The Value of Mortgage Choice: Payment Structure and Contract Length

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Abstract

We study how households choose between three mortgage contracts with different payment structures: fixed-rate fixed-payment, variable-rate variable-payment, and a hybrid variable-rate fixed-payment mortgage where interest rate changes affect principal repayment rather than payment size. This hybrid contract, which is offered in only a few countries around the world, gives households additional flexibility to insure against payment risk while exposing them to the risk of larger future mortgage balances. We model these mortgage types simultaneously and decompose the welfare from offering each contract into aggregate risk, idiosyncratic risk, and lifecycle factors. Our calibrated model matches mortgage choice patterns in Canada, where all these options are offered with short terms. We demonstrate that restricting contract choice or mandating long terms, as in the U.S. system, can lead to substantial welfare losses by limiting risk management strategies and increasing mortgage pricing ex-ante.

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1 Introduction

Mortgages represent the largest component of household liabilities in developed economies and play a crucial role in household risk management. Mortgage markets around the world have evolved into remarkably different structures dominated by two main contract types. Most countries, especially in Europe, feature adjustable-rate mortgages with shorter contract terms, with households bearing the brunt of interest rate risk. In contrast, the dominant contract in the United States is a 30-year fixed-rate mortgage, where interest rate risk is transferred to lenders and households pay significant mortgage premia for this payment certainty.

However, a third option exists that has received far less attention in the academic literature: variable-rate fixed-payment mortgages, which maintain payment certainty for households while reducing long-term interest rate risk for lenders. This hybrid structure allows interest rate changes to affect the allocation between interest and principal rather than changing payment amounts. Countries like Canada have developed markets where this hybrid structure is available alongside traditional fixed-rate and adjustable-rate mortgages, creating a more diverse menu of mortgage options for households.

The existence of this hybrid contract invites us to revisit fundamental questions about optimal mortgage design: What drives household preferences for different mortgage payment structures? How do payment structure and contract length interact to influence household risk management? For which types of households and economic conditions might each contract structure be optimal? To address these questions, we build a quantitative life-cycle model in which households choose between three distinct contracts when they originate or refinance their mortgages. We include standard fixed-rate fixed-payment (FF) mortgages, where both interest rates and payments are fixed for the contract term, and variable-rate variable-payment (VV) mortgages, where both float with market rates.

The primary contribution of our analysis is also modeling variable-rate fixed-payment (VF) mortgages, where rates float but payments remain fixed, and studying the economic tradeoff faced by households when considering this full menu of mortgage types. The VF contract represents a middle ground between traditional FF and VV mortgages: interest rate changes affect the speed of principal repayment, not the payment size. For example, when interest rates increase, principal payments decrease but total payments remain the same. This contract was advocated for by Black (1998), who noted that this type of contract can appease both households that value payment certainty and lenders who charge premia for carrying interest rate exposure. Modeling household mortgage choice in the presence of all three contract types is essential to uncover the underlying trade-offs households face in balancing payment stability, interest rate risk, and total mortgage cost.

Using our model, we show that all three contract types can coexist in equilibrium, serving different household types depending on their circumstances. Building on insights from Koijen et al. (2009), who demonstrate the importance of bond risk premia for mortgage choice, we examine how both aggregate factors (interest rates and term premia) and household characteristics (leverage, income, and wealth) drive mortgage choice. Our model captures the rich dynamics of the Canadian mortgage market between 2014 and 2022, including significant shifts in mortgage type origination shares in response to changing market conditions. Consistent with recent evidence from Denmark (Andersen et al., 2023), we find substantial heterogeneity in household preferences over mortgage types, driven by differences in their financial circumstances and risk management needs.

