term refers to the duration of the loan during which the mortgage rate is fixed. Mortgage terms often vary from 2 to 5 years at 1-year intervals. In contrast, amortization periods are typically between 25 and 30 years.

Second, the mortgage rate has to be reset for the next term according to the prevailing market rate when the mortgage contract is renewed at the end of the current term. When renewing the contract with the same lender, the borrower's repayment ability, measured by LTV and DTI ratios, is not reassessed. Thus, both rate decreases and increases are automatically passed on to renewing borrowers, unlike in the United States where borrowers often refinance their long-term FRMs when the interest rate falls and are reassessed in the process.[3]

Third, the existence of large prepayment penalties ensures that borrowers renew their mortgage contracts on schedule. Although the penalty varies from lender to lender, it is usually the higher of (i) three months' interest on the remaining balance, and (ii) the interest differential based on the current contract rate and the current market rate for a term of the same length as the remaining time left on the current term. When the mortgage rate declines, the interest differential of (ii) captures all financial gains from prepaying the mortgage in full and originating a new mortgage at a lower rate. In practice, the renewal often takes place at the end of the current term, or a few months prior to the scheduled month if renewing with the same lender. In the latter case, there are no prepayment penalties. As shown in Figure 2, more than 98% of renewals occur in the six months leading up to the scheduled date, with on-time renewals accounting for 50%.[4]

These institutional features imply that the timing of a mortgage rate reset is predetermined. These features combined with the movements of the market rates over time generate sizable

[3] Conditional on the prevailing rates, the mortgage rate obtained by individual borrowers may still vary with their bargaining power (see Allen et al. (2014, 2017)). In all of our analysis, we control for loan fixed effects and a set of borrower-level characteristics which help to remove the sources of variation in the bargaining power. It is also possible that competition among banks may lead to a rate dispersion. In Section 8, we provide further analysis that shows that the fraction of the loans switching to other lenders is small, and that switching borrowers do not obtain more favorable rates.

[4] While not fully prepayable, Canadian mortgage contracts allow for an annual prepayment of up to 20% of the initial balance on top of the scheduled amortization without penalty. This partial prepayment, however, is not associated with a change in the mortgage rate, and hence does not affect our identification.

mortgage rate reductions or increases upon reset that are exogenous with respect to the borrowers' spending and savings decisions and do not depend on their financial position or creditworthiness.

2.2 Data

We use data provided by TransUnion Canada, one of the two credit reporting agencies in Canada, that collects information on 35 million individuals and covers nearly every consumer in the country that has had a credit report. The data are available from 2009 onwards at monthly frequency. We merge two sources of information provided by TransUnion: one is on consumers' credit reports and the other is on the characteristics of the mortgage loans of each consumer.[5]

The consumer credit reports include information on (i) borrowers' characteristics such as age, credit scores, the first 3 digits of the postal code (or the "forward sortation area (FSA) code"), and the encrypted last 3 digits of the postal code, and (ii) balance sheet variables that summarize the credit limits, balances, payments, and delinquency status of each type of the loans a borrower has such as auto loans, credit cards, and lines of credit. The latter include home equity, student and other lines of credit. The mortgage loan-level data have information on the origination date, initial amount, insurance status, whether the loan is taken out jointly, whether the borrower is the primary holder of the loan, and other relevant characteristics of a loan. In addition, it contains monthly updates on outstanding balances, contracted payments, contracted terms, delinquency status, and the indicator of whether the loan is closed.

For our purpose, knowing the exact timing of a mortgage rate reset is crucial. However, not all mortgages in the loan-level dataset can be associated with their scheduled renewal dates, because lenders do not consistently report the information on loan maturity dates. In particular, a large fraction of these dates refers to the end of the amortization period, as opposed to the end of the current term. For this reason, we perform our analysis on mortgages issued by one of the five largest banks in Canada (the "Big Five" banks), which is the only bank among the Big Five that reports the end of the current term as the loan maturity date, thus allowing us to identify the timing of a mortgage renewal.

We show that our sample based on this bank is large and representative of the loans and the borrowers in the Canadian mortgage market. First, using our dataset and several alternative sources, we establish that this bank's share, both in mortgage originations and in the stock of debt

[5]The data collected by TransUnion Canada are reported in accordance with the Metro 2 format of the Canadian credit reporting guidelines, which specify the variables for reporting. The data we rely on have been stripped of all personal identifiers.

outstanding of the overall Canadian mortgage market, is close to 20%. Second, we compare the characteristics of the loans originated by this bank and by all other federally regulated lenders using an alternative dataset, the Bank of Canada-OSFI mortgage originations dataset, that covers more detailed origination information on more than 80% of the mortgages originated in Canada since 2014. The upper panel of Table 1 shows that the FRMs for home purchases originated by this bank are very similar to those originated by other lenders. Since 5-year FRMs account for the majority of Canadian mortgages, the lower panel of Table 1 focuses on this subset of loans. Again, 5-year FRMs originated by this bank are quite similar to those originated by other lenders.[6]

One potential concern about using data from one bank is that borrowers switching to other lenders for mortgage renewal may be offered different contract rates from the borrowers who stay with the bank. We address this concern in Section 8 by tracking borrowers who closed their mortgage accounts in this bank. Our evidence shows that, six months after the account closure, less than 2% of the borrowers renew their mortgages with other lenders, and that the switchers do not obtain more favorable mortgage rates.

2.3 Construction of Key Variables

Our analysis requires information on the type of the mortgage rate (i.e., fixed or variable), and the level of the mortgage rate. Both pieces of information are not provided by the TransUnion dataset. To identify the type of the mortgage rate, we classify a loan as a FRM within the term if the contracted payment does not change over the duration of the term.[7] We take a series of steps to recover the rates associated with the FRMs in our sample. In Appendix A, we describe in detail how these rates are constructed, and how we use two alternative administrative datasets that contain direct information on actual mortgage rates to validate our procedure. The distribution of our constructed rates closely matches that in each of the two alternative datasets.

Given the new mortgage rate upon reset, we construct a counterfactual payment schedule that measures the automatic payment adjustment implied by a rate reset by keeping the remaining amortization period and the outstanding balances the same as in the month before the reset. Comparing the counterfactual payment to the payment chosen by the borrower, we are able to examine the choice between mortgage prepayment and cash withdrawal due to the reset. Moreover,

[6] We also compared loan characteristics by origination purpose, by insurance status, and by broker status. In all of these breakdowns, loans issued by the bank of our sample are quite similar to those by other lenders. We report the statistics for home purchase loans because this category appears to have the most consistency in lenders' reporting.

[7] Although some lenders in Canada offer fixed payment schedules for variable-rate mortgages, the lender in our sample typically does not. This helps to identity variable-rate mortgages based on the within-term changes in the contracted payments.

using mortgage rates, contracted payments and monthly balances, we can infer actual payments and any prepayments made in addition to the scheduled amortization.[8]

We follow Di Maggio et al. (2017) in using car purchases financed by auto loans as a proxy for durable consumption.[9] Specifically, we identify a car purchase as the incidence where the monthly auto loan balance of a borrower increases by at least $1,000. The spending on an auto purchase is measured by the change in the auto loan balance when a borrower purchases a car.

In our data, the consumer-level information on lines of credit does not distinguish between secured and unsecured lines of credit. However, we are particularly interested in understanding how borrowers adjust lines of credit secured by their homes, i.e., home equity lines of credit (HELOCs), in response to mortgage rate changes. This is because HELOCs constitute an important source of household debt that finances spending.[10] In addition, the interest rates on HELOCs are often lower than on unsecured lines of credit and on credit card debt. Given that the HELOC identifiers in Canadian credit-reporting agency data are often missing, the common practice is to approximate HELOCs as any lines of credit with an initial credit limit of at least $50,000. We follow this convention in identifying HELOCs at the loan level. Finally, since we know borrowers' FSA codes, we construct the FSA-level LTV ratio as a measure of housing wealth.[11]

2.4 Summary Statistics

Table 2 reports the summary statistics of key variables used in Sections 4 and 5. Our analysis for the rate decrease episode is performed on the loans renewed in 2015.1-2017.1, and for the rate increase episode on the loans renewed in 2017.7-2018.9. We focus on FRMs that have terms of 2, 3, 4, and 5 years before the reset, and present summary statistics for each term separately. In total, we have 164,391 loans reset during the rate decrease episode and 121,688 loans reset during the rate increase episode.[12]

[8] The TransUnion dataset has information on contracted payments and outstanding balances, but the reporting of actual payments is missing for more than 90% of mortgages. In particular, the bank of our sample does not provide such information.

[9] According to Watts (2016), as of 2016, 83% of new motor vehicles in Canada were obtained with financing, and the trend of financed vehicle sales has closely tracked that of total sales. In addition, historical data show that the average LTV of motor vehicles in Canada is close to 100% between 2007 and 2016.

[10] Bailliu et al. (2012) show that in Canada between 40% and 50% of the funds extracted from home equity is used for consumption and home improvement spending.

[11] The TransUnion dataset does not provide information on borrowers' house prices. To obtain the FSA-level LTV ratios, we first use our sample to construct the quarterly FSA-level median mortgage balance. We then use the FSA-level median house price in 2014Q4 from the Bank of Canada-OSFI mortgage originations dataset and the quarterly FSA-level house price indexes from the Teranet Inc. to construct the quarterly FSA-level current house price.

[12] Since a mortgage can be taken out jointly by two or more individuals, our mortgage data include all accounts associated with a joint loan. This inclusion may create compositional bias if the mortgage rates of joint accounts

Mortgage rates between 2015.1 and 2017.1 fell substantially upon reset with significant heterogeneity across mortgage terms, ranging from 23 basis points for 2-year term mortgages to 114 basis points for 5-year term mortgages. The contracted payments chosen by borrowers upon reset, however, did not appear to take full advantage of the falling mortgage rates. In the 2017.7-2018.9 period, except for 5-year term mortgages, all other loans experienced upward adjustments in the mortgage rate, ranging from 54 basis points for the 2-year term mortgages to 20 basis points for 4-year term mortgages. Borrowers also experienced increased mortgage payments when rates are rising.

At the borrower level, the distributions of credit scores and age are similar to those in Table 1, but less so in the cases of LTV ratios. This is probably because our data cannot be used to distinguish between different origination purposes such as home purchasing, cash-out refinancing and renewal with different lenders. According to the spending measures, the fraction of borrowers using debt to finance auto purchases is about 0.5 percent in a month, and the corresponding monthly auto spending is about $120. The average credit card balance is about $5,000 without much variation across mortgage terms. Although more than half of the borrowers in our sample have some lines of credit, less than 20% of the borrowers have HELOCs. The amount of HELOC balances is large, however, accounting for about 55% of the balances on lines of credit.

3 Empirical Strategy

Our empirical strategy is designed to exploit the variation in the predetermined timing of mortgage rate resets in two episodes: the 2015.1-2017.1 episode, characterized by declining market interest rates, and the 2017.7-2018.9 episode, featured by increasing interest rates. These two episodes contain the major monetary policy shifts during our sample period.[13] Our strategy

differ systematically from non-joint accounts. One way to address this issue is to include loan fixed effects, as we did in all of our specifications. Our data also provide joint-account and primary-holder indicators. As a robustness check, we re-estimate our baseline specifications using a restricted sample that removes the non-primary holders of joint accounts. The results based on this restricted sample are very similar to the baseline results in Sections 4 and 5. In addition, a small fraction (about 9%) of consumers have two or more mortgage accounts at the same time. This may correspond to the case of having separate mortgages on different properties, or the case of having multiple liens on one property taken out at different points in time. In our baseline results, we include all mortgage accounts of a consumer because the timing of renewal for different mortgages is likely to be independent. As a robustness check, we restrict our sample to the consumers who never have more than one mortgage account at a point in time, and re-estimate our baseline specifications. The results are very similar to those presented in Sections 4 and 5.

[13] One may be concerned that the set of consumers who reset their mortgage rates in the first episode is different from the set who reset their mortgage rates in the second episode. This concern is partially addressed by the fact that these resets are predetermined by the institutional features of the Canadian mortgage market, which eliminate self-selection and allow us to treat the sample as random. Moreover, our identification strategy relies on the comparison of otherwise identical borrowers who reset their mortgages at different points in time within the same episode rather than a comparison of borrowers across the two regimes. That being said, in Section 8 we show that

compares, for each episode, the mortgage payment choices and the spending and savings patterns of borrowers who hold the same type of mortgage contracts but reset their mortgage rates at different points in time, controlling for borrowers' characteristics.[14]

We focus on all FRMs that were renewed in the two episodes and had terms of 2, 3, 4, and 5 years before the reset. Our analysis is carried out separately for each mortgage term, so we can compare borrowers with similar contracts and avoid potential endogeneity concerns due to the selection into different terms. The rich panel structure of the data allows us to include individual fixed effects and time fixed effects in all of our specifications. Moreover, the matched consumer-level information allows us to control for a set of time-varying borrower-level characteristics that may confound the effects of a mortgage rate change on consumer choices.[15]

Our baseline specification is

$$y_{j,t} = \alpha_0 + \alpha_1 PostRenew_{j,t} + \alpha_2 \mathbf{x}_{j,t} + \gamma_j + \delta_t + \varepsilon_{j,t}, \tag{1}$$

where j denotes the loan for the loan-level analysis, or the borrower for the borrower-level analysis. t denotes the month. $y_{j,t}$ denotes either a loan-level outcome variable (analyzed in Section 4) or a borrower-level outcome variable (analyzed in Section 5). $PostRenew_{j,t}$ is a dummy variable that takes the value of 1 starting with the month of mortgage renewal. $\mathbf{x}_{j,t}$ is a vector of borrower-level characteristics, including the previous-month credit score, age, and the previous-quarter LTV ratio of the borrowers' FSA. γ_j is the individual fixed effect that absorbs all time-invariant unobserved heterogeneity correlated with the loan-level or borrower-level responses. δ_t is the monthly fixed effect designed to capture the trend in the macro economy and to control for the confounding effects of aggregate shocks. α_1 is the key parameter of interest that captures the effect of a mortgage rate reset. The standard errors are clustered at the loan level for the loan-level analysis, and at the borrower level for the borrower-level analysis.

To study the heterogeneity in the responses, we interact the post-renewal indicator, $PostRenew_{j,t}$, with borrowers' characteristics. We use the credit score as a measure of creditworthiness, and the FSA-level LTV as a proxy for the housing wealth of the area where the

similar results hold for the subset of borrowers who reset their mortgages during both falling and raising rate periods.

[14] A similar strategy is used in Fuster and Willen (2017) and Di Maggio et al. (2017), both exploiting the timing of automatic rate resets of ARMs in the U.S. to study borrowers' responses to lower mortgage payments.

[15] Our results are robust to controlling for the region-time fixed effect or controlling for the cohort-time fixed effect, where region is defined as the province, and cohort is defined as the quarter of the previous reset. The first set of fixed effects allows for the region-specific time trend. For example, the effect of an oil price shock may vary substantially across regions, as the oil sector is geographically concentrated in Canada (see Kilian and Zhou (2018)). The second set of fixed effects allows for unobserved heterogeneity across cohorts that may confound the effect of mortgage rate resets on consumer choices.

borrower lives. In addition, we explore heterogeneity across age, since standard life-cycle theory with borrowing constraints suggests that young homeowners are more likely to be constrained by cash. In the data, different dimensions of heterogeneity are highly correlated (for example, young borrowers on average have low credit scores, and tend to live in high-LTV areas), so we estimate the heterogeneous responses arising from different sources jointly, rather than running a separate regression for each dimension.

Borrowers may change their consumption or savings even before the renewal in anticipation of a mortgage rate change. To explore these anticipation effects, we estimate a dynamic version of equation (1) that, instead of a single post-renewal indicator, includes a set of quarterly dummies. Specifically, we estimate α_1^q's from

$$y_{j,t} = \alpha_0 + \sum_{q \in Q} \alpha_1^q \mathbf{1}_j(t \in q) + \alpha_2 \mathbf{x}_{j,t} + \gamma_j + \delta_t + \varepsilon_{j,t}, \tag{2}$$

where q denotes the quarter since the mortgage renewal, and $\mathbf{1}_j(t \in q)$ is a dummy that takes the value of 1 if month t is in the qth quarter since the mortgage renewal. For the rate decrease episode, we set Q to include the values from -3 to 6 and the time beyond the 6th quarter. For the rate increase episode, we set Q to include the values from -3 to 3 and the time beyond the 3rd quarter. We choose a shorter horizon for the post-renewal period in the latter episode due to the short sample for this episode. Therefore, α_1^q's capture the responses to a mortgage rate reset starting from three quarters before the reset to the end of our sample.

One potential concern with this strategy is that it may be unable to account for the mortgage-age effect that drives consumption and savings decisions. For example, consumers tend to expand their consumption several years after a home purchase. This timing may overlap with their mortgage renewal. In this case, consumption increases for reasons related to preferences or life-cycle needs, rather than due to mortgage rate resets. Given that the mortgage-age effect would be collinear with the post-renewal indicator, we cannot control for it.

We implement two alternative empirical strategies as robustness checks. First, we consider a difference-in-difference design that introduces as the control group longer-term mortgages (7 and 10-year term). These mortgages have the rates reset previously at the same time as the loans in our baseline sample. Intuitively, we compare two mortgages, say, both originated in 2010.1, but one gets reset in 2015.1 and the other has to wait until two years later. While this approach is able to control for the mortgage-age effect, the precision of the estimates is limited by the small size of the control group, since not many Canadian borrowers take longer-term mortgages. In addition, one

might be concerned about the endogenous selection into these longer-term mortgages. For these reasons, we consider a second difference-in-difference design that introduces mortgages of the same term but not renewed in the period of interest as the control group. For example, we use 5-year FRMs reset in 2012.1-2014.12 as the control group for the 5-year FRMs in our baseline sample for the rate decrease episode.