The model generates two main findings about mortgage contract design and welfare. First, we show that different mortgage contracts serve distinct and valuable purposes and can coexist in equilibrium because they offer different forms of risk management that appeal to different household types. FF contracts provide complete certainty in both payments and balance evolution, making them particularly valuable when term premia are low and for highly leveraged households who prioritize payment stability. However, the benefits of this full insurance are priced by the lender, and FF contracts are typically the most expensive. VV contracts offer potentially lower costs but require households to manage payment uncertainty, making them attractive when term premia are high and for households with sufficient financial buffers. VF contracts provide a middle ground by fixing payments, particularly valuable for households managing short-term liquidity constraints but creating long-term uncertainty in balance evolution. The welfare gains from having all options available are substantial, ranging from 1% to 6% in consumption-equivalent terms depending on the levels of interest rates and term premia.

A key insight of our analysis is that the properties of each contract type for household risk management depend fundamentally on contract length. When contract terms are shorter than amortization periods, as is common in many countries outside the United States, this creates additional considerations for household risk management that interact differently with each payment structure. This is especially true for VF mortgages, where shorter terms create a new consideration: when interest rates rise, fixed payments mean less principal is repaid, leading to larger balances at renewal. For FF mortgages, shorter terms limit the horizon of rate commitments, which has implications for both the demand and supply of mortgage debt, while shorter terms have little effect on payment patterns for VV mortgages. This interaction between payment structure and contract length has received little attention in previous work on optimal mortgage design (Guren et al., 2021).

Second, our framework allows us to analyze alternative mortgage market structures, including the U.S. system that combines long-term fixed-rate contracts with costly refinancing. Recent work has highlighted how market structure can affect both household welfare and macroeconomic stability (Keys et al., 2016; Greenwald, 2018; Greenwald et al., 2020; Campbell et al., 2021). Our model, recalibrated to match key features of the U.S. mortgage market, generates the observed distribution of mortgage rates and refinancing patterns documented in the literature (Campbell, 2006; Chen et al., 2020), including the recent "lock-in" effect that occurs when rates rise rapidly (Fonseca and Liu, 2024; Aladangady et al., 2024; Fonseca et al., 2024).

We show that the U.S. approach leads to welfare losses through two channels: limited contract choice prevents households from selecting optimal payment structures, while the combination of long-term fixed-rate contracts and refinancing options forces lenders to price refinancing risk into rates ex-ante, effectively making all borrowers pay for an option that benefits only some. This ex-ante pricing of optionality parallels findings in Berger et al. (Forthcoming), who show that automatic refinancing programs would lead to higher mortgage rates as lenders price in the certainty of refinancing. The Canadian system, with its menu of contracts and shorter terms, better allows households to manage their mortgage risk while reducing the costs that lenders must price into rates.

We also use the model to inform current policy debates around the relationship between mortgage contract design and monetary policy passthrough. Our analysis contributes to the large literature on monetary policy transmission through mortgage markets (Di Maggio et al., 2017; Beraja et al., 2019; Berger et al., 2021). Conventional monetary policy that targets short rates operates most strongly through variable-rate mortgages, with a contractionary 1 percentage point shock reducing consumption by 1.1% in variable-rate mortgage economies compared to only 0.2% in fixed-rate mortgage economies. Conventional monetary policy is less effective in fixed-rate mortgage economies because these contracts are priced using long-term rates that are less responsive to short-term monetary policy changes. Conversely, unconventional monetary policy that targets long-term bond yields through term premia can be highly effective in fixed-rate mortgage economies, but only when households must regularly renew their contracts. This analysis highlights two challenges to monetary policy transmission in the current U.S. system of 30-year fixed-rate mortgages: fixed-rate mortgages are priced using long-term rates largely unaffected by conventional monetary policy and households can "lock-in" to their current mortgages to avoid refinancing when rates rise (Fonseca and Liu, 2024; Aladangady et al., 2024; Fonseca et al., 2024).

Our paper is most closely related to recent work using structural models to study mortgage choice and design. Campbell and Cocco (2003) pioneered the use of life-cycle models to study mortgage choice between fixed-rate mortgages and adjustable-rate mortgages, while Guren et al. (2021) extended this framework to study optimal mortgage design for macroeconomic stability. Campbell et al. (2021) analyze how alternative mortgage structures could enhance financial stability during crises, and Elenev and Liu (2024) study financial stability with endogenous risk premia under fixed-rate mortgage and adjustable-rate mortgage regimes. Like these papers, we employ a quantitative life-cycle framework, but we make two key methodological advances: we introduce the VF contract as a hybrid between fixed-rate mortgage and adjustable-rate mortgage and we allow households to switch between multiple contract types throughout their lifecycle. Liu (2022) studies fixed-rate mortgage contracts of varying "fixation" lengths and shows that demand for short- versus long-term contracts depends on loan-to-value ratios. In our setting, we focus on a single fixation period length and study mortgage contracts that have different payment structures. These innovations yield our central contribution: showing how payment structure and contract length interact to determine household risk management options and welfare. By analyzing these features in a unified framework that can accommodate different market structures, we provide new insights for mortgage market design and regulation.

The paper proceeds as follows. Section 2 presents our model of mortgage choice, and Section 3 describes the benchmark model calibration to the Canadian mortgage market. Section 4, the core of our paper, describes the economics underlying mortgage-type choice. Section 5 details the welfare benefits of having a menu of different mortgage contract types available. Section 6 recalibrates the baseline model to reflect the U.S. mortgage market and discusses welfare costs of a single long-term fixed-rate contract relative to the menu of contracts available in Canada. Finally, Section 7 studies the passthrough of conventional and unconventional monetary policy shocks to consumption depending on the mix of mortgage contracts available in the economy. Section 8 concludes.

2 Model

We model the decisions of households that live for $T = T_W + T_R$ periods. In the first T_W working life periods, the household receives stochastic labor income, and during the T_R retirement periods, it receives pension income. At the beginning of their working lives, households take on a mortgage to finance the purchase of a house. In addition to standard consumption and savings decisions, they make mortgage-related decisions that ultimately dictate mortgage principal and interest payments.

The key decision in our model is the mortgage-type choice: households choose between three types of mortgage described below and have multiple opportunities to switch between mortgage types via refinancing. The model is general in that it can easily accommodate different mortgage market structures by calibrating different prepayment and refinancing costs, thereby reflecting market structures and capturing behaviors consistent with observed data in different countries such as Canada and the United States.

We consider a real economy in which either all mortgages are inflation-indexed or the price level is constant and abstract from inflation dynamics. This allows us to focus on the determinants of mortgage-type choice conditional on aggregate interest rate, term premium, and income dynamics. We only model the loan market and otherwise take a partial equilibrium approach.

2.1 Bond Market

Households can save in a 1-period bond at rate $R_{1,t}$. Let the log of the 1-period bond rate be denoted $r_{1,t}$, i.e., $r_{1,t} \equiv \log(1 + R_{1,t})$. The 1-period log interest rate follows an AR(1) process:

$$r_{1,t+1} = (1 - \rho_r)\bar{r} + \rho_r r_{1,t} + \epsilon_{r,t+1}. \tag{1}$$

The return for an n-period bond combines the expectation hypothesis of interest rates and a time-varying term premium:

$$r_{n,t} = \frac{1}{n} \sum_{j=0}^{n-1} E_t[r_{1,t+j}] + \omega_{n,t}, \tag{2}$$

where $\omega_{n,t}$ is a time-varying term premium that is also persistent:

$$\omega_{n,t} = (1 - \rho_\omega)\bar{\omega} + \rho_\omega \omega_{n,t} + \epsilon_{\omega,t+1}. \tag{3}$$

2.2 Mortgage Contracts

A representative risk-neutral financial institution elastically supplies mortgage debt to households in the economy. The financial institution offers three types of mortgage contracts: FF, VF, and VV. FF mortgages have a contractual interest rate that fixes over the length of the term, while VV mortgages have their interest and total payments determined by the current level of short-term rates. With VF mortgages, two different interest rates are used to set payments: the total payment is fixed according to the contractual interest rate and interest payments fluctuate according to the current level of short-term rates. Each mortgage is designed to amortize after N_A years, and switching between mortgage types does not reset the amortization schedule. The contract is defined by the type, $\chi \in \{\text{FF}, \text{VF}, \text{VV}\}$, and the endogenous contractual interest rate, R^M.