Both empirical designs can be captured by the following specification, estimated separately for each episode:

$$y_{j,t} = \beta_0 + \beta_1 Renew_j \times PostPolicy_t + \beta_2 \mathbf{x}_{j,t} + \gamma_j + \delta_t + \epsilon_{j,t}, \tag{3}$$

where $Renew_j$ is a dummy variable that takes the value of 1 if loan j is renewed in an episode. $PostPolicy_t$ is a time dummy variable that takes the value of 1 if t is between 2015.1-2017.1 for the first episode, or between 2017.7-2018.9 for the second episode.[16] All other variables are similarly defined as in equation (1). The parameter of interest is β_1, which captures the difference-in-difference effect. We also estimate a version of equation (3) that allows us to study the heterogeneous responses across borrowers, and a version that allows for dynamic loan-level and borrower-level responses. In Section 8, it is shown that the estimates based on our baseline specification are robust to these two alternative empirical designs.

4 The Effect of Mortgage Rate Resets on Mortgage Payment Choices

In this section, we present the results for the mortgage loan-level adjustments upon reset in each episode. We start by documenting, for each term, the change in the mortgage rate, the required payment (or the counterfactual payment), the contracted payment and the additional prepayment for the average borrower. We then present evidence on the heterogeneity in these responses across borrowers. Finally, we estimate the response of mortgage payment delinquency.

4.1 Rate Decrease Episode

Table 3 presents the loan-level adjustments upon reset for the 2015.1-2017.1 episode, prior to which the prevailing mortgage rates had experienced a prolonged period of declines. This trend was amplified by the two monetary policy rate cuts in early 2015. As expected, all mortgages renewed during this period experienced a substantial downward adjustment in the rate. The degree of the

[16] We do not follow an earlier version of Di Maggio et al. (2017) in interacting the renewal indicator, $Renew_j$, with the life-cycle-stage indicator, for example, $\mathbf{1}(Loan\ age_{jt} > 60\ months)$ for the 5-year term mortgages, because some loans are renewed earlier than scheduled in our sample.

rate adjustment, however, varies with mortgage terms.[17] In general, having a longer term before the reset results in a larger rate reduction. For example, 5-year term mortgages experienced the largest reduction of 112 basis points, corresponding to a 30% cut relative to the rate before the reset. This type of mortgages accounts for the majority of the FRMs in Canada, suggesting that most borrowers who renewed their mortgage contracts in this episode experienced sizable positive income shocks.

A lower mortgage rate implies savings on interest payments. The change in the required payment measures the maximum reduction in the monthly payment a borrower can take advantage of. It varies from $15 per month for 2-year term mortgages to $92 per month for 5-year term mortgages. The change in the contracted payment, however, suggests that borrowers do not fully cash out these potential interest savings. For example, out of the maximum possible payment reduction of $92 per month for 5-year term mortgages, the actual payment reduction in the new contract amounts to only $49, with the rest of the interest savings used to repay the principal. We also find that the additional prepayment declines upon reset, but the magnitude of the decline is small.

Combining these estimates, we can compute a measure of the income gains due to the reset. The key to this computation is the assumption on the length of the new term. We therefore estimate term transition probabilities (see Appendix D), and use the expected length of the new term to compute the cash-on-hand associated with mortgage rate resets. The implied amounts are shown in Table 4, and vary from $184 for borrowers holding 2-year term mortgages to almost $3,000 for borrowers holding 5-year term mortgages.

The results in Table 3 suggest that, on average, borrowers cash out about half of the interest savings when the mortgage rate declines, and use the rest to prepay the principal. This pattern, however, differs across borrowers. We focus on three dimensions of heterogeneity: (1) credit score, as a measure of creditworthiness, (2) LTV ratio, as a proxy for housing wealth, and (3) age, as a proxy for borrowing constraints. We examine the relationship between the change in the required payment and the change in the contracted payment, which captures the choices between mortgage prepayment and liquidity withdrawal.[18]

[17] The rate adjustment also depends on the term after the reset, especially when there are term spreads associated with longer-term mortgages. In Section 8, we perform a robustness check that restricts our mortgage sample to the loans that have the same term before and after the reset, and show that our baseline estimates are robust to removing the term spread effect.

[18] We also examined heterogeneity arising from credit utilization, based on the credit-card utilization rate and the combined utilization rate of credit cards and lines of credit. The responses of the borrowers who have above-the-median utilization rates are qualitatively similar to those who have below-the-median credit scores.

Table 5 shows the heterogeneity in mortgage payment choices. Combining the estimates in the two panels, we find that borrowers with low credit scores, living in high-LTV areas, below age 45, and are retired tend to cash out more of the potential interest savings. Consider borrowers who renewed their 5-year term mortgages. As a benchmark, a high credit-score middle-aged borrower who lives in a low-LTV area would cash out 31%(=24.4/77.5) of the interest savings and use the rest to prepay the principal. All else equal, a borrower with a credit score below the median would cash out 62%(=[24.4+30.9]/[77.5+12.1]) of the interest savings. Similarly, a borrower living in a high LTV area would cash out 48% of the interest savings, a young borrower would cash out 43%, and a retired borrower would cash out 47%. Since all these characteristics can be viewed as measuring how liquidity constrained a borrower is, our estimates suggest that liquidity constrained borrowers tend to smooth their consumption by cashing out more of the interest savings, consistent with life-cycle consumption models with borrowing constraints.

Figure 3 shows the dynamic adjustments of the loan-level outcomes for 5-year term mortgages. The patterns for other terms are similar and are consistent with the estimates in Table 3. The estimates in Figure 3 show that the mortgage rate, required payment and contracted payment fall sharply upon reset, and that these declines are persistent. Consistent with the results in Table 3, borrowers on average cash out roughly half of the potential interest savings when choosing the new contracted payments. Moreover, they reduce additional prepayments before the reset, but only slightly in comparison with a large reduction in the quarter of the reset.

Finally, we examine the response of mortgage payment delinquency. The results in Table 6 show that the delinquency rate falls for all measures (30+ days, 60+ days, and 90+ days) and all terms. This finding is consistent with the view that income gains due to reduced mortgage payments can lower the probability of mortgage default (see, e.g., Ganong and Noel (2016)).

4.2 Rate Increase Episode

Table 7 shows the loan-level adjustments for the 2017.7-2018.9 episode, when the prevailing market rates started to rise, concurrent with the monetary policy tightening. The upper panel shows that all shorter-term mortgages (2 to 4-year term) experienced rate increases upon reset. In particular, the 2-year term mortgages had the largest rate increase of 55 basis points. The 5-year term mortgages, in contrast, experienced a slight rate reduction of 16 basis points on average. These patterns are consistent with the trend in the prevailing mortgage rates. The 2-year term mortgages renewed in this episode were previously reset between 2015 and 2017, when the market

rates were at historical lows. On the other hand, the 5-year term mortgages renewed in this episode were previously reset between 2012 and 2013, when the market rates, on average, were higher than during this episode.

Turning to the adjustment in the required and contracted payments, we find a different pattern from the rate decrease episode. For shorter-term mortgages (2 to 4-year term), when the required payment rises, borrowers choose the payment to be roughly the same as the required amount, leaving the amortization schedule almost unchanged.[19] For the 5-year term mortgages, although the required payments fall, almost all the resulting interest savings are used to pay down the principal. We also find an increase in the additional prepayment made by borrowers holding 3-year term mortgages, but the magnitude small.

Based on these estimates, Table 8 shows the implied cash-on-hand due to a mortgage rate reset, varying from -$1,771 for 2-year term mortgages to $367 for 5-year term mortgages. These numbers suggest that borrowers of shorter-term mortgages (2 to 4-year term) all experienced negative income shocks upon reset. Since we are interested in the behavior of those who experienced mortgage rate increases in this episode, we will mainly focus on the responses of the borrowers who have 2 to 4-year term mortgages in the following loan-level and consumer-level analysis.

Are liquidity constrained borrowers able to smooth their consumption when the mortgage rate increases? Table 9 examines the heterogeneous responses across borrowers and shows that this is possible by adjusting the additional prepayments. The left and middle panels of Table 9 show that borrowers adjust their contracted payment to meet the required amount. This is the case for all types of borrowers. The right panel, however, shows that low credit-score, young and retired borrowers reduce their additional prepayments substantially relative to high credit-score, middle-aged borrowers. Borrowers living in high-LTV areas, in contrast, raise their additional prepayments, which may be explained by the incentive to free up some home equity for future use.

Figure 4 shows the dynamic loan-level adjustments for 2-year term mortgages. The patterns for other shorter-term mortgages are similar and are consistent with the estimates in Table 7. The mortgage rate, required and contracted payments rise upon reset, with the response of the contracted payment following closely the required payment. Unlike in the rate decrease episode, there is a downward trend in the mortgage rate, required and contracted payments after the reset.

[19]The asymmetric prepayment pattern is also documented in La Cava et al. (2016) using Australian household survey data. They find that borrowers tend to prepay more of their mortgages during lower interest rate periods, indicating the role of expectations of higher future interest rates in explaining the deleveraging behavior.

This does not mean that the payments are trending down, since we know that these mortgages are FRMs. This pattern is due to the fact that the prevailing rates have been gradually increasing, and that the dynamic responses at longer horizons are mainly driven by the mortgages renewed earlier in this episode, which experienced smaller rate increases than the mortgages renewed later.

Finally, Table 10 examines mortgage default in the rate increase episode. Although payments rise for the loans reset to higher rates, we do not find increased delinquency on these loans. This suggests that higher mortgage rates in this episode do not contribute to the rise in the mortgage default rate, if any.

5 The Effect of Mortgage Rate Resets on Consumer-Level Choices

Since our mortgage loan-level data can be merged to the corresponding consumers' reports on other credit accounts, we now examine the responses of durable consumption proxied by auto spending, non-mortgage debt repayment, and non-mortgage payment delinquencies. One of our main findings that consumers actively repay non-mortgage debt, especially in the rate increase episode, raises the question of whether a mortgage rate change affects consumer behavior through channels other than income. In Section 5.3, we provide suggestive evidence that expectations about future interest rates help to explain this finding.

5.1 Rate Decrease Episode

The upper panel of Table 11 shows the change in the likelihood of purchasing an automobile caused by a mortgage rate reset. While this estimate is insignificant for borrowers having shorter-term mortgages, it is significant at the 1% level for borrowers with 5-year term mortgages. This is not surprising given that the 5-year term mortgages experienced the largest payment reductions upon reset. Given that the unconditional likelihood of purchasing an auto is 0.42 percent in a month, the estimated response of 0.05 percent implies a 12% increase in auto purchases. The change in the spending amount shown in the lower panel of Table 11 reveals a similar pattern: borrowers with 5-year term mortgages have the largest increase in auto spending, $12.7 per month (or 11.5%). Combining this estimate with the change in the required payment for 5-year term mortgages in Table 3, we conclude that a $1 reduction in the mortgage payment leads to a 14 cents increase in auto spending, similar to the estimate in Di Maggio et al. (2017) for U.S. borrowers.[20]

[20]The marginal propensity to consume may be estimated by computing the present discounted value of the reduction in mortgage payments, and then regressing the change in spending on this amount. This approach, however, requires the assumption on the discount factor and on the expected duration of the new mortgage term, as well as the assumption of perfect-foresight borrowers, all of which could potentially bias the estimates. Alternatively, one

An interesting question is whether these estimates should be interpreted as the response to an unanticipated or an anticipate change in the mortgage rate. One way to address this question is to examine the dynamic response before and after the reset. Figure 5 shows that in the three quarters before the reset, auto spending does not change significantly, whereas in the quarter of the reset, it jumps up significantly, reaching $20 and staying at this level for the next four quarters. This suggests that borrowers do not respond to a rate reset scheduled in the future, and that the anticipatory effects, if exist, are weak. In Section 8, we provide additional analysis to show that anticipatory effects are unlikely to affect our results.

We next examine consumer deleveraging in the form of paying down revolving debt. Although we only observe the outstanding balance at a point in time, assuming borrowers repay at least the interest, a reduction in the balance represents net debt repayment, and an increase in the balance means that spending on net outweighs repayment. Table 12 shows that borrowers pay down their credit card debt by about $150 to $270 (3.0 to 5.4 percent) depending on the mortgage term. We also find evidence of deleveraging through paying down lines of credit, especially by borrowers holding 5-year term mortgages. The fact that the HELOC balance increases rather than decreases for most borrowers suggests that the repayment of lines of credit is achieved by repaying non-HELOCs, which often have higher interest rates than HELOCs. In addition, we find no evidence of anticipatory effects on debt repayment, as there are sharp and persistent declines in the balances only at the time of the reset, as shown in Figure 5.[21] For robustness, we also estimate equations (1) and (2) for monthly changes (instead of levels) in the revolving debt balances. The results are consistent with those in Table 12 and Figure 5.

While we do not find much heterogeneity across borrowers in the spending response, we document substantial heterogeneity in the response of debt repayment in Table 13. Although all borrowers reduce their credit card balances upon reset, young and low credit score borrowers deleverage less. In contrast, retired borrowers deleverage more. These patterns are consistent with standard life-cycle models with liquidity constraints. For lines of credit, low credit-score borrowers increase their balances relative to the benchmark group, indicating higher spending financed by this type of debt. Both young borrowers and retired borrowers, however, deleverage more than

may scale the post-renewal indicator by the change in the required payment and evaluate the allocation of the funds to different purposes. In unreported results, we document that the latter approach produces similar asymmetric spending responses as our baseline empirical strategy.

[21] The estimates in Table 12 may raise the concern that households choose to repay more expensive debt regardless of the timing of the reset. The dynamic responses of revolving debt balances in Figure 5 show that these declines only appear at the time of the reset, indicating the absence of the trend effect.

the benchmark group. These patterns extend to the responses of HELOC balances, except that even borrowers in the benchmark group raise their HELOC balances, which indicates some usage of HELOCs for consumer spending.[22]

We find significant declines in delinquency of credit card and lines of credit payments, as shown in Table 14. The point estimate of auto loan delinquency shows a reduction, which is mostly driven by the response of low credit score borrowers. On the other hand, these borrowers are more likely to fall behind on their credit card and lines of credit payments relative to other borrowers.

5.2 Rate Increase Episode

We find asymmetric responses in auto spending: when the mortgage rate falls, borrowers increase their auto spending, while they do not change this spending when the mortgage rate increases, as shown in Table 15 and the upper left panel of Figure 6. However, we find an increased delinquency rate on auto loan payments, as shown in Table 18. This latter evidence suggests that the overall auto spending may decline due to the existing auto loan holders who default, but the quantitative importance of the defaulting borrowers is likely to be small.

Another interesting finding is that borrowers appear to have strong incentives to deleverage. Table 16 shows that borrowers pay down their credit card debt by about $200 (4 percent), and their lines of credit by $500 to $900 (1.7 to 3.2 percent) depending on the mortgage term. These patterns are confirmed by examining the dynamic responses of revolving debt balances (see Figure 6), although the response of lines of credit debt cannot be estimated precisely in the case of 2-year term mortgages. Mortgages of other terms display similar but stronger responses. These estimates raise the question of whether a change in the mortgage rate affects consumer behavior through channels other than income, as a higher mortgage payment resulting from a higher rate does not generate extra liquidity for borrowers to pay down their non-mortgage debt. We explore alternative channels in Section 5.3.[23]

Although we do not find heterogeneity in auto spending, we find heterogeneity in the responses

[22] Our finding that young borrowers deleverage less on credit-card debt but more on lines of credit than middle-aged borrowers seems inconsistent with life-cycle consumption theory that predicts higher leverage of young borrowers than middle-aged borrowers. One explanation is that young borrowers are close to their credit limits on the lines of credit. This is true in our data. The utilization rate of lines of credit is 90% for young borrowers, compared to 59% for middle-aged borrowers. Young borrowers also have a higher utilization rate of credit cards (55%) than middle-aged borrowers (40%), but this rate is far from full utilization.

[23] An interesting question is how consumers finance their debt repayment in the rate increase episode, given that there are no income gains resulting from mortgage rate resets. Since we do not find evidence of decreased durable spending, debt repayment must be financed by non-durable spending cuts, by other types of savings, or by income. Our data, however, do not have such information. We leave this question for future research.

of revolving debt repayment similar to that in the rate decrease episode (see Table 17). Specifically, first, borrowers with low credit scores deleverage less on both credit-card debt and lines of credit. Second, young borrowers deleverage less on credit-card debt but more on HELOCs, whereas retired borrowers deleverage more on all types of revolving debt. Third, borrowers living in high-LTV areas repay more on HELOCs. The last pattern can be explained by the incentive to free up some of home equity for future use, in conjunction with the expectations about future interest rates as discussed in Section 5.3. Finally, we find higher delinquency rates on credit card and lines of credit payments, making their responses symmetric to a mortgage rate change.

5.3 How to Explain Debt Repayment When the Mortgage Rate Increases?

Our finding of non-mortgage debt repayment in response to a mortgage rate decline is consistent with Di Maggio et al. (2017), who interpret lower mortgage rates as positive income shocks and postulate that borrowers use extra liquidity resulting from lower mortgage payments to repay their debt. If a change in the mortgage rate affects consumer choices only through the income channel, however, we would not expect them to pay down debt when the rate increases because there are no income gains, but rather, income losses. Thus, the income effect alone cannot explain our findings.

We evaluate two other channels through which a change in the mortgage rate can affect consumer debt repayment. First, deleveraging may not be voluntary, but is imposed by lenders, especially in the rate increase episode, because lenders may be concerned about the ability of the borrowers to repay their debt. Second, borrowers may actively pay down their debt because of their expectations about future interest rates. We show that the first channel is not supported by the data, but the second channel is consistent with evidence from consumer expectations surveys.

If borrowers were forced to deleverage, we would expect the credit limit on some non-mortgage accounts to drop. Our data have information on the credit limit of each account, allowing us to test this hypothesis.[24] Table 19 shows the response of the two credit-limit measures: the probability of the credit limit growing by at least $1,000 over one month, and the amount of the credit limit. The responses of both measures suggest that credit limits do not fall, but instead rise upon reset for both credit cards and lines of credit in both episodes. Therefore, our evidence rejects the hypothesis of forced deleveraging imposed by lenders.

[24] It is possible that borrowers may voluntarily reduce their credit limits by closing their accounts, by contacting the lenders to downsize the available credit, or by opening fewer accounts than otherwise. If we find the credit limit to fall, it would be hard to determine whether such a fall is driven by supply or demand side factors. However, our finding that borrowers' credit limits do not fall but rather rise rules out the explanation that lenders force borrowers to deleverage.

We next evaluate the channel of consumer expectations about future interest rates. The intuition is that, if borrowers expect future interest rates to be higher, especially for loans with variable rates such as lines of credit, they will choose to pay down these types of debt. Since our credit-bureau data do not have information on borrowers' expectations, we use data from the Canadian Survey of Consumer Expectations (CSCE) to complement our analysis.[25] We establish three facts: (i) consumers expect future interest rates to be higher, especially when the current market rates are on the rise, (ii) consumers expect future interest rates to continue rising, and (iii) in response to these expectations, they are most likely to pay down debt. These patterns persist both in the nationally representative sample and in the restricted sample of all FRM borrowers. [26]

Figure 7 establishes the first fact. It plots the mean and median responses of homeowners who hold FRMs to the question "*What do you think is the percent chance that 12 months from now the average interest rate on things such as mortgages, bank loans and savings will be higher than it is now?*" The two vertical lines represent 2015Q1, the first quarter of the rate decrease episode, and 2017Q3, the first quarter of the rate increase episode. In both episodes, consumers expect the probability of higher interest rates in the next year to be above 50%. In the rate increase episode, this probability is as high as 80%. One concern with these responses is that consumers may not understand the concept of interest rates, or they may not be aware of the recent history of the interest rates. Figure 8 provides evidence that consumers are aware of the changes in the interest rates in the past. In the rate decrease episode, half of the consumers indicated that interest rates had declined relative to the year before, and in the rate increase episode, almost 80% of consumers indicated that rates had risen.

Figure 9 establishes the second fact. It plots the average expected interest rate in 1, 2, and 5 years. The level of these expected rates may not be so informative because consumers were asked about their expectations about the average interest rate across several types of debt and assets. However, the change in the expected interest rate from 1 year to 2 years, from 2 years to 5 years, and the next-12-month expectations (see Figure 7) suggest that households expect interest rates to continue rising.

[25] The Canadian Survey of Consumer Expectations (CSCE), launched by the Bank of Canada in 2014Q4, provides comprehensive information about consumer expectations for inflation, interest rates, labor markets, credit markets and housing markets. The survey also collects information on demographics and income. The survey data are collected from a nationally representative sample of 1,000-2,000 household heads every quarter. The methodology and design used for the survey largely follow those of the Federal Reserve Bank of New York's Survey of Consumer Expectations. See Gosselin and Khan (2015) for a detailed description of the CSCE.

[26] The survey does not have information on mortgage terms or the timing of mortgage renewal.

Figure 10 establishes the third fact. When asked about the actions taken or intended to take in response to their expectations, about 60% of consumers choose paying down debt, making it the most likely response to higher interest rate expectations. These three facts suggest that mortgage rate resets, especially in the rate increase episode, may affect household deleveraging through the expectations channel.[27]

6 The Aggregate Effect of Mortgage Rate Resets

Since our analysis is based on a representative sample of Canadian mortgage borrowers, we can use the estimates to compute the aggregate effect of mortgage rate resets. Given that mortgage rate resets have had continuous effects on consumer choices over the last few decades, we extend our analysis from the two episodes we have focused on so far to the entire period of 2009.1-2018.9 for which microdata are available. In addition to examining the effect on aggregate auto spending, we also address the question of whether mortgage rate resets have contributed to the trend in the Canadian aggregate saving rate, which has fallen sharply since mid 2015.

At any specific time t, the effect on aggregate auto spending or on aggregate saving can be computed by integrating the effects across all mortgage terms, that is,

$$\int_D \triangle R_t^D \times \epsilon_t^D \times \phi_t(D) dD, \tag{4}$$

where D denotes the mortgage term before the reset, $\triangle R_t^D$ is the average rate adjustment of term-D mortgages reset at t, ϵ_t^D is the interest rate semi-elasticity (of auto spending or saving) of borrowers who reset their term-D mortgages at t, and $\phi_t(D)$ is the number of the borrowers who reset their term-D mortgages at t.[28]

We first estimate $\triangle R_t^D$ by computing the average change in the mortgage rate upon reset in month t for term-D mortgages, $D = 2, 3, 4, 5$ and $t \geq 2009.1$. We then estimate $\phi_t(D)$ using census data on the total number of mortgages combined with our estimates of the share of each mortgage term. For the interest rate semi-elasticity of auto spending, we use suitably scaled auto spending responses in Table 11 when the rate declines, i.e., $\triangle R_t^D < 0$, and the responses in Table 15 when

[27] Although we are unable to link the households in the CSCE to their credit reports in the TransUnion dataset, it is natural to presume that households' expectations about future interest rates are updated when they are forced to reset their mortgage contract at a new rate. Put differently, while most households may have a rough idea of how interest rates move in the economy (see Figure 8), having to make a major financial decision such as resetting a mortgage contract forces them to articulate and revise their own beliefs. This conjecture is confirmed by comparing the expectations of VRM and FRM borrowers in the CSCE data. The former, subject to more frequent rate resets, are more aware of the changes in the interest rates in the past, and expect the interest rates more likely to continuously grow in the future when the current rates are on the rise.

[28] The aggregate effects calculated using this formula do not incorporate the general equilibrium effects arising from the adjustments in other sectors of the economy.

the rate increases, i.e., $\triangle R_t^D \geq 0$. For the interest rate semi-elasticity of saving, we use suitably scaled debt repayment responses in Tables 3 and 12 for rate declines, and the responses in Tables 7 and 16 for rate increases.[29]

Figure 11 shows the time-varying effect of mortgage rate resets on aggregate auto spending. Between 2015.1 and 2017.1, the total auto spending stimulus generated by mortgage rate resets was 1.5 billion dollars, accounting for about 1 percent of aggregate new auto spending during this period.[30] This effect, however, is dwarfed by that in other historical episodes when the average rate adjustments were larger. For example, in 2013.1, auto spending due to mortgage rate resets reached 1.3 billion dollars (at annual rate), and accounted for 3.7% of aggregate new auto spending, corresponding to a 49% increase in the annual growth rate of aggregate new auto spending. In 2013.10, in contrast, mortgage rate resets had a much smaller impact on auto spending: the resulting aggregate spending effect was only 0.8%. After mid 2017, as most FRMs have experienced rate increases upon reset, the overall auto spending stimulus has been close to zero.

Figure 12 shows the time-varying effect of mortgage rate resets on the aggregate saving rate. The Canadian aggregate saving rate reached its maximum in 2013.1 and has fallen sharply since mid 2015.[31] The effect of mortgage rate resets on consumer saving (scaled by aggregate disposal income) mirrors these dynamics of the aggregate saving rate. The correlation of the two series is 0.6, indicating high co-movement, which suggests that mortgage rate resets are one of the factors that help to explain the evolution of the aggregate saving rate.[32]

To understand the source of the time variation in the aggregate effects of mortgage rate resets, Figure 13 plots the estimated rate adjustments, $\triangle R_t^D$, for $D = 2, 3, 4, 5$. It shows that the time-varying rate adjustment at the individual level mainly accounts for variation in the aggregate spending and saving effects of mortgage rate resets. The rate reductions of 5-year FRMs, for example, reached the maximum in late 2012, creating large spending and saving effects in the economy. In the second half of 2013, in contrast, the rate adjustment of 5-year FRMs fell to the

[29] Since the estimated auto spending responses are measured at monthly frequency, we multiply these responses by 84 based on the fact that the most common auto loan duration in Canada is 7 years. We then divide them by the historical LTV ratio of auto loans (see Watts (2016)). Finally, these responses are scaled by the changes in the mortgage rate, so they can be interpreted as semi-elasticities.

[30] Our data for the monthly, seasonally adjusted aggregate new motor vehicle sales is obtained from Statistics Canada (Table 20-10-0001-01), scaled by the share used for non-commercial purposes, which is 87%.

[31] Our data for the quarterly, seasonally adjusted aggregate household saving rate and disposable income are obtained from Statistics Canada (Table 36-10-0112-01).

[32] The magnitude of this effect, however, is small relative to the aggregate saving rate. On average, the effect due to mortgage rate resets account for only 2.2 percent of aggregate saving. The fact that our estimates are not higher is expected, given that we restrict attention to consumers who reset their mortgages and that we only track saving through debt repayment rather than asset accumulation.

lowest level since 2011, limiting the spending and saving effects of mortgage rate resets. Similar time-varying patterns can be found in other FRMs, despite larger variances.

7 Implications of Mortgage Rate Refinancing for Monetary Policy

In this section, we explore two implications of mortgage rate refinancing for monetary policy. First, due to the rigidity in mortgage contracts, current monetary policy changes only contribute partially to the rate adjustment at the individual level. We quantify the extent to which monetary policy shifts in the two episodes have contributed to the mortgage rate changes through refinancing. Second, the effect of current monetary policy actions depends on the margin of the borrowers who currently refinance their mortgages, which is partly driven by the past monetary policy actions. We quantify the degree of this path dependence using historical time series data on monetary policy rate shocks and mortgage origination in Canada.

7.1 Decomposing Mortgage Rate Adjustment

Our estimates of the mortgage rate adjustment upon reset are substantial, reaching -112 basis points for 5-year term mortgages in the rate decrease episode, and +55 basis points for 2-year term mortgages in the rate increase episode. Two observations, however, suggest that current monetary policy actions may have only partially contributed to the mortgage rate adjustment. First, in the rate decrease episode, the change in the rate of 5-year term mortgages is too large compared to the total change in the policy rate (50 basis points). Second, the average rate adjustment of 5-year term mortgages in the rate increase episode is negative. Correctly accounting for the pass-through of current monetary policy to mortgage rates is important for understanding its impact on the economy through the mortgage market.

To gauge the contribution of monetary policy to the rate adjustment at the individual level, we decompose the change in the mortgage rate estimated in Table 3 and 7 into the component driven by the trend in the prevailing mortgage rates and the component driven by current monetary policy shifts. Specifically, we adopt a two-step procedure. First, we restrict the sample to the loans renewed within one year prior to the starting month of the corresponding episode, and estimate a linear function of the renewal rate by regressing it on a constant and the characteristics of the loan.[33] Second, we use the estimated coefficients from the first step, and the characteristics of a loan renewed in each episode to construct a counterfactual renewal rate as if the loan was renewed

[33]These characteristics include the mortgage term, outstanding balance, insurance status, credit score, borrower age, FSA-level LTV ratio, and province. The R^2 of the fitted model for each episode is about 25%, indicating a high goodness of fit for cross-sectional regressions.

before the policy shock. We then estimate equation (1) for the change in the mortgage rate with the new rate being the counterfactual rate.

The results are shown in Table 20. In the first episode, without the monetary policy cuts in 2015, the downward rate adjustment would have been smaller. For example, the reduction for 5-year term mortgages would have been only 83 basis points, rather than 112 basis points. In the second episode, without the tightening of monetary policy, most loans would have experienced a downward, rather than upward rate adjustment.

These estimates allow us to isolate the part of the mortgage rate change driven by monetary policy actions from the part driven by the mortgage rate trend, as shown in the third row of each panel in Table 20. We find that, for longer-term mortgages, the bulk of the rate adjustment is driven by the trend in the prevailing market rates, whereas for shorter-term mortgages, current monetary policy actions explain much of the adjustment. Moreover, given the change in the monetary policy rate, we can compute the pass-through of the policy rate to the mortgage rates. It varies from 24% to 58% in the rate decrease episode, and from 33% to 44% in the rate increase episode depending on the mortgage term.

7.2 Path Dependence of Monetary Policy

To see how the effect of current monetary policy actions may depend on past policies, i.e., path dependence, rewrite expression (4) with two modifications as

$$\int_D \left(\triangle R_t^{T,D} + \triangle R_t^{M,D} \right) \times \epsilon_t^D \times \left(\theta_t^D \times \Phi_t(D) \right) dD. \tag{5}$$

First, the average rate adjustment of term-D mortgages at time t, $\triangle R_t^D$, is decomposed into the rate change driven by the trend in the prevailing market rates, $\triangle R_t^{T,D}$, and the pass-through of current monetary policy to the mortgage rate, $\triangle R_t^{M,D}$. Second, the number of borrowers who reset their term-D mortgages at t, $\phi_t(D)$, is expressed as the product of the stock of term-D mortgages, $\Phi_t(D)$, and the renewal rate of term-D mortgages, θ_t^D. Thus, given $R_t^{T,D}$, the effect of current monetary policy through the mortgage refinancing channel is

$$\int_D \triangle R_t^{M,D} \times \epsilon_t^D \times \theta_t^D \times \Phi_t(D) dD. \tag{6}$$

Note that, given a policy shock and a pass-through rate, $\triangle R_t^{M,D}$ is determined, ϵ_t^D is driven by preferences, and θ_t^D is fixed because the timing of mortgage rate reset is predetermined in the Canadian mortgage market. Therefore, the only component in (6) that is likely to be affected by past monetary polices is $\Phi_t(D)$, the stock of mortgages at time t. Intuitively, low mortgage rates

resulting from expansionary monetary policy in the past may have stimulated home purchases and mortgage origination, which determine the number of borrowers refinancing in the current period, and hence the effect of current monetary policy actions.

Figure 14 illustrates this path dependence by plotting the number of homeowners who reset their 5-year term mortgages in each month and the rate of 5-year FRMs five years ago. The two series are negatively correlated with a correlation of -0.28. This suggests that when the mortgage rate was high in the past, the current number of renewing mortgages is small such as in 2012-2013, and vice versa such as in 2016-2017.

To formally establish the relationship between monetary policy actions and the change in the stock of mortgages, we estimate the causal effect of monetary policy shocks on mortgage originations using quarterly time series data between 1994Q3 and 2015Q3. Our monetary policy shock measure is from Champagne and Sekkel (2018), who construct a series of the exogenous component of monetary policy that is orthogonal to the policy-makers' information set. We use the Jorda (2005) local projection method to estimate the impulse response of mortgage origination to a monetary policy shock,

$$x_{t,t+h} = \delta_0 + \delta_h \epsilon_t + Controls_t + u_{t+h} \tag{7}$$

for $h = 1, ..., 8$, where $x_{t,t+h}$ denotes the growth rate of mortgage origination from quarter t to $t+h$.[34] ϵ_t is the monetary policy shock in quarter t. δ_h is the impulse response at horizon h. We also include a set of quarterly dummies as the control variables to remove seasonality. Since the error terms are moving averages, we use HAC standard errors based on 24 autocorrelations.

Figure 15 shows the results. We find that a contractionary monetary policy shock that raises the policy rate by 100 basis points reduces mortgage origination by about 10 percent on impact. This effect is significant and persists for 5 quarters. Our estimates suggest that current monetary policy has an immediate and significantly negative impact on mortgage origination, which contributes to the change in the stock of mortgages and affects the number of mortgages to be renewed in the future.

[34] We obtain quarterly data on the value of mortgage origination by all federally regulated lenders from the Bank of Canada's Banking and Financial Statistics. Since the value of a mortgage depends on the house price, we subtract from the growth rate of mortgage origination the growth rate of house prices to obtain a proxy for the growth rate of the number of mortgage origination. Our house price measure is the MLS national average sale price, which covers the sample period of our analysis.

8 Further Evidence and Robustness Analysis

In this section, we provide further analysis that supports our main results in Sections 4 and 5. This analysis helps to address a number of potential concerns arising from the identification strategy, the institutional features, the data, and the anticipatory effects.

Difference-in-Difference Estimates. As described in Section 3, one concern with our baseline strategy is the inability to account for the mortgage-age effects that could drive consumption and borrowing decisions. To address this problem, we use a difference-in-difference design that introduces longer-term mortgages as the control group. Specifically, for the mortgages in the treatment group, we use the mortgages previously reset (either renewed or originated) at the same time but having a 7 or 10 year term as the control group.

Table B1 shows the mortgage loan-level adjustments using this approach. The results confirm that loans renewed in the first episode experienced substantial rate reductions, and that shorter-term mortgages renewed in the second episode reset to higher rates. It also confirms the asymmetric prepayment pattern documented in Section 4. Borrowers convert only part of their interest savings into liquidity and use the rest to pay down their mortgages when the rate decreases, while adjusting their payments upward to meet the required amount when the rate rises.

Note that the responses of the mortgage rate, required and contract payment in Table B1 are roughly half as large as the estimates in Tables 3 and 7. The reason is that not all loans in the treatment group have their rates reset at the beginning of the episode. We would expect these responses to become stronger toward the end of the episode as more loans experienced resets. This can be seen by examining the dynamic adjustments. Figure B1 illustrates this point for the 5-year term mortgages in the first episode. By the end of the episode when all loans in the treatment group have their rates reset, the estimates are almost the same as in Table 3.

Table B2 shows borrower-level auto spending and revolving debt repayment responses. As in Section 5, we find asymmetric spending responses. Auto purchases increase when the rate falls, but do not change when the rate rises. On the other hand, borrowers actively pay down their revolving debt in both episodes. These patterns show that our results based on the baseline empirical strategy are robust to controlling for the mortgage-age effects.

The main reason why we do not use this alternative specification as the baseline is that the size of the control group is small, as not many Canadian borrowers take longer-term mortgages, especially in the earlier period of our sample. In our data, 7-year and 10-year term mortgages account for only

2% of the mortgage stock. This leads to large standard errors, especially for the effects based on 5-year term mortgages. In addition, one might be concerned about the endogenous selection into longer-term mortgages. For these reasons, we estimate a second difference-in-difference specification that introduces the loans not reset in the two episodes but having the same term as the loans in the treatment group as the control group.