2.2.1 Market Interest Rates and Payment Functions

The financial institution sets the interest rate on each type of mortgage using a combination of bond rates and mortgage risk premia. For each mortgage type $\chi \in \{\text{FF}, \text{VF}, \text{VV}\}$, the mortgage interest is given by:

$$R_{\chi,t} \equiv R_{\chi}(\{r_{n,t}\}_n, \phi_{\chi}),$$

where $\{r_{n,t}\}_n$ represents the bond yield curve defined above and ϕ_{χ} is the mortgage premium chosen by the financial institution. For example, in our Canadian calibration detailed below, we price FF as a fixed premium over 5-year bond rates while VF and VV mortgages are priced as a fixed premium over 1-year bond rates.

The exact interest rate used to calculate mortgage payment for a given household in a given period of time will depend on the mortgage type, market rates, and contract rates, as well as the outstanding mortgage balance and periods remaining in the amortization. Therefore, for a given set of interest rates, we define general mortgage payment functions using standard formulae and then tailor them to each type of mortgage in the next section.

Given the types of mortgages that the financial institution offers, we allow for different interest rates to be used in calculating the total mortgage payment and the interest payment. Letting R_T denote the total payment interest rate, the total mortgage payment is given by:

$$TP(R_T) = \frac{R_T}{1 - (1 + R_T)^{-T_A}} M,$$

where M is the outstanding balance and T_A is the number of periods remaining in the amortization. Letting R_I denote the interest rate for the interest payment, interest is given by:

$$IP(R_I) = R_I M,$$

and the principal payment is the residual from the total payment after interest has been paid:

$$PP(R_T, R_I) = TP(R_T) - IP(R_I) = \left(\frac{R_T}{1 - (1 + R_T)^{-T_A}} - R_I \right) M.$$

2.2.2 Contract Rates and Payment Structure

In this section, we detail the differences between the three types of mortgages in terms of how the contract rate is set and how the payments depend on market and contract rates. We allow for a fully flexible refinancing system that will eventually nest the Canadian renewal system described in the previous section, where a Canadian renewal is equivalent to a penalty-free refinancing. Table 1 summarizes the three types of mortgages.

1. **Fixed-Rate Fixed-Payment Mortgages**
When the household chooses an FF mortgage in period s, the contract rate is set to the market rate in that period, $R_s^M = R_{FF,s}$. This is incorporated into the mortgage contract rate and remains in effect until the household refinances into a new mortgage. The total and interest payments for the mortgage are both calculated using the mortgage contract rate. In period t for a contract that was signed in period t^*, total and interest payments are $TP(R_{t*}^M)$ and $IP(R_{t*}^M)$.

2. **Variable-Rate Fixed-Payment mortgages Mortgage**
As with an FF mortgage chosen in period s, the contract rate for a VF mortgage is set to the market rate, $R_s^M = R_{VF,s}$ and remains effective until the household refinances. The key difference is that in each period that the household has this mortgage, the contract rate is used to calculate the total payment, but the market rate is used to calculate the interest payment. In period t for a contract signed in period t^*, the total payment is $TP(R_{t*}^M)$ and does not vary with market rates. The interest payment, $IP(R_{VF,t})$, varies with the current market rate for a VF mortgage. As a result, while the total payment does not fluctuate, the share of the total payment going towards principal will change as the market rate changes.

3. **Variable-Rate Variable-Payment Mortgage**
With a VV mortgage, there is no contract rate. The market interest rate is used to calcu-

late both the total and interest payments for the mortgage in each period, $TP(R_{VV,t})$ and $IP(R_{VV,t})$.