Table B3 shows the loan-level adjustments, which are very similar to the estimates in Table B1. Figure B2 plots the dynamic adjustments of 5-year term mortgages in the rate decrease episode, which confirms that, by the end of the episode, when all loans in the treatment group reset their rates, the rate and payment responses are almost the same as the estimates based on the baseline empirical strategy. Turning to the borrower-level responses, we find strong debt repayment incentives in both episodes as in Section 5. However, we do not find significant consumption responses in either episode. This might be explained by the inability of this strategy to control for the mortgage-age effects. Another caveat of this strategy is that we are unable to obtain a control group for the 2-year term mortgages renewed in the 2015-2017 episode, because all existing mortgages with a 2-year term would be renewed during this episode.

Transition to other Financial Institutions (FIs). Since mortgages in our sample are issued by one bank, a potential concern is that our estimates may not capture the effects of mortgage rate resets when borrowers switch to other FIs for renewal. To address this concern, we track the activity of the borrowers who close their mortgage accounts in this bank for another six months after the accounts are closed. The objective of this analysis is to assess whether our baseline results are affected by the borrowers who switch to other FIs at mortgage renewal.

We classify the purpose for an account closure into four categories: (1) cash-out refinance, if, within the six months of the closing date, the borrower opens another account with an initial balance $5,000 more than the balance of the previously closed account, and keeps the same postal code; (2) renewal, if all other conditions in (1) are met, but the change in the balance is less than $5,000; (3) purchase, if, within the six months of the closing date, the borrower opens another account with any balance and a different postal code; (4) final closure, if the borrower does not open a new account with any FIs within the six months of the closing date.

Table C1 shows the distribution of the purpose for closing an account in this bank. We find that cash-out refinancing and final closure are the most important purposes for closing an account. In contrast, only 3-4% of borrowers renew their mortgages after closing the previous account, among

whom less than 40% switch to another FI. Based on these statistics, in a two-year episode, the fraction of the borrowers who switch to other FIs for mortgage renewal is at most 0.5% (=1.3% $\times$ $24 \times 4\% \times 37\%$), where 1.3% is the monthly account closure rate.

Although the number of switching borrowers is too small to matter quantitatively for our main results, we still report the estimated change in the mortgage rate for these borrowers in Table C2. In the rate decrease episode, mortgages renewed with the bank of our sample obtain more favorable rates than those switching to other FIs, for all terms. In the rate increase episode, the rate obtained by renewing a 3-year or a 4-year term FRM with other FIs is not different from renewing it with the bank of our sample. However, when renewing the popular products, i.e., 2-year and 5-year term FRMs, borrowers obtain more favorable rates if not switching. These results show that switching to a different lender for renewal in general does not benefit the borrower.

Term Spread Effect. In our baseline analysis, we separately estimate the effects of mortgage rate resets for each mortgage term before the reset, but we do not restrict the mortgage term after the reset to be the same as before the reset. Thus, our estimates capture the average responses across all terms after the reset. One concern is that, if borrowers having shorter-term mortgages switch to longer-term mortgages at renewal or the other way around, our estimates may be confounded by the spread between the longer and shorter-term mortgage rates. As shown in Table 2, the mortgage rate is increasing in the mortgage term. To address this concern, Appendix D estimates the term transition probabilities, and examines to what extent the main results in Sections 4 and 5 are affected by removing the term spread effect, when we restrict the mortgage sample to loans having the same term before and after the reset.

Table D1 shows that the choice of the term is persistent for borrowers holding the shortest and the longest term mortgages. More than 60% of the 2-year term mortgage borrowers still choose the 2-year term after the reset. Around 70% of the 5-year term mortgage borrowers keep the same term in the rate decrease episode, but this fraction falls to 53% in the rate increase episode. Borrowers with a 3-year or 4-year term mortgage, however, tend to switch to other terms.

Table D2 examines the loan-level adjustments using the restricted sample. As expected, shorter-term mortgages experienced larger rate reductions in the first episode and smaller rate increases in the second episode when the term spread effect is removed. For longer-term mortgages, the estimates are very close to those reported in Section 4. The mortgage prepayment pattern also resembles that in Section 4. Turning to the borrower-level outcomes in Table D3, the patterns of

asymmetric auto spending responses and the voluntary deleveraging in both episodes are robust to removing the term spread effect.

Mortgages Reset in Both Episodes. When studying the asymmetric responses to a mortgage rate change, it would be ideal to focus on the same loans renewed in both episodes, which helps to control for unobserved heterogeneity arising from the cohort effect. Given how close in time the two episodes are, however, mortgages reset in both episodes are those having a 2-year or 3-year term before and after the reset, not representative to the mortgages in Canada. Nevertheless, we show in Appendix E that the patterns documented in Sections 4 and 5 holdin this restricted sample. Specifically, Table E1 shows asymmetry in mortgage prepayment, similar to the pattern in Section 4. Table E2 shows asymmetric auto spending responses driven by borrowers having 3-year term mortgages, and the voluntary deleveraging in both episodes driven by borrowers having 2 -year term mortgages. These patterns are consistent with the baseline estimates in Section 5.

Timing of Renewal. As shown in Figure 2, although almost 50% of borrowers renew their mortgages in the scheduled month, some borrowers choose to do it up to six months earlier with the current lender, in which case no prepayment penalties apply. This observation may lead to the concern that borrowers self-select into the rates offered by the lender at different points in time. This self-section may bias our estimated consumption and savings responses. For example, in the period of declining rates, impatient borrowers may renew their mortgages earlier to cash out interest savings. This selection leads to an upward bias in our estimated consumption response, because a smaller rate reduction will cause a larger average consumption response.

In Appendix F, we examine to what extent the mortgage rate adjustment and auto spending response depend on the timing of renewal. We establish two facts: (1) Except for a few cases, borrowers who renew their mortgages earlier do not obtain a very different rate from on-time renewers, especially in the rate decrease episode, as shown in Table F1. (2) Borrowers who renew their mortgages earlier in the rate decrease episode do not appear to be more impatient, as shown in Table F2. Our analysis suggests that changes in mortgage rates are mostly driven by the change in the prevailing market rates, rather than borrowers' characteristics or the competition among banks, and that our estimated auto spending responses are not confounded by the selection of the timing of mortgage renewal.

Anticipatory Effect. An interesting question is whether the estimated spending and debt repayment responses in Section 5 should be interpreted as the responses to an unanticipated or an

anticipated mortgage rate change. According to standard consumption models, the response to an unanticipated positive income shock (due to the reduction in mortgage payments), for example, should be larger than the response when such a shock is anticipated, assuming the fraction of liquidity constrained households is small in the population. It is possible that sophisticated, unconstrained consumers may have already anticipated the change in their mortgage rates based on the history of the prevailing market rates. If so, we would underestimate the true effects on spending and savings.

We show that this is not the case by isolating a group of consumers who renewed their mortgages in a short window of time when an unexpected monetary policy cut took place. Our premise is that borrowers who renewed their mortgages in 2015Q1 should have larger responses than similar borrowers who renewed their mortgages in, say, 2015Q2, because the unexpected monetary policy rate cut was implemented in January 2015. We therefore estimate the heterogeneity in the timing of renewal by interacting the post-renewal indicator with the quarterly dummy of renewal. Our results show no significant heterogeneity across borrowers who renewed in 2015, suggesting that the baseline estimates capture the responses to an unanticipated mortgage rate shock. Put differently, the anticipatory effect, if exists, are weak and are unlikely to alter our results. The lack of the anticipatory effect has also been documented in Di Maggio et al. (2017) for the case of ARM borrowers in the United States.

9 Conclusion

Ten years after the global financial crisis, interest rates in many developed economies have started to rise. This change will undoubtedly affect the cost of new mortgage borrowing, but its impact on existing mortgages is likely to be even greater, especially in the countries where short-term FRMs or ARMs dominate. This is a concern for policy makers because consumer spending depends on mortgage payments.

We study the effects of mortgage rate changes through refinancing on consumer spending and savings using a comprehensive credit-bureau dataset covering more than one million Canadian borrowers. The institutional structure of Canadian mortgage markets permits a clean identification of the causal effects. In addition, we provide a detailed analysis of how consumers respond not only to mortgage rate decreases but also to mortgage rate increases.

Our analysis reveals that durable spending of mortgage borrowers responds asymmetrically to mortgage rate changes. When the rate falls, auto spending rises, but the reverse does not

happen when the rate increases. This result helps to alleviate the concern that mortgage rate refinancing during the contractionary monetary policy period in the post-crisis era may discourage durable spending. We also find that mortgage borrowers actively repay their non-mortgage debt in response to both rate increases and decreases, but especially so in the latter case. Thus, improved household balance sheets upon refinancing are likely to provide some buffer for future negative shocks. However, the rise in the delinquency rates on consumer debt in response to higher interest rates remains a concern for financial stability. We show that the conventional explanation of how consumers respond to mortgage rate changes based on the income effect alone cannot account for the deleveraging when the mortgage rate increases. We explore several alternative explanations, and show that consumer expectations about future interest rates are likely to be an explanation.

The short-term FRMs we focus on are quite popular in OECD countries. While these contracts offer greater flexibility compared to the long-term FRMs prevalent in the U.S., they are still associated with a non-trivial degree of rate rigidity. We highlight several implications of this rigidity for monetary policy. First, mortgage rate adjustment at the individual level is driven by both the pass-through of monetary policy shocks to mortgage rates and the trend in the prevailing market rates over time. Therefore, the effect of refinancing on aggregate spending cannot be simply attributed to the current expansionary monetary policy actions. Second, monetary policy is path dependent. In Canada – and in countries with similar mortgage instruments – past monetary policies may have changed the margin of the borrowers who refinance today, making the effect of current monetary policy state dependent.

Understanding the transmission of monetary policy to consumer spending and savings through mortgage refinancing is important for central banks in economies with well-developed mortgage markets. Previous studies largely relied on evidence from the United States. Whether these conclusions can be generalized to other developed countries is unclear, because the United States is unique in several aspects such as having an unusually high share of long-term FRMs, the common use of securitization in housing finance, and the absence of prepayment penalties (see Lea (2010)). Our estimates may depend on the specific time episodes studied and on the Canadian socio-economic conditions, our empirical approach and the implications of mortgage rate refinancing for monetary policy should apply more broadly to other countries.

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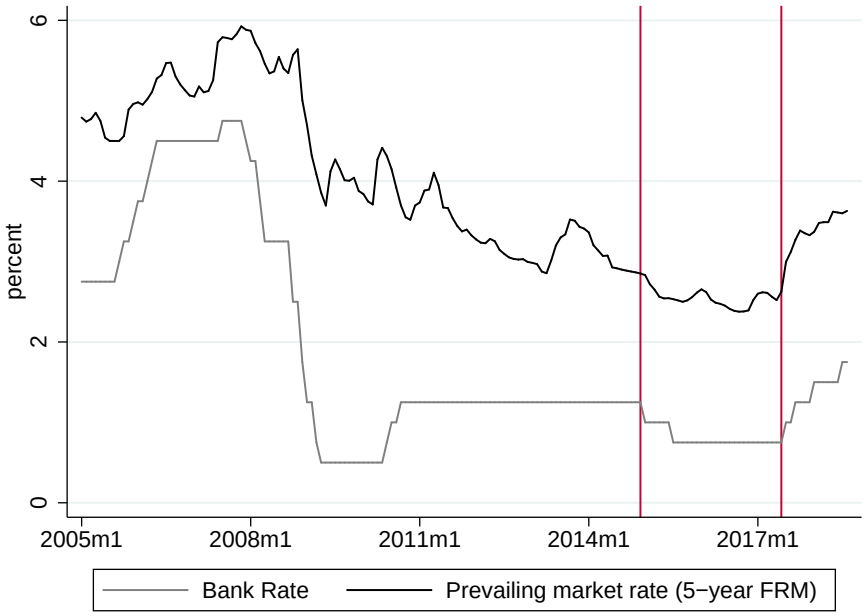
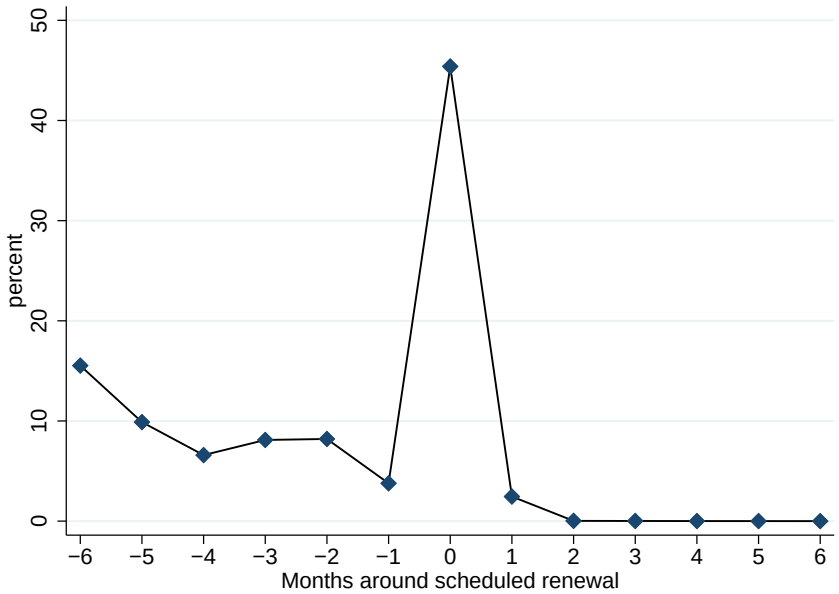
Figure 1: Canadian Interest Rates



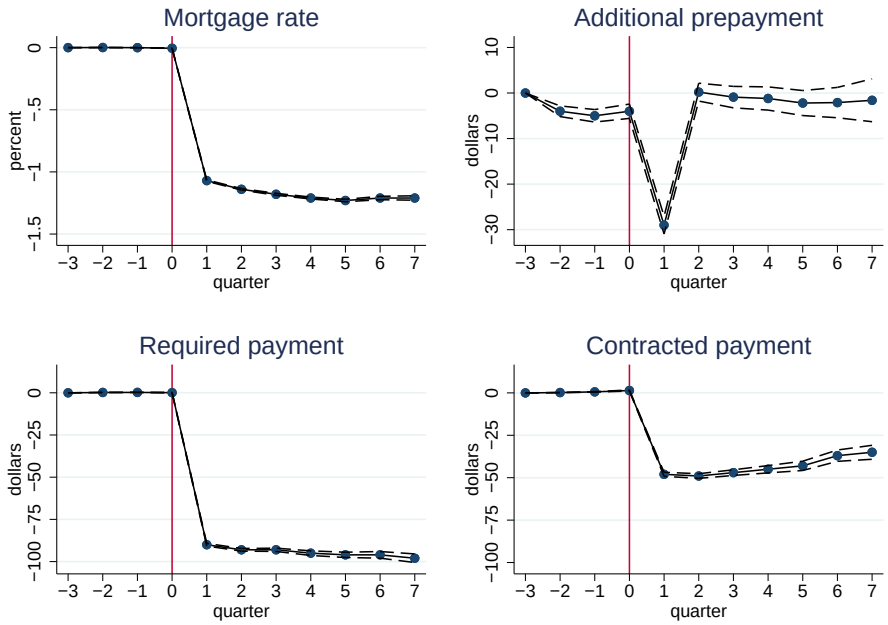
Notes: The Bank Rate is the rate at which the Bank of Canada lends funds to financial institutions for one day. The prevailing market rate refers to the average 5-year FRM rate among national mortgage brokers. The two vertical lines indicate the beginning of the two episodes in our study: 2015.1 and 2017.7.

Figure 2: Distribution of the timing of mortgage renewal



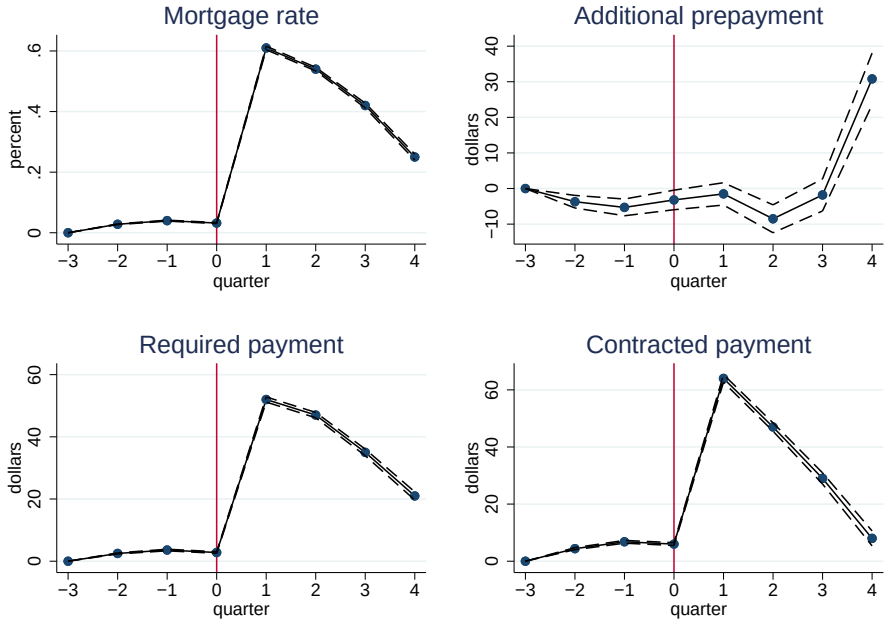
Notes: This figure plots the percent of borrowers in our sample who renew their mortgages within x months of the scheduled renewal month, where x is a value on the x-axis. "0" refers to on-time renewal.

Figure 3: Dynamic loan-level adjustments: 5-year FRMs (rate decrease episode)



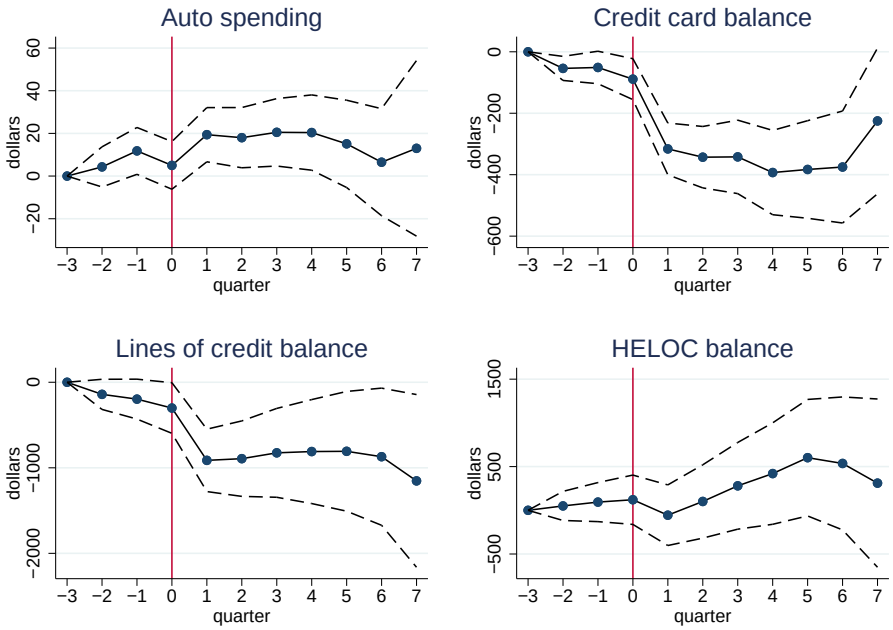
Notes: Point estimates in dots are obtained by estimating equation (2). 95% confidence intervals are in dashed lines.

Figure 4: Dynamic loan-level adjustments: 2-year FRMs (rate increase episode)



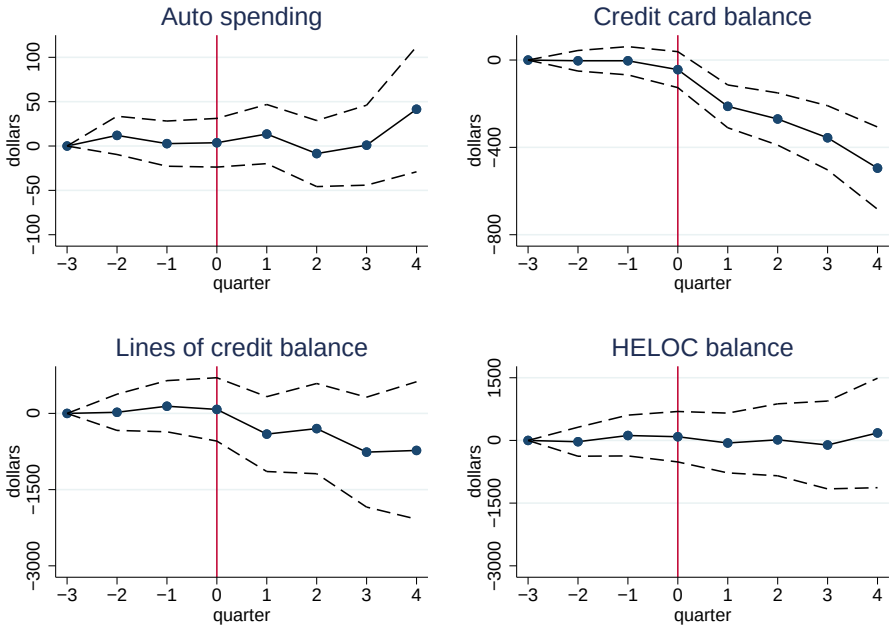
Notes: Point estimates in dots are obtained by estimating equation (2). 95% confidence intervals are in dashed lines.

Figure 5: Dynamic borrower-level responses: Borrowers with 5-year FRMs (rate decrease episode)



Notes: Point estimates in dots are obtained by estimating equation (2). 95% confidence intervals are in dashed lines.

Figure 6: Dynamic borrower-level responses: Borrowers with 2-year FRMs (rate increase episode)

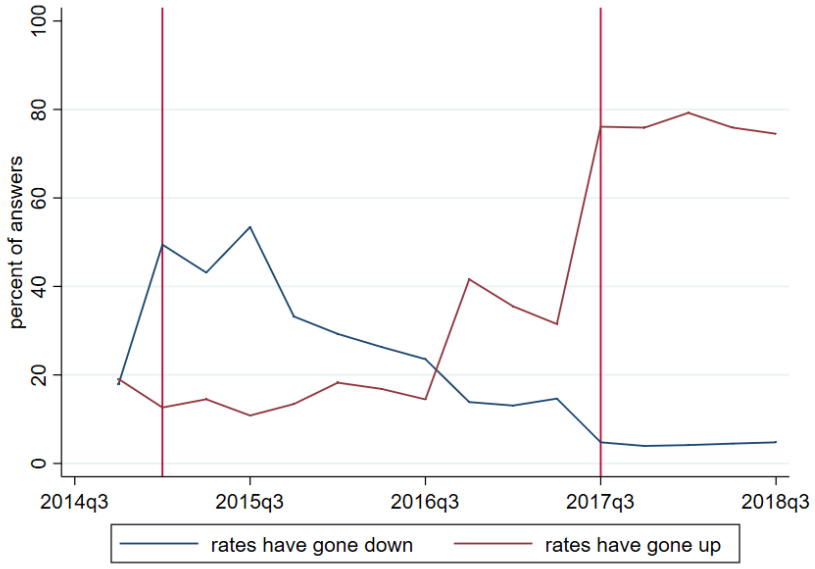


Notes: Point estimates in dots are obtained by estimating equation (2). 95% confidence intervals are in dashed lines.

Figure 7: Survey responses: Probability of higher interest rates in the next 12 months

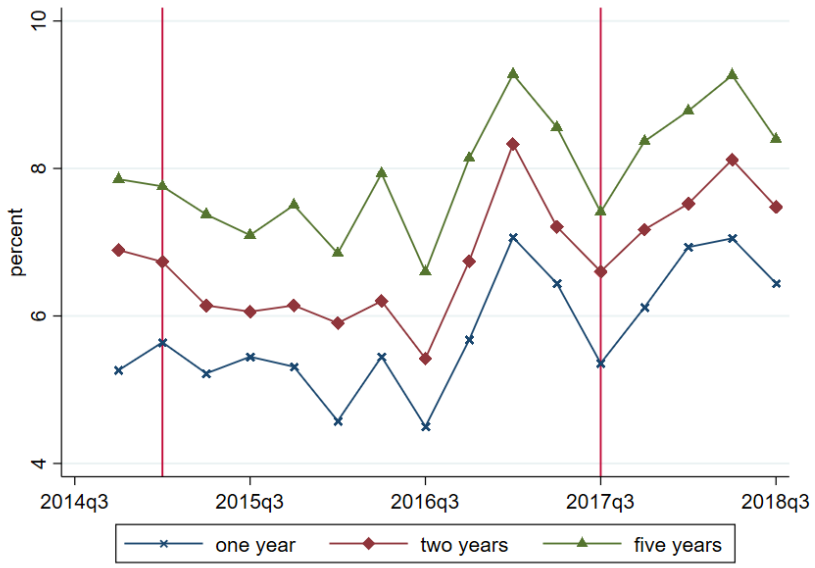
Source: Canadian Survey of Consumer Expectations (CSCE). Mean and median responses of homeowners with FRMs to the question "*What do you think is the percent chance that 12 months from now the average interest rate on things such as mortgages, bank loans and savings will be higher than it is now?*"

Figure 8: Survey responses: Change in interest rates over the past 12 months



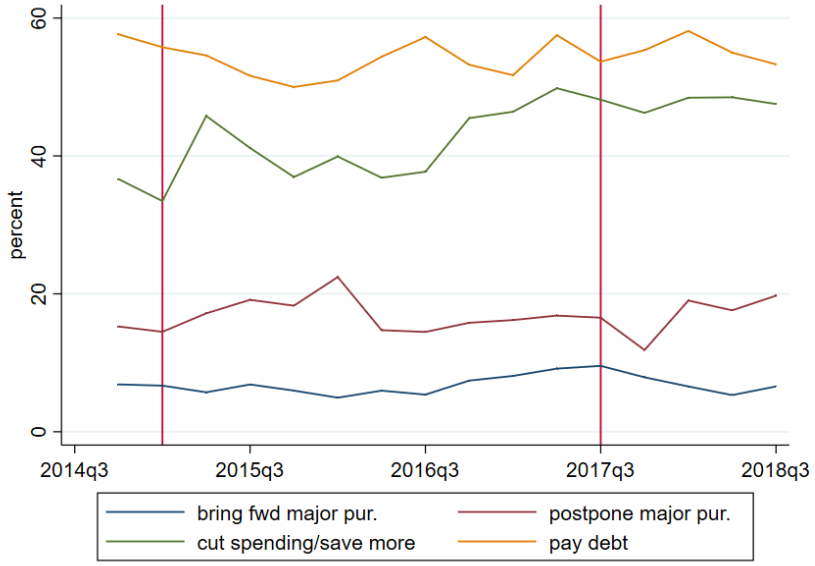
Source: CSCE. Fraction of the responses of homeowners with FRMs to the question "*How would you say interest rates on things such as mortgages, bank loans and savings have changed over the last 12 months? Fallen a lot/a little, About the same, Risen a lot/a little.*"

Figure 9: Survey responses: Expected interest rates in 1, 2, and 5 years



Source: CSCE. Mean responses of homeowners with FRMs to the question "*At what level do you think that interest rates on things such as mortgages, bank loans and savings will be in one, two and five years from now?*"

Figure 10: Survey responses: Action taken/planning to take in response to interest rate expectations



Source: CSCE. Fraction of responses of homeowners with FRMs to the question "*Which, if any, of the following actions are you taking, or planing to take, in light of your expectations for interest rates?*"

Figure 11: Effect of mortgage rate resets on aggregate auto spending

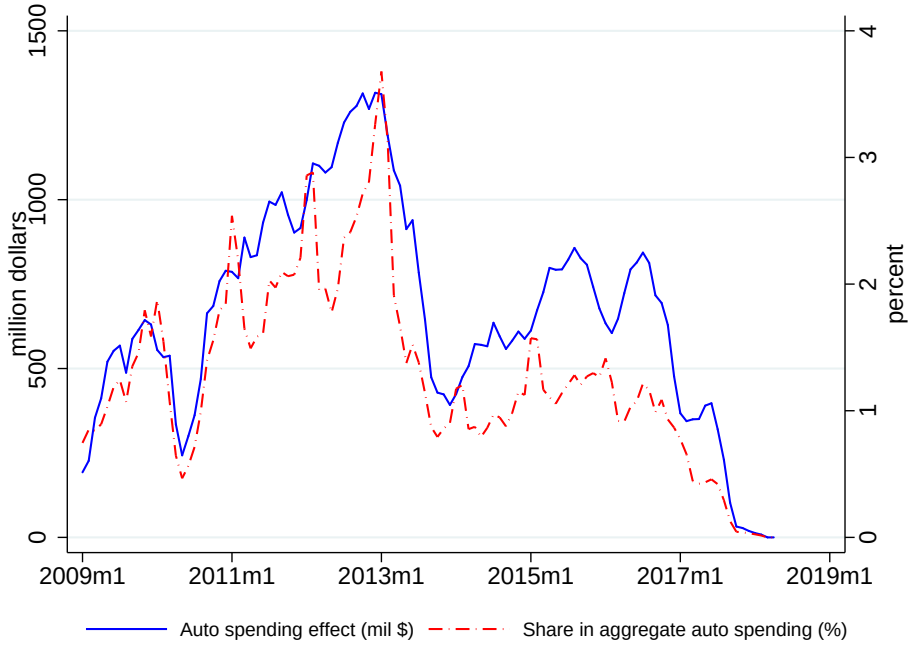


Figure 12: Aggregate saving rate and saving rate due to mortgage rate resets

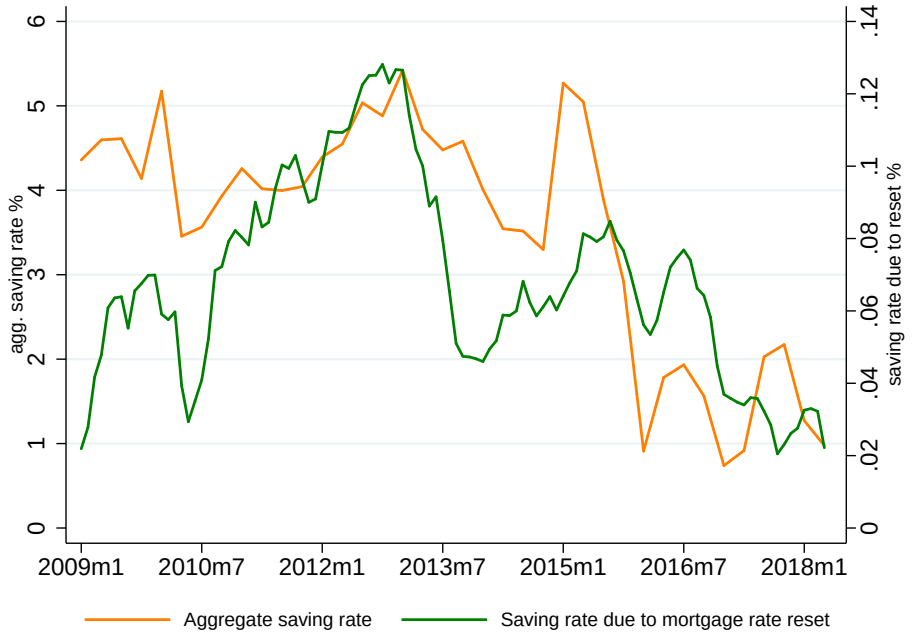


Figure 13: Mortgage rate adjustment upon reset

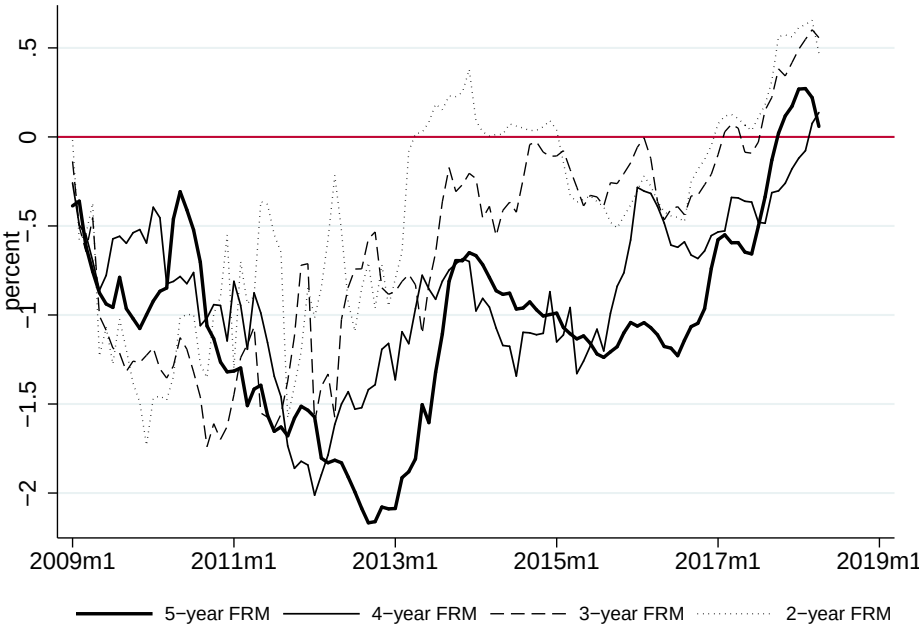


Figure 14: Number of households renewing 5-year FRMs and 5-year FRM rate in the past

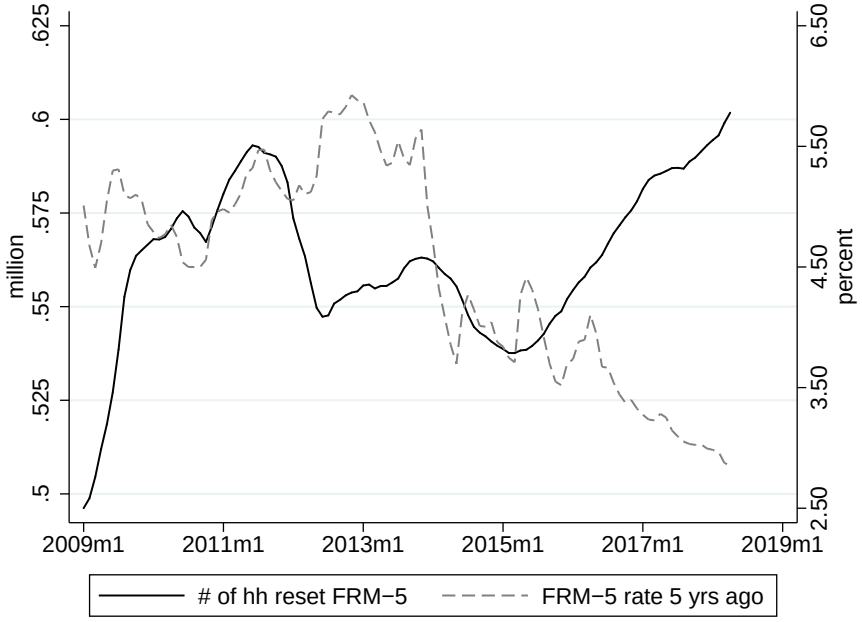
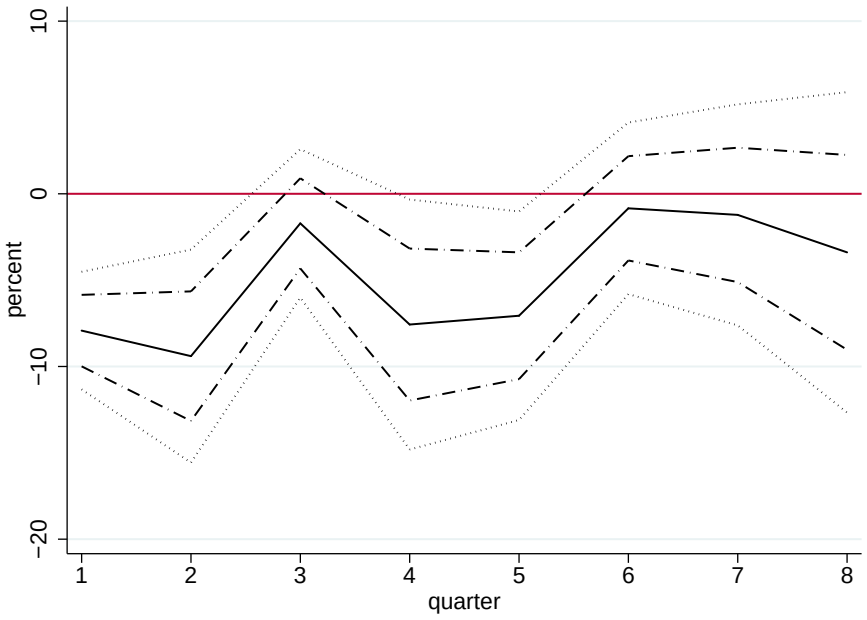


Figure 15: Impulse response of mortgage origination to a 100 b.p. monetary policy shock



Notes: Dashed lines and dotted lines represent 68% and 90% confidence intervals, respectively. HAC standard errors are computed based on 24 autocorrelations.