2.3 Households

2.3.1 Homeowners with Mortgages

Homeowners with mortgages are characterized by their age, Age_{it}, cash-on-hand, W_{it}, persistent income component, Z_{it}, mortgage debt, M_{it}, the mortgage type chosen in the previous period, $\chi_{i,t-1} \in \{FF, VF, VV\}$, and (for FF and VF mortgages) the corresponding mortgage contract rate, $R^M_{i,t-1}$. The aggregate economy state variables are the interest rate for a 1-year bond, R_{1t}, and the term premium, ω_t. To ease exposition, we define the household's idiosyncratic state variables, $S_{it} \equiv \{Age_{it}, W_{it}, Z_{it}, M_{it}, \chi_{i,t-1}, R^M_{i,t-1}\}$, and the aggregate state variables, $A_t \equiv \{R_{1,t}, \omega_t\}$.

Mortgage Value Function We begin with a general value function for homeowners with mortgages, $V^{Mortgage}$, that takes in as arguments the two interest rates used to calculate the total and interest payments, $\{R_T, R_I\}$, and the household and aggregate state variables:

$$V^{Mortgage}(\{R_T, R_I\}, S_{it}, A_t) = \max_{C_{it}} F(C_{it}, V^{Owner,Mortgage}(S_{i,t+1}, A_{t+1})),$$

where F is the Epstein-Zin operator over current consumption and future value, the value function $V^{Owner,Mortgage}$ is defined in the next section, and subject to the budget constraint:

$$W_{i,t+1} = Y_{i,t+1} + (1 + R_{1,t})(W_{it} - C(\cdot) - TP(R_T)).$$

Income, $Y_{i,t}$, contains both a deterministic life-cycle profile and stochastic shocks detailed in the next section. The consumption policy function, $C_{it} \equiv C(\{R_T, R_I\}, S_{it}, A_t)$, depends on the mortgage interest rates, household state variables, and aggregate state variables. Mortgage debt, M_{it}, is measured at the beginning of the period and evolves as the existing balance less principal payment, $P(R_T, R_I) = TP(R_T) - I(R_I)$:

$$M_{i,t+1} = M_{it} - P(R_T, R_I).$$

Homeowner Optimization In each period, the household makes a choice to *Continue* in the same mortgage contract, *Refinance* into a new contract, or sell its home and *Rent* instead. If the household chooses to rent, it permanently enters the rental market. Otherwise, it faces this same menu of options in each period. The household problem is given by:

$$V^{Owner,Mortgage}(S_{it}, A_t) = \max\{V^{Continue}(S_{it}, A_t), \\ V^{Refinance}(S_{it}, A_t), \\ V^{Owner,Rent}(S_{it}, A_t)\}.$$

Continuing in the Same Mortgage Contract The household can continue in the same mortgage, which uses the contract rate when relevant:

$$V^{Continue}(S_{it}, A_t) = \begin{cases} V^{Mortgage}(\{R^M_{i,t-1}, R^M_{i,t-1}\}, S_{it}, A_t) - \gamma_t(FF) & \text{if } \chi_{t-1} = FF, \\ V^{Mortgage}(\{R^M_{i,t-1}, R_{VF,t}\}, S_{it}, A_t) - \gamma_t(VF) & \text{if } \chi_{t-1} = VF, \\ V^{Mortgage}(\{R_{VV,t}, R_{VV,t}\}, S_{it}, A_t) - \gamma_t(VV) & \text{if } \chi_{t-1} = VV, \end{cases}$$

where $\gamma_t(\chi)$ is the utility cost the household pays to continue in the same contract in period t with mortgage type χ. These expressions highlight the difference between each of the three mortgage types if the household chooses to continue in the existing contract.

With an FF mortgage, the contract rate, $R^M_{i,t-1}$, which is a state variable for the household, is used to calculate both the total and interest payments. With a VF mortgage, the contract rate is used to calculate the total payment, but the market rate, $R_{VF,t}$, which is calculated as a function of the aggregate state variables, is used to calculate the interest payment. With a VV mortgage, the market rates are always used to calculate both types of payments.