Table 1: Mortgage loan characteristics at origination

	Sample bank		Other lenders	
	Mean	Median	Mean	Median
All FRMs				
Share of total market (%)	18	-	82	-
Contract rate (%)	2.89	2.84	2.90	2.79
Outstanding balance ($)	289,766	248,541	302,050	255,745
LTV ratio (%)	78.6	80.0	77.9	80.0
DTI ratio (%)	329.0	302.1	334.8	296.8
Credit score	768	771	756	763
Borrower age	42.5	41.0	41.9	40.0
Fraction of insured (%)	33.1	-	35.9	-
Fraction of FRM-5 (%)	64.1	-	58.0	-
FRM-5				
Share of total market (%)	19	-	81	-
Contract rate (%)	2.90	2.82	2.88	2.79
Outstanding balance ($)	307,691	266,540	291,600	255,272
LTV ratio (%)	80.0	80.5	80.7	80.0
DTI ratio (%)	352.3	332.3	340.7	313.9
Credit score	765	768	756	762
Borrower age	41.4	39.0	41.0	39.0
Fraction of insured (%)	38.5	-	45.4	-

Source: Bank of Canada-OSFI mortgage originations dataset. This table shows the characteristics of the mortgages originated by the sample bank and by all other federally regulated lenders between 2014 and 2018 for the purpose of home purchases.

Table 2: Summary statistics

	2-year		3-year		4-year		5-year	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
FRMs renewed in 2015.1-2017.1								
Initial balance ($)	185,267	139,683	191,335	134,338	209,110	134,251	195,317	124,748
Current balance ($)	159,955	129,365	165,040	124,838	180,650	126,622	171,148	118,932
Rate before renewal (%)	2.62	0.23	2.71	0.25	2.86	0.26	3.79	0.51
Rate after renewal (%)	2.39	0.43	2.48	0.45	2.51	0.43	2.65	0.49
Contracted payment b.f. renewal ($/month)	922	636	967	608	1,067	622	1,025	596
Contracted payment a.f. renewal ($/month)	922	619	970	607	1,049	615	975	541
Payments delayed for 30+ days (%)	0.13	3.62	0.16	3.92	0.15	0.38	0.41	6.37
Payments delayed for 60+ days (%)	0.03	1.63	0.03	1.75	0.03	1.72	0.08	2.85
Payments delayed for 90+ days (%)	0.01	0.86	0.01	0.82	0.01	0.88	0.02	1.23
Number of loans	46,724		31,750		14,847		71,070	
Corresponding consumers								
Credit score	775	97	773	99	779	96	754	109
Age	50	12	50	12	49	12	48	12
FSA-level LTV (%)	55.7	11.4	57.7	11.7	58.2	12.0	61.7	11.8
Prob. of auto purchase (%)	0.42	6.46	0.43	6.52	0.43	6.57	0.42	6.48
Auto spending ($/month)	115	1,979	117	1,995	119	2,012	110	1,899
Credit card balance ($)	4,936	7,668	4,954	7,734	4,928	7,717	5,036	7,660
Lines of credit balance ($)	25,799	48,874	25,355	47,830	24,844	48,358	19,987	38,148
HELOC balance ($)	14,703	44,864	14,129	43,921	14,040	44,313	8,784	33,946
FRMs renewed in 2017.7-2018.9								
Initial balance ($)	203,566	173,751	189,656	132,305	183,740	115,232	241,575	151,237
Current balance ($)	174,830	161,692	151,897	116,273	150,548	106,050	210,834	141,123
Rate before renewal (%)	2.22	0.25	2.53	0.28	2.77	0.17	3.01	0.39
Rate after renewal (%)	2.76	0.42	2.85	0.41	2.97	0.38	2.94	0.45
Contracted payment b.f. renewal ($/month)	951	735	950	613	944	547	1,170	679
Contracted payment a.f. renewal ($/month)	986	740	975	592	980	558	1,181	676
Payments delayed for 30+ days (%)	0.10	3.10	0.14	3.72	0.19	4.41	0.27	5.13
Payments delayed for 60+ days (%)	0.02	1.32	0.03	1.71	0.04	1.93	0.05	2.32
Payments delayed for 90+ days (%)	0.004	0.66	0.01	1.02	0.01	0.83	0.01	1.10
Number of loans	35,137		10,925		26,800		48,826	
Corresponding consumers								
Credit score	773	100	774	101	771	101	764	105
Age	51	12	51	12	51	13	48	12
FSA-level LTV (%)	49.8	13.3	53.0	13.0	55.4	13.0	56.4	14.6
Prob. of auto purchase (%)	0.49	7.00	0.41	6.36	0.41	6.38	0.44	6.63
Auto spending ($/month)	141	2,258	116	2,050	117	2,049	123	2,072
Credit card balance ($)	5,194	7,786	5,133	7,826	5,082	7,698	5,494	8,051
Lines of credit balance ($)	27,766	54,986	26,993	52,689	24,554	45,060	25,022	51,950
HELOC balance ($)	17,042	51,233	15,769	48,932	12,611	41,140	14,763	48,419

Source: TransUnion Canada consumer and account data.

Table 3: Mortgage loan-level adjustments (rate decrease episode)

	2-year	3-year	4-year	5-year
	Mortgage rate (percent)			
PostRenew	-0.17***	-0.17***	-0.40***	-1.12***
	(0.002)	(0.003)	(0.005)	(0.003)
# Obs.	1,392,956	1,283,121	742,924	4,394,396
	Required payment ($/month)			
PostRenew	-15.1***	-13.3***	-35.7***	-92.0***
	(0.25)	(0.35)	(0.59)	(0.41)
# Obs.	1,392,956	1,283,121	742,924	4,394,396
	Contracted payment ($/month)			
PostRenew	-3.0***	-2.3***	-11.5***	-48.8***
	(0.56)	(0.77)	(1.32)	(0.65)
# Obs.	1,392,956	1,283,121	742,924	4,394,396
	Additional prepayment ($/month)			
PostRenew	-2.4***	-4.1***	-5.0***	-9.3***
	(0.76)	(0.91)	(1.66)	(0.59)
# Obs.	1,392,956	1,283,121	742,924	4,394,396

Notes: ***, **, and * denote significance levels at 1%, 5% and 10% respectively. Standard errors are clustered at the loan level. The RHS of the estimated specification includes a set of time-varying borrower-level and FSA-level characteristics (age, previous-month credit score, previous-quarter FSA-level LTV ratio), loan and monthly fixed effects.

Table 4: Implied cash-on-hand (rate decrease episode)

	2-year	3-year	4-year	5-year
Expected length of new term (months)	34	41	49	51
Total interest savings ($)	513	545	1,749	4,692
Total mortgage prepayments ($)	329	283	941	1,729
Through contracted payments ($)	411	451	1,186	2,203
Through additional prepayments ($)	-82	-168	-245	-474
Cash-on-hand ($)	184	262	808	2,963

Notes: The expected length of the new term is computed based on term transition probabilities in Table D1. Total interest savings are computed by multiplying the estimated change in the required payment by the expected length of the new term; prepayments through contracted payments are computed by multiplying the difference between the change in the required payment and in the contracted payment by the expected length of the new term; additional prepayments are computed by multiplying the additional prepayment estimate by the expected length of the new term; cash-on-hand is computed by subtracting total mortgage prepayments from total interest savings.

Table 5: Heterogeneous loan-level adjustments (rate decrease episode)

	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
	Required payment ($/month)				Contracted payment ($/month)			
PostRenew	-17.8***	-15.7***	-34.8***	-77.5***	-3.3***	-1.3	-5.9***	-24.4***
	(0.34)	(0.48)	(0.76)	(0.59)	(1.00)	(1.31)	(1.86)	(1.09)
PostRenew	6.3***	7.3***	3.0***	-12.1***	-0.7	-1.2	-6.8***	-30.9***
$\times LowCreditScore$	(0.46)	(0.60)	(0.92)	(0.66)	(0.97)	(1.27)	(1.88)	(1.08)
PostRenew	2.0	-5.4	9.8	-40.7***	-6.4	-13.9*	32.1	-32.1***
$\times HighLTV$	(4.49)	(4.98)	(9.09)	(6.74)	(5.80)	(7.27)	(30.7)	(8.42)
PostRenew	-1.5***	-3.1***	-8.6***	-25.5***	2.9**	0.3	-6.4***	-20.4***
$\times Age \leq 45$	(0.59)	(0.78)	(1.14)	(0.82)	(1.22)	(1.65)	(2.36)	(1.32)
PostRenew	3.1***	1.6*	6.5***	20.9***	-2.8*	-3.9*	-5.9*	-2.2
$\times Age \geq 65$	(0.68)	(0.84)	(1.25)	(0.99)	(1.63)	(2.04)	(3.47)	(1.72)
# Obs.	1,392,956	1,283,121	742,924	4,394,396	1,392,956	1,283,121	742,924	4,394,396

Notes: *LowCreditScore* refers to borrowers whose credit scores are below the median of the distribution. *HighLTV* refers to borrowers whose FSA-level LTV ratios are greater than or equal to 0.8.

Table 6: Mortgage delinquencies (rate decrease episode)

	2-year	3-year	4-year	5-year
	30+ days delay (%)			
PostRenew	-0.08***	-0.09***	-0.24***	-0.30***
	(0.017)	(0.021)	(0.055)	(0.025)
# Obs.	1,392,956	1,283,121	742,924	4,394,396
	60+ days delay (%)			
PostRenew	-0.02**	-0.02*	-0.04	-0.07***
	(0.007)	(0.009)	(0.033)	(0.011)
# Obs.	1,392,956	1,283,121	742,924	4,394,396
	90+ days delay (%)			
PostRenew	-0.006*	-0.01**	-0.03*	-0.01***
	(0.004)	(0.004)	(0.017)	(0.004)
# Obs.	1,392,956	1,283,121	742,924	4,394,396

Notes: See Table 3.

Table 7: Mortgage loan-level adjustments (rate increase episode)

	2-year	3-year	4-year	5-year
	Mortgage rate (percent)			
PostRenew	0.55***	0.26***	0.14***	-0.16***
	(0.003)	(0.005)	(0.004)	(0.003)
# Obs.	848,630	397,795	1,216,148	2,805,902
	Required payment ($/month)			
PostRenew	47.0***	18.3***	8.8***	-13.3***
	(0.39)	(0.60)	(0.41)	(0.40)
# Obs.	848,630	397,795	1,216,148	2,805,902
	Contracted payment ($/month)			
PostRenew	52.5***	16.9***	16.9***	-0.7
	(0.69)	(1.17)	(0.79)	(0.72)
# Obs.	848,630	397,795	1,216,148	2,805,902
	Additional prepayment ($/month)			
PostRenew	-0.4	10.0***	-0.2	-7.1***
	(0.93)	(1.89)	(1.20)	(0.91)
# Obs.	848,630	397,795	1,216,148	2,805,902

Notes: See Table 3.

Table 8: Implied cash-on-hand (rate increase episode)

	2-year	3-year	4-year	5-year
Expected length of new term (months)	34	39	44	47
Total interest savings	-1,598	-714	-387	625
Total mortgage prepayments	173	335	347	258
Through contracted payments	187	-55	356	592
Through additional prepayments	-14	390	-9	-334
Cash-on-hand	-1,771	-1,049	-734	367

Notes: See Table 4.

Table 9: Heterogeneous loan-level adjustments (rate increase episode)

	2-year	3-year	4-year	2-year	3-year	4-year	2-year	3-year	4-year
	Required payment ($/month)			Contracted payment ($/month)			Additional prepayment ($/month)		
PostRenew	42.7***	15.4***	6.8***	48.4***	18.7***	15.8***	8.1***	20.5***	16.2***
	(0.57)	(0.73)	(0.46)	(1.13)	(1.88)	(1.24)	(1.34)	(2.48)	(1.86)
PostRenew	4.9***	6.4***	4.1***	3.6***	-0.5	1.9	-9.5***	-14.1***	-19.4***
$\times$*LowCreditScore*	(0.69)	(1.21)	(0.60)	(1.26)	(2.06)	(1.24)	(1.37)	(2.12)	(1.86)
PostRenew	12.6***	12.5**	-10.4**	10.2**	20.4***	-8.1*	16.6***	32.8***	18.9*
$\times$*HighLTV*	(0.91)	(5.81)	(4.65)	(4.98)	(7.14)	(4.43)	(6.19)	(11.60)	(10.73)
PostRenew	11.0***	4.7***	1.5*	13.5***	3.1	3.9***	-5.8***	-5.8**	-11.3***
$\times Age \leq 45$	(0.94)	(1.35)	(0.86)	(1.56)	(2.27)	(1.50)	(1.57)	(2.35)	(2.16)
PostRenew	-10.2***	-8.5***	-0.6	-13.0***	-17.7***	-4.9***	-18.4***	-19.9***	-32.3***
$\times Age \geq 65$	(0.91)	(1.23)	(0.62)	(1.92)	(3.97)	(1.83)	(1.98)	(2.69)	(2.55)
# Obs.	848,630	397,795	1,216,148	848,630	397,795	1,216,148	848,630	397,795	1,216,148

Notes: See Table 5.

Table 10: Mortgage delinquencies (rate increase episode)

	2-year	3-year	4-year
	30+ days delay (%)		
PostRenew	-0.05***	-0.00	-0.03
	(0.016)	(0.031)	(0.029)
# Obs.	848,630	397,795	1,216,148
	60+ days delay (%)		
PostRenew	-0.01	-0.01	-0.00
	(0.007)	(0.015)	(0.013)
# Obs.	848,630	397,795	1,216,148
	90+ days delay (%)		
PostRenew	-0.01**	-0.01	-0.01
	(0.004)	(0.008)	(0.006)
# Obs.	848,630	397,795	1,216,148

Table 11: Responses of consumption measures (rate decrease episode)

	2-year	3-year	4-year	5-year
	Probability of auto purchase (%)			
PostRenew	0.03	0.01	-0.05	0.05***
	(0.022)	(0.024)	(0.040)	(0.014)
# Obs.	1,367,672	1,259,343	728,408	4,338,654
	Auto spending ($/month)			
PostRenew	1.8	10.2	-13.5	12.7***
	(6.95)	(7.42)	(12.92)	(4.27)
# Obs.	1,367,672	1,259,343	728,408	4,338,654

Notes: The probability of purchasing an auto and the corresponding auto spending are constructed based on auto loan balances. See Section 2.3 for a detailed description.

Table 12: Responses of revolving debt balances (rate decrease episode)

	2-year	3-year	4-year	5-year
	Credit cards ($)			
PostRenew	-147***	-201***	-226***	-270***
	(21.0)	(33.1)	(53.7)	(27.6)
# Obs.	1,367,672	1,259,343	728,408	4,338,654
	Lines of credit ($)			
PostRenew	20.7	-276	-570*	-661***
	(131.9)	(194.6)	(344.8)	(121.2)
# Obs.	1,367,672	1,259,343	728,408	4,338,654
	Home equity lines of credit ($)			
PostRenew	144	273	146	-9
	(128.3)	(183.2)	(331.0)	(116.0)
# Obs.	1,367,672	1,259,343	728,408	4,338,654

Table 13: Heterogeneous responses of revolving debt balances (rate decrease episode)

	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
	Credit cards ($)				Lines of credit ($)				Home equity lines of credit ($)			
PostRenew	-346***	-457***	-508***	-730***	-533**	-1109***	-1055**	-1328***	255	479*	382	366**
	(30.3)	(45.0)	(68.8)	(36.9)	(210.9)	(291.7)	(468.0)	(189.0)	(205.1)	(276.5)	(445.4)	(181.6)
PostRenew	309***	383***	251***	594***	1369***	2626***	2259***	1792***	253	961***	954**	290*
$\times$*LowCreditScore*	(39.3)	(53.3)	(80.5)	(36.2)	(217.5)	(282.1)	(430.8)	(160.5)	(211.2)	(265.4)	(417.5)	(152.1)
PostRenew	-49	11	89	140	-319	-859	-649	-743	-662	-1025**	1988	-28
$\times$*HighLTV*	(262.9)	(276.0)	(413.6)	(205.0)	(1568.4)	(1107.0)	(3658.7)	(1035.0)	(1513.6)	(508.1)	(3560.9)	(980.0)
PostRenew	141***	268***	447***	310***	6	-831***	-1132**	-393**	-524**	-1463***	-1760***	-912***
$\times Age \leq 45$	(44.9)	(62.3)	(85.0)	(42.9)	(261.6)	(350.1)	(507.3)	(197.9)	(252.1)	(330.7)	(486.3)	(187.2)
PostRenew	-94	-245***	-107	-133*	-855**	-721	-836	-1214***	-476	-1025**	-357	-1539***
$\times Age \geq 65$	(61.2)	(87.4)	(129.3)	(68.5)	(399.2)	(546.0)	(750.8)	(299.4)	(391.5)	(508.1)	(753.0)	(283.1)
# Obs.	1,367,672	1,259,343	728,408	4,338,654	1,367,672	1,259,343	728,408	4,338,654	1,367,672	1,259,343	728,408	4,338,654

Table 14: Number of accounts with 90+ days delay in payments, scaled up by 1,000 (rate decrease episode)

	Auto loans		Credit cards		Lines of credit		HELOC	
PostRenew	-0.04	-0.05	-1.94***	-9.37***	-2.01***	-8.20***	0.05	-0.28***
	(0.05)	(0.05)	(0.44)	(0.52)	(0.37)	(0.44)	(0.07)	(0.08)
PostRenew		-0.08**		13.41***		12.23***		0.94***
$\times$*LowCreditScore*		(0.04)		(0.65)		(0.50)		(0.12)
PostRenew		-0.06		-2.95		-1.15		-0.44***
$\times$*HighLTV*		(0.11)		(2.84)		(2.25)		(0.07)
PostRenew		0.06		1.89***		0.94*		-0.25*
$\times Age \leq 45$		(0.05)		(0.67)		(0.54)		(0.13)
PostRenew		0.07**		-2.50***		-3.16***		-0.27*
$\times Age \geq 65$		(0.03)		(0.93)		(0.54)		(0.16)
# Obs.	7,694,077	7,694,077	7,694,077	7,694,077	7,694,077	7,694,077	7,694,077	7,694,077

Table 15: Responses of consumption measures (rate increase episode)

	2-year	3-year	4-year
	Probability of auto purchase (%)		
PostRenew	0.02	-0.01	-0.06**
	(0.031)	(0.049)	(0.031)
# Obs.	832,453	390,414	1,199,076
	Auto spending ($/month)		
PostRenew	0.8	0.3	-10.3
	(10.23)	(15.61)	(10.18)
# Obs.	832,453	390,414	1,199,076

Notes: See Table 11.

Table 16: Responses of revolving debt balances (rate increase episode)

	2-year	3-year	4-year
	Credit cards ($)		
PostRenew	-202***	-219***	-193***
	(29.0)	(64.8)	(45.5)
# Obs.	832,453	390,414	1,199,076
	Lines of credit ($)		
PostRenew	-481***	-868**	-526**
	(208.7)	(412.5)	(263.6)
# Obs.	832,453	390,414	1,199,076
	Home equity lines of credit ($)		
PostRenew	-134	-752*	112
	(204.2)	(400.3)	(253.3)
# Obs.	832,453	390,414	1,199,076

Table 17: Heterogeneous responses of revolving debt balances (rate increase episode)

	2-year	3-year	4-year	2-year	3-year	4-year	2-year	3-year	4-year
	Credit cards ($)			Lines of credit ($)			Home equity lines of credit ($)		
PostRenew	-394***	-171**	-463***	-766***	-778	-1266***	-174	-174	3
	(37.5)	(82.5)	(54.6)	(296.4)	(552.8)	(369.6)	(290.0)	(542.1)	(357.7)
PostRenew	193***	-101	348***	931***	975**	2497***	612**	366	1644***
$\times LowCreditScore$	(48.1)	(96.1)	(71.0)	(302.4)	(481.6)	(384.3)	(293.2)	(465.5)	(373.2)
PostRenew	-66	-1035*	-90	-3152**	-3707*	-2052	-3435***	-2845	-2652*
$\times HighLTV$	(218.0)	(537.4)	(355.2)	(1387.4)	(1960.1)	(1438.3)	(1274.5)	(2310.6)	(1378.0)
PostRenew	319***	162	438***	155	-447	-266	-193	-1282**	-1061**
$\times Age \leq 45$	(55.6)	(102.4)	(78.7)	(362.9)	(591.2)	(436.6)	(356.4)	(567.0)	(418.9)
PostRenew	-23	-309**	-137	-1267**	-2160***	-1506***	-1128**	-2104***	-1591***
$\times Age \geq 65$	(70.2)	(142.5)	(95.0)	(522.9)	(759.5)	(558.5)	(500.1)	(732.6)	(549.5)
# Obs.	832,453	390,414	1,199,076	832,453	390,414	1,199,076	832,453	390,414	1,199,076

Table 18: Number of accounts with 90+ days delay in payments, scaled up by 1,000 (rate increase episode)

	Auto loans		Credit cards		Lines of credit		HELOC	
PostRenew	0.15**	0.06	0.68	1.49**	1.56***	2.52***	-0.13*	0.15**
	(0.07)	(0.07)	(0.65)	(0.71)	(0.50)	(0.55)	(0.07)	(0.07)
PostRenew		0.19*		-4.11***		-4.15***		-0.56***
$\times LowCreditScore$		(0.11)		(0.99)		(0.83)		(0.14)
PostRenew		-0.16**		5.34		3.78		0.56*
$\times HighLTV$		(0.08)		(4.36)		(4.85)		(0.29)
PostRenew		0.03		1.99*		1.44*		-0.17
$\times Age \leq 45$		(0.10)		(1.04)		(0.87)		(0.18)
PostRenew		-0.06		1.33		1.96**		0.12*
$\times Age \geq 65$		(0.07)		(1.06)		(0.82)		(0.07)
# Obs.	2,421,943	2,421,943	2,421,943	2,421,943	2,421,943	2,421,943	2,421,943	2,421,943

Table 19: Responses of revolving debt limits

	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
				Rate decrease episode				
	Prob. of credit card limit growing by 1k (%)				Credit card limit ($)			
PostRenew	0.59***	0.50***	0.96***	0.57***	251***	510***	856***	367***
	(0.070)	(0.073)	(0.140)	(0.044)	(37.7)	(68.3)	(140.1)	(52.5)
# Obs.	1,367,672	1,259,343	728,408	4,338,654	1,367,672	1,259,343	728,408	4,338,654
	Prob. of LOC limit growing by 1k (%)				LOC limit ($)			
PostRenew	1.20***	1.34***	1.85***	0.97***	2415***	1897***	2405***	1644***
	(0.063)	(0.071)	(0.149)	(0.043)	(176.5)	(268.8)	(536.5)	(170.3)
# Obs.	1,367,672	1,259,343	728,408	4,338,654	1,367,672	1,259,343	728,408	4,338,654
				Rate increase episode				
	Prob. of credit card limit growing by 1k (%)				Credit card limit ($)			
PostRenew	0.38***	0.19	0.46***		69	-179*	168**	
	(0.083)	(0.136)	(0.093)		(42.7)	(94.4)	(70.7)	
# Obs.	832,453	390,414	1,199,076		832,453	390,414	1,199,076	
	Prob. of LOC limit growing by 1k (%)				LOC limit ($)			
PostRenew	1.37***	1.77***	1.98***		3327***	4582***	4258***	
	(0.085)	(0.155)	(0.096)		(329.4)	(654.1)	(414.2)	
# Obs.	832,453	390,414	1,199,076		832,453	390,414	1,199,076	

Table 20: Decomposition of mortgage rate adjustment

	2-year	3-year	4-year	5-year
		Rate decrease episode		
Actual rate adjustment	-0.17***	-0.17***	-0.40***	-1.12***
	(0.002)	(0.003)	(0.005)	(0.003)
Counterfactual rate adjustment	0.03***	-0.05***	-0.16***	-0.83***
	(0.001)	(0.002)	(0.004)	(0.002)
Implied rate adjustment due to policy rate cuts	-0.20	-0.12	-0.24	-0.29
Policy rate cuts	-0.50	-0.50	-0.50	-0.50
		Rate increase episode		
Actual rate adjustment	0.55***	0.26***	0.14***	-0.16***
	(0.003)	(0.005)	(0.004)	(0.003)
Counterfactual rate adjustment	0.11***	-0.07***	-0.27***	-0.57***
	(0.001)	(0.003)	(0.002)	(0.003)
Implied rate adjustment due to policy rate tightening	0.44	0.33	0.41	0.41
Policy rate tightening	1.00	1.00	1.00	1.00

Notes: All estimates are in percentage points. Actual rate adjustments are the same as in Tables 3 and 7. See Section 7.1 for a detailed description of the counterfactual rate adjustments.

For Online Publication Appendices

A Data: Construct Mortgage Rates

We take a series of steps to impute the rates associated with the FRMs in our sample. First, assuming no prepayment in addition to contracted payments, the outstanding balances and contracted payments can be used to pin down the mortgage rate (adjusted to annual rate). Second, from the rates obtained in the first step, we remove the ones that are either too low (most likely due to the prepayment above the amortization schedule) or too high (most likely due to the delays in payments). Third, we take the median of the remaining rates within each term of a mortgage as the contracted rate. Finally, we winsorize our contracted rates using the 1% cutoffs at the bottom and the top of the distribution. A minor caveat of this procedure is that we are unable to recover the rates for a small fraction of loans that are characterized by systematic prepayment in addition to the required amortization or by the frequent delays in contracted payments.

To validate our imputation procedure, we compare the distribution of the recovered mortgage rates in our data to two alternative data sources, one is the 5-year FRM rates quoted by national mortgage brokers, and the other is the contracted rates reported in the Bank of Canada-OSFI mortgage originations dataset. Both datasets report the actual mortgage rates received by borrowers. The broker data series spans a long time period, but is only available for the average rate across all 5-year FRMs. The OSFI dataset allows us to further break down the mortgages by insurance status and purpose, but is available only from 2014. Since mortgages in both sources are newly originated, we compare their rate distributions with those of the newly originated mortgages in our sample.

Figure A1 shows that the imputed mortgage rates track the brokers' rates quite closely over time. Classifying mortgages by their insurance status, Figure A2 shows that the imputed rates are similar to the rates in the mortgage originations dataset, and that the rate differentials for insured and uninsured mortgages are small. Although our sample does not allow us to distinguish between loan purposes, the originations dataset suggests that the rates for home purchases do not differ much from other purposes such as cash-out refinancing, especially for uninsured mortgages. We also compare the standard deviations of our recovered rates with those from the originations dataset by insurance status. The results are quite close, both varying between 20 and 30 basis points since 2014.

Figure A1: Imputed 5-year FRM rates and the 5-year FRM rate among national mortgage brokers

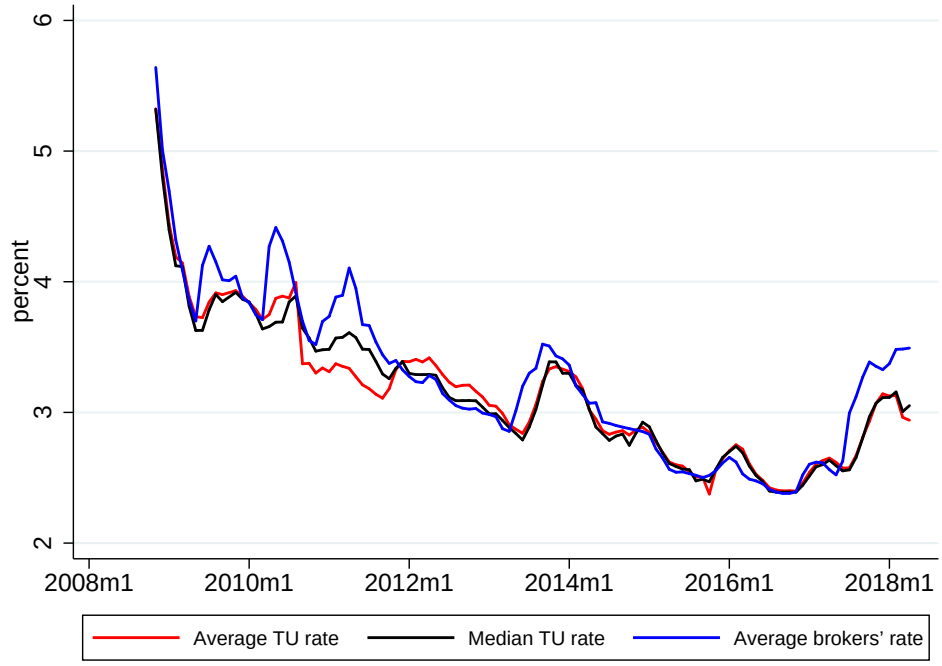
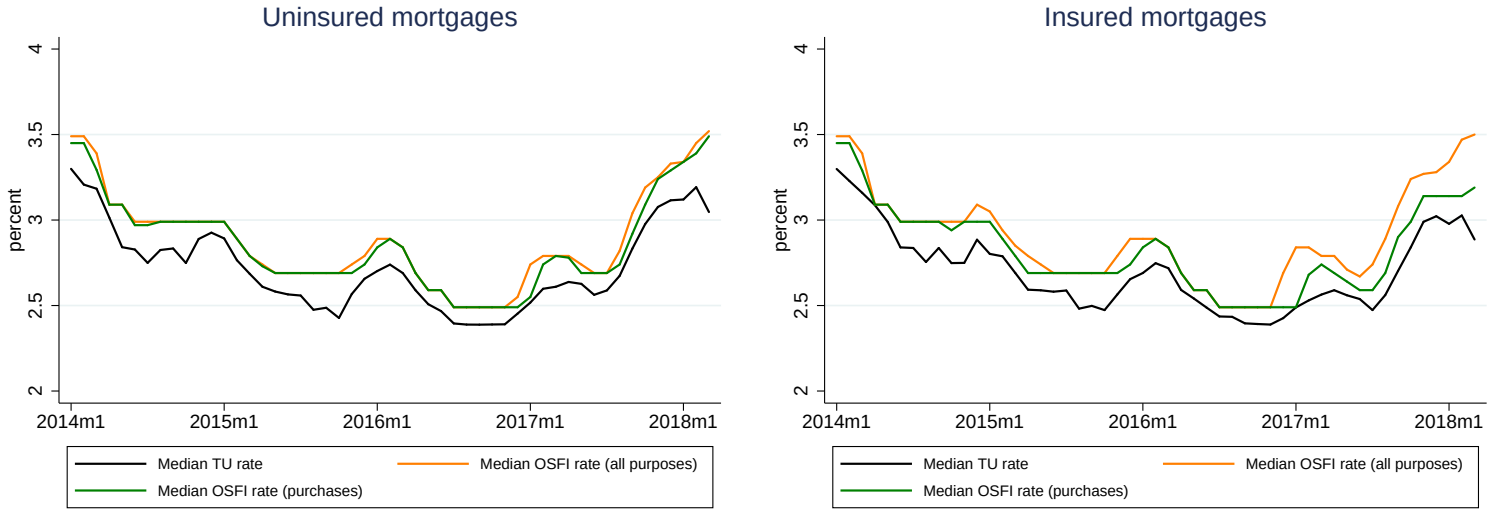


Figure A2: Imputed rates and OSFI mortgage origination rates



Notes: OSFI rates are constructed based on the Bank of Canada-OSFI mortgage originations dataset.

B Difference-in-Difference Estimates

Table B1: Diff-in-diff estimates: Loan-level adjustments
(Control group: longer-term mortgages)

	Rate decrease episode				Rate increase episode			
	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
Mortgage rate (percent)								
$Renew_j \times PostPolicy_t$	-0.12***	-0.10***	-0.14***	-0.55***	0.25***	0.14***	0.05***	-0.05***
	(0.001)	(0.002)	(0.002)	(0.008)	(0.002)	(0.003)	(0.001)	(0.001)
# Obs.	1,761,752	1,705,987	821,831	4,413,997	857,670	413,902	1,449,731	3,252,914
Required payment ($)								
$Renew_j \times PostPolicy_t$	-9.2***	-7.5***	-12.6***	-44.2***	21.1***	9.9***	3.1***	-3.9***
	(0.18)	(0.19)	(0.22)	(0.69)	(0.22)	(0.39)	(0.33)	(0.24)
# Obs.	1,761,752	1,705,987	821,831	4,413,997	857,670	413,902	1,449,731	3,252,914
Contracted payment ($)								
$Renew_j \times PostPolicy_t$	-2.3***	-2.4***	-3.7***	-24.0***	22.5***	9.1***	6.1***	1.6***
	(0.42)	(0.42)	(0.47)	(0.49)	(0.36)	(0.63)	(0.39)	(0.34)
# Obs.	1,761,752	1,705,987	821,831	4,413,997	857,670	413,902	1,449,731	3,252,914
Additional prepayment ($)								
$Renew_j \times PostPolicy_t$	-1.9*	-0.7	-4.7	-16.7	-32.9***	-22.6***	-10.9***	-4.2***
	(1.10)	(1.08)	(3.01)	(13.73)	(8.79)	(8.12)	(1.94)	(1.43)
# Obs.	1,761,752	1,705,987	821,831	4,413,997	857,670	413,902	1,449,731	3,252,914

Figure B1: Dynamic loan-level adjustments: 5-year FRMs (rate decrease episode)

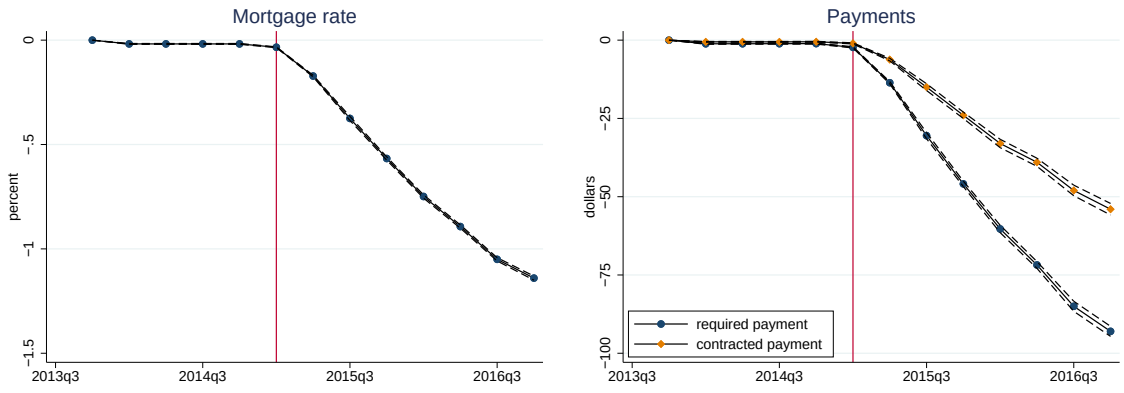


Table B2: Diff-in-diff estimates: Borrower-level responses
(Control group: longer-term mortgages)