If the household chooses to continue, then the mortgage type and mortgage contract rate are the same as in the previous period:

$$\chi_{it} = \chi_{i,t-1}, \;\; R^M_{it} = R^M_{i,t-1}.$$

Refinancing The household can refinance into a new mortgage, subject to the refinancing costs that depend on the new mortgage type and the current mortgage type. We also include a preference shock over each type of refinancing option that represents other factors that influence mortgage choice but are not captured in our model. Specifically, the household solves:

$$V^{Refinance}(S_{it}, A_t) = \max\Big\{V^{Mortgage}(\{R_{FF,t}, R_{FF,t}\}, S_{it}, A_t) - \kappa_t(FF|\chi_{t-1}) + \sigma\epsilon_{FF,it}, \\ V^{Mortgage}(\{R_{VF,t}, R_{VF,t}\}, S_{it}, A_t) - \kappa_t(VF|\chi_{t-1}) + \sigma\epsilon_{VF,it}, \\ V^{Mortgage}(\{R_{VV,t}, R_{VV,t}\}, S_{it}, A_t) - \kappa_t(VV|\chi_{t-1}) + \sigma\epsilon_{VV,it}\Big\},$$

where $\kappa_t(\chi|\chi_-)$ is the utility cost that a household with mortgage type χ_- pays to refinance into a new contract with mortgage type χ in period t. These expressions emphasize that with respect to the mortgage calculations, the framework for calculating the value from refinancing is the same as for the value of continuing except for the interest rate used to construct the mortgage payments.[1] Note also that refinancing into the same type of mortgage is essentially a means of resetting the contract rate, while refinancing into a new mortgage type both resets the contract rate and changes the structure of payments. In each of the refinancing options, $\chi \in \{\text{FF}, \text{VF}, \text{VV}\}$, the relevant interest rate is the market rate for each mortgage type. When the household chooses to refinance, the mortgage type is set to the new choice, and the new contract rate is the market rate for the new mortgage type:

$$\chi_{it} = \chi, \;\; R^M_{it} = R_{\chi,t}.$$

Renting The homeowner also considers becoming a renter. This entails selling the home, which yields (potential) profit $\pi^H_{it} = (1 - \phi_S - \tau_S)(H - M_{it})$, where ϕ_S is the transaction fee charged by a real estate agent, τ_S is the tax rate on real estate transactions, and $(H - M_{it})$ is the net equity in the home. The proceeds from the home sale are added to cash-on-hand and total value is calculated using the renter's value function defined in Section 2.3.3:

$$V^{Owner,Rent}(S_{it}, A_t) = V^{Renter}(W_{it} + \pi^H_{it}, Z_{it}, R_{1t}, \omega_t).$$

2.3.2 Homeowners without Mortgages

After fully amortizing the mortgage, homeowners live in their homes with no mortgage payments. However, they may still choose to transition to the rental market, which yields the net profit from the home sale but then requires paying rent in each period. Thus, for $t > N_A$, the value function for a homeowner is given by:

$$V_t(W, z, R) = \max\left\{V_t^{\text{Owner,NM}}(W, z, R), V_t^{\text{Renter}}(W + \pi_H, z, R)\right\},$$

with the same home sale profit equation above, except that, by virtue of not having a mortgage, net equity is equal to the value of the house. The value of renting is compared against the value of owning without a mortgage:

$$V_t^{\text{Owner,NM}}(W, z, R) = \max_{c_t^{\text{Owner,NM}}} F\left(c_t^{\text{Owner,NM}}(W, z, R), V_{t+1}(W', z', R')\right),$$

[1] The choices will also differ based on the continuation and refinancing costs set by the financial institution. If the continuation cost of a VV mortgage and the refinancing cost from VV to VV are equal, i.e., $\gamma_t(VV) = \kappa_t(VV|VV)$, then the choice between continuing and refinancing is identical.

with wealth evolving according to $W' = Y' + (1 + R')(W - c_t^{\text{Owner,NM}}(W, z, R))$.

2.3.3 Renters

In the model, all households are initially homeowners, but may choose to make a permanent transition into the rental market at any point in the lifecycle. The cost of renting is equal to the user cost of housing plus a rental premium.

During the working periods of life, renters occupy the same size house as that available to homeowners. The date $t \leq J_w$ rental cost, RC, is defined as:

$$RC_t = (R_{1t} + \tau_r^H + \mu_r^H + \phi_r^H)H_t,$$

where τ_r^H and μ_r^H are the property tax rate and maintenance costs of rental housing, respectively, and ϕ_r^H is the rental premium of rental housing.

In retirement, renter households move to an assisted living facility whose quality is proportional to their retirement income. Rental cost during retirement, $t > J_w$, is defined as:

$$RC_t = (R_{1t} + \tau_r^A + \mu_r^A + \phi_r^A)A(Y_t),$$

where $A(Y_t) = \bar{A}Y_t$, τ_r^A and μ_r^A are the property tax rate and maintenance costs of assisted living housing, respectively, and ϕ_r^A is the premium paid for assisted living.

2.3.4 Preferences and Income

As in Campbell (2006), we assume that preferences are separable between housing and non-housing consumption and that house size is fixed throughout each household's lifetime. Under these assumptions, we can drop housing from the preference specification. Our agents have Epstein and Zin (1989) preferences,

$$V_{it} = F(C_{it}, V_{i,t+1}) = \left\{ (1-\beta)C_{it}^{1-1/\psi} + \beta E_t(V_{it+1}^{1-\gamma})^{\frac{1-1/\psi}{1-\gamma}} \right\}^{\frac{1}{1-1/\psi}}, \tag{4}$$

where γ is the coefficient of risk aversion, β is the subjective discount factor, and ψ is the elasticity of intertemporal substitution.

During the work life, agents are endowed with stochastic labor income Y_{it}. Income during the household's working life is modeled following Guvenen et al. (2021). In period t of the household i's working life, income is given by:

$$Y_{it} = (1 - \nu_{it}) \exp(g(t) + \alpha_i + z_{it} + \epsilon_{it}), \tag{5}$$

where $g(t)$ captures the age profile of the household's earnings and α_i is a household fixed effect calibrated to match average earnings. The unemployment shock, ν_{it}, generates a large decrease in income when the household is unemployed, while the stochastic processes, z_{it} and ϵ_{it}, capture, respectively, persistent and transitory income shocks for employed households.

The persistent income process, z_{it}, follows an AR(1),

$$z_{it} = \rho z_{i,t-1} + \eta_{it}, \tag{6}$$

with innovations drawn from a mixture of normal distributions. The persistent shock η_{it} is $\mathcal{N}(\mu_{\eta,1}, \sigma_{\eta,1})$ with probability p_z and $\mathcal{N}(\mu_{\eta,2}, \sigma_{\eta,2})$ otherwise.

The transitory shock, ϵ_{it}, is also a mixture of normal distributions drawn from $\mathcal{N}(\mu_{\epsilon,1}, \sigma_{\epsilon,1})$ with probability p_ϵ and $\mathcal{N}(\mu_{\epsilon,2}, \sigma_{\epsilon,2})$, otherwise. In both cases, the expected value of the mixed distribution is zero.

The unemployment shock, $1 - \nu_{it}$, is given by

$$1 - \nu_{it} = \begin{cases} 1 & \text{with prob. } 1 - p_\nu(t, z_t^i), \\ \lambda & \text{with prob. } p_\nu(t, z_t^i), \end{cases} \tag{7}$$

where

$$p_\nu^i(t, z_t) = \frac{\exp(a_\nu + b_\nu t + c_\nu z_t^i + d_\nu z_t^i t)}{1 + \exp(a_\nu + b_\nu t + c_\nu z_t^i + d_\nu z_t^i t)}. \tag{8}$$

This shock depends on the household's age and the persistent component of the income process. When the unemployment shock is realized, the household's income is scaled down by a constant fraction, λ.

Following Cocco et al. (2005), retired households receive a deterministic fraction, ω, of their income in the last period of their working lives. More precisely, for retired household i in period t, income is given by

$$Y_{it} = \omega \cdot \exp(g(T^r) + \