	Rate decrease episode				Rate increase episode		
	2-year	3-year	4-year	5-year	2-year	3-year	4-year
Prob. of auto purchase (%)							
$Renew_j \times PostPolicy_t$	0.09***	0.08***	0.04	0.01	-0.03	0.03	-0.01
	(0.03)	(0.02)	(0.05)	(0.13)	(0.15)	(0.12)	(0.03)
# Obs.	1,730,268	1,675,217	806,156	4,357,818	841,360	406,250	1,427,801
Auto spending ($)							
$Renew_j \times PostPolicy_t$	27.9***	24.6***	17.4	20.3	-16.2	0.8	4.2
	(7.95)	(7.22)	(14.1)	(40.0)	(39.1)	(34.9)	(9.3)
# Obs.	1,730,268	1,675,217	806,156	4,357,818	841,360	406,250	1,427,801
Credit card balances ($)							
$Renew_j \times PostPolicy_t$	-254***	-320***	-571***	-395	-79	-284	125*
	(48.0)	(48.9)	(126.6)	(386.3)	(227.2)	(181.3)	(67.9)
# Obs.	1,730,268	1,675,217	806,156	4,357,818	841,360	406,250	1,427,801
LOC balances ($)							
$Renew_j \times PostPolicy_t$	-1463***	-2421***	-3853***	-469	-2457**	-1240	-1251***
	(257.3)	(258.9)	(615.7)	(1594.0)	(1177.9)	(1419.1)	(425.2)
# Obs.	1,730,268	1,675,217	806,156	4,357,818	841,360	406,250	1,427,801
HELOC balances ($)							
$Renew_j \times PostPolicy_t$	-762***	-1253***	-2939***	-899	-1164	848	-1222***
	(243.6)	(246.1)	(611.9)	(1289.2)	(1126.3)	(1449.3)	(417.1)
# Obs.	1,730,268	1,675,217	806,156	4,357,818	841,360	406,250	1,427,801

Table B3: Diff-in-diff estimates: Loan-level adjustments
(Control group: same-term mortgages)

	Rate decrease episode				Rate increase episode			
	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
Mortgage rate (percent)								
$Renew_j \times PostPolicy_t$	-	-0.09***	-0.14***	-0.57***	0.22***	0.14***	0.05***	-0.05***
	-	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
# Obs.	-	1,631,602	3,379,363	15,909,684	1,487,331	1,019,480	2,745,286	15,504,457
Required payment ($)								
$Renew_j \times PostPolicy_t$	-	-6.8***	-12.5***	-46.3***	18.8***	9.9***	3.3***	-4.0***
	-	(0.16)	(0.22)	(0.22)	(0.18)	(0.38)	(0.12)	(0.17)
# Obs.	-	1,631,602	3,379,363	15,909,684	1,487,331	1,019,480	2,745,286	15,504,457
Contracted payment ($)								
$Renew_j \times PostPolicy_t$	-	-2.2***	-3.7***	-25.3***	20.5***	9.0***	6.2***	1.3***
	-	(0.37)	(0.46)	(0.32)	(0.29)	(0.61)	(0.22)	(0.29)
# Obs.	-	1,631,602	3,379,363	15,909,684	1,487,331	1,019,480	2,745,286	15,504,457
Additional prepayment ($)								
$Renew_j \times PostPolicy_t$	-	-5.1**	0.7	0.2	-2.5**	4.6***	-4.3***	-3.7***
	-	(2.08)	(0.84)	(0.35)	(1.22)	(1.23)	(0.76)	(0.48)
# Obs.	-	1,631,602	3,379,363	15,909,684	1,487,331	1,019,480	2,745,286	15,504,457

Figure B2: Dynamic loan-level adjustments: 5-year FRMs (rate decrease episode)

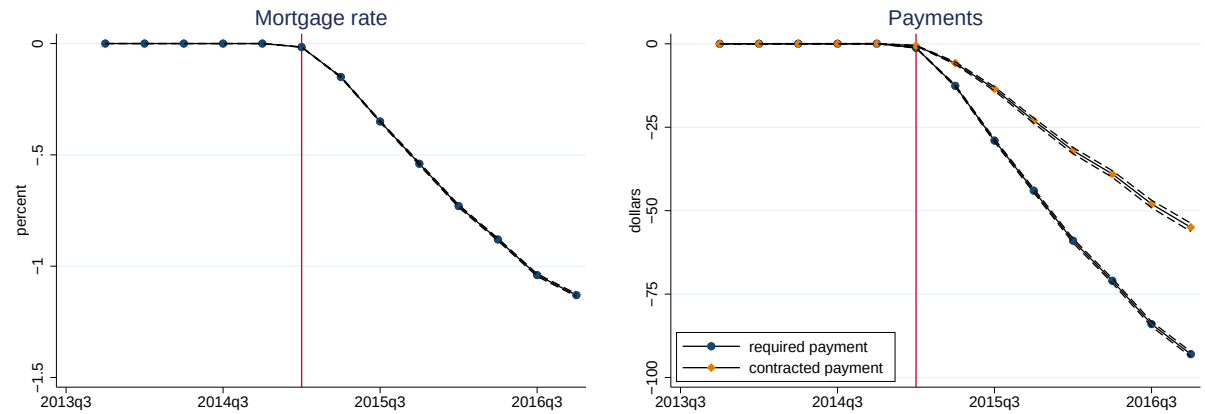


Table B4: Diff-in-diff estimates: Borrower-level responses
(Control group: same-term mortgages)

	Rate decrease episode				Rate increase episode		
	2-year	3-year	4-year	5-year	2-year	3-year	4-year
Prob. of auto purchase (%)							
$Renew_j \times PostPolicy_t$	-	0.01	0.02	0.01	0.02	-0.05	0.00
	-	(0.05)	(0.02)	(0.01)	(0.04)	(0.03)	(0.02)
# Obs.	-	1,602,747	3,334,732	15,689,210	1,458,463	1,001,708	2,711,336
Auto spending ($)							
$Renew_j \times PostPolicy_t$	-	-4.0	0.9	1.3	8.6	-14.9	0.7
	-	(14.6)	(6.5)	(2.4)	(12.1)	(10.5)	(6.2)
# Obs.	-	1,602,747	3,334,732	15,689,210	1,458,463	1,001,708	2,711,336
Credit card balances ($)							
$Renew_j \times PostPolicy_t$	-	-443***	-409***	-592**	-266***	-552***	-412***
	-	(57.5)	(39.8)	(19.9)	(33.7)	(46.0)	(31.2)
# Obs.	-	1,602,747	3,334,732	15,689,210	1,458,463	1,001,708	2,711,336
LOC balances ($)							
$Renew_j \times PostPolicy_t$	-	-1711***	-3515***	-3002***	-1504***	-2733***	-3626***
	-	(369.1)	(233.9)	(91.2)	(267.9)	(311.3)	(191.6)
# Obs.	-	1,602,747	3,334,732	15,689,210	1,458,463	1,001,708	2,711,336
HELOC balances ($)							
$Renew_j \times PostPolicy_t$	-	-450	-958***	-1117***	-926***	-1084***	-2077***
	-	(353.3)	(220.2)	(86.2)	(259.8)	(301.4)	(184.1)
# Obs.	-	1,602,747	3,334,732	15,689,210	1,458,463	1,001,708	2,711,336

C Transition to Other Financial Institutions (FIs)

Table C1: The purpose of closing a mortgage account

	Rate decrease episode			Rate increase episode		
	Share	with sample bank	with other FIs	Share	with sample bank	with other FIs
Cash-out refinance (balance difference>5k; same postal code)	47%	92%	8%	45%	91%	9%
Renewal (balance difference≤5k; same postal code)	4%	63%	37%	3%	76%	24%
Purchase (switch to different postal code)	3%	78%	22%	2%	75%	25%
Final closure (no match found)	46%	-	-	59%	-	-

Table C2: Change in the mortgage rate after renewal (percent)

	Rate decrease episode		Rate increase episode	
Term	Renewal with sample bank	Renewal with other FIs	Renewal with sample bank	Renewal with other FIs
5-year	-1.12***	-0.95***	-0.16***	0.15***
	(0.003)	(0.03)	(0.003)	(0.04)
4-year	-0.40***	-0.20***	0.14***	0.15
	(0.005)	(0.05)	(0.004)	(0.09)
3-year	-0.17***	-0.08**	0.26***	0.24**
	(0.003)	(0.04)	(0.005)	(0.12)
2-year	-0.17***	-0.07	0.55***	0.88***
	(0.002)	(0.05)	(0.003)	(0.06)

D Remove Term Spread Effect

Table D1: Term transition probabilities and market shares (%)

	Rate decrease episode					Rate increase episode				
before/after	2-year	3-year	4-year	5-year	Share	2-year	3-year	4-year	5-year	Share
2-year	65.5	6.6	4.2	23.7	18	61.4	13.2	7.1	18.3	16
3-year	38.3	18.4	5.5	37.8	16	35.6	31.7	7.2	25.6	8
4-year	21.6	6.4	17.9	54.1	10	26.8	13.1	26.2	33.9	23
5-year	19.1	7.2	5.3	68.4	56	23.8	12.2	11.1	52.9	53

Table D2: Loan-level adjustments

	Rate decrease episode				Rate increase episode			
	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
Mortgage rate (percent)								
PostRenew	-0.35***	-0.19***	-0.36***	-1.13***	0.38***	0.24***	0.12***	-0.19***
	(0.002)	(0.005)	(0.012)	(0.002)	(0.003)	(0.008)	(0.007)	(0.004)
# Obs.	788,499	197,930	113,690	2,576,087	412,746	102,561	245,720	1,174,655
Required payment ($)								
PostRenew	-30.5***	-17.8***	-32.4***	-96.2***	33.1***	17.3***	6.7***	-17.0***
	(0.22)	(0.54)	(1.22)	(0.46)	(0.40)	(0.74)	(0.62)	(0.46)
# Obs.	788,499	197,930	113,690	2,576,087	412,746	102,561	245,720	1,174,655
Contracted payment ($)								
PostRenew	-17.1***	3.3*	-3.1	-44.3***	35.6***	21.4***	16.4***	0.32
	(0.72)	(1.91)	(3.65)	(0.81)	(0.90)	(2.34)	(1.54)	(1.06)
# Obs.	788,499	197,930	113,690	2,576,087	412,746	102,561	245,720	1,174,655
Additional prepayment ($)								
PostRenew	-3.5***	-0.6	-4.5	-7.8***	-0.6	17.1***	3.9	-3.0**
	(1.06)	(2.28)	(4.61)	(0.72)	(1.43)	(4.37)	(2.65)	(1.26)
# Obs.	788,499	197,930	113,690	2,576,087	412,746	102,561	245,720	1,174,655

Table D3: Borrower-level responses

	Rate decrease episode				Rate increase episode		
	2-year	3-year	4-year	5-year	2-year	3-year	4-year
Prob. of auto purchase (%)							
PostRenew	0.01	0.05	-0.10	0.06***	0.00	0.04	0.05
	(0.03)	(0.06)	(0.10)	(0.02)	(0.05)	(0.10)	(0.07)
# Obs.	774,367	193,959	111,759	2,545,010	404,572	100,533	242,147
Auto spending ($)							
PostRenew	-2.6	11.0	-58.8*	13.7**	-7.8	35.0	23.5
	(9.48)	(20.2)	(35.5)	(5.44)	(14.9)	(35.2)	(23.2)
# Obs.	774,367	193,959	111,759	2,545,010	404,572	100,533	242,147
Credit card balances ($)							
PostRenew	-161***	-199**	-294**	-268***	-155***	-187	-175**
	(27.3)	(90.0)	(131.0)	(34.9)	(40.4)	(118.7)	(89.4)
# Obs.	774,367	193,959	111,759	2,545,010	404,572	100,533	242,147
LOC balances ($)							
PostRenew	153	-447	-641	-617***	147	-557	212
	(178.2)	(548.2)	(653.7)	(149.2)	(309.4)	(768.4)	(509.1)
# Obs.	774,367	193,959	111,759	2,545,010	404,572	100,533	242,147
HELOC balances ($)							
PostRenew	225	55	418	162	370	-4.6	814*
	(173.3)	(496.9)	(604.2)	(142.7)	(301.6)	(735.4)	(482.9)
# Obs.	774,367	193,959	111,759	2,545,010	404,572	100,533	242,147

E Mortgages Reset in Both Episodes

Table E1: Loan-level adjustments

	Mortgage rate (%)		Req. payment ($)		Contr. payment ($)		Add. prepayment ($)	
	2-year	3-year	2-year	3-year	2-year	3-year	2-year	3-year
				Rate decrease episode				
PostRenew	-0.35***	-0.24***	-29.9***	-21.3***	-14.2***	-5.0	-3.7***	-2.5
	(0.002)	(0.010)	(0.28)	(1.09)	(0.87)	(3.40)	(1.21)	(7.50)
# Obs.	660,238	62,653	660,238	62,653	660,238	62,653	660,238	62,653
				Rate increase episode				
PostRenew	0.29***	0.36***	21.4***	27.3***	23.4***	24.4***	-4.3***	3.1
	(0.003)	(0.017)	(0.33)	(1.74)	(0.80)	(3.26)	(1.39)	(5.90)
# Obs.	491,296	37,172	491,296	37,172	491,296	37,172	491,296	37,172

Table E2: Borrower-level responses

	Prob. auto purchase (%)		Auto spending ($)		Credit card balances ($)		LOC balances ($)		HELOC balances ($)	
	2-year	3-year	2-year	3-year	2-year	3-year	2-year	3-year	2-year	3-year
					Rate decrease episode					
PostRenew	0.03	0.35***	3.6	101.1***	-75**	-28	-316	-403	283	-819
	(0.04)	(0.12)	(10.71)	(37.0)	(35.9)	(181.7)	(264.4)	(1078.8)	(325.0)	(1356.4)
# Obs.	650,375	61,730	650,375	61,730	650,375	61,730	650,375	61,730	650,375	61,730
					Rate increase episode					
PostRenew	0.02	-0.01	1.8	-2.1	-77*	-278	-322	-419	-1059***	-1160
	(0.04)	(0.13)	(12.34)	(44.57)	(39.6)	(204.2)	(293.7)	(1298.1)	(380.7)	(1931.1)
# Obs.	483,283	36,657	483,283	36,657	483,283	36,657	483,283	36,657	483,283	36,657

F Timing of Renewal

Table F1: Mortgage rate adjustments: Heterogeneity in the timing of renewal (percent)

	Rate decrease episode				Rate increase episode			
	2-year	3-year	4-year	5-year	2-year	3-year	4-year	5-year
PostRenew	-0.34***	-0.20***	-0.30***	-1.15***	0.37***	0.33***	-0.00	-0.32***
(On time renewal)	(0.003)	(0.008)	(0.016)	(0.005)	(0.004)	(0.013)	(0.012)	(0.009)
PostRenew×	-0.01	0.03	0.00	0.02*	0.01	-0.10***	0.03	0.03
1 month b.f. schedule	(0.008)	(0.035)	(0.031)	(0.013)	(0.013)	(0.034)	(0.037)	(0.023)
PostRenew×	-0.01	0.07***	-0.04	0.02**	0.01	-0.10***	0.16***	0.13***
2 month b.f. schedule	(0.005)	(0.015)	(0.026)	(0.010)	(0.008)	(0.024)	(0.018)	(0.015)
PostRenew×	-0.01*	0.06***	-0.02	0.02*	0.03***	-0.11***	0.21***	0.17***
3 month b.f. schedule	(0.006)	(0.020)	(0.020)	(0.010)	(0.009)	(0.024)	(0.017)	(0.014)
PostRenew×	-0.02***	-0.04*	-0.05**	0.00	0.04***	-0.13***	0.25***	0.21***
4 month b.f. schedule	(0.008)	(0.018)	(0.024)	(0.010)	(0.010)	(0.027)	(0.016)	(0.015)
PostRenew×	-0.03***	-0.06***	-0.05	0.02**	0.03***	-0.14***	0.21***	0.22***
5 month b.f. schedule	(0.007)	(0.019)	(0.031)	(0.009)	(0.010)	(0.024)	(0.016)	(0.013)
PostRenew×	-0.03***	-0.00	-0.12***	0.04***	0.02**	-0.17***	0.22***	0.20***
6 month b.f. schedule	(0.005)	(0.020)	(0.022)	(0.007)	(0.007)	(0.022)	(0.013)	(0.010)
# of Obs.	782,093	196,021	113,071	2,564,997	407,866	100,880	243,757	1,167,483

Table F2: Auto spending responses in the rate decrease episode (5-year term mortgages)

	Prob. auto purchase (%)	Auto spending ($)
PostRenew	0.08***	23.2***
(On time renewal)	(0.024)	(7.57)
PostRenew×	-0.01	-4.9
1 month b.f. schedule	(0.053)	(18.15)
PostRenew×	-0.01	-12.5
2 month b.f. schedule	(0.039)	(11.95)
PostRenew×	-0.02	-10.3
3 month b.f. schedule	(0.037)	(11.38)
PostRenew×	-0.09**	-30.0**
4 month b.f. schedule	(0.039)	(11.59)
PostRenew×	-0.08**	-30.4***
5 month b.f. schedule	(0.033)	(9.84)
PostRenew×	0.01	-1.2
6 month b.f. schedule	(0.028)	(8.45)
# of Obs.	2,534,170	2,534,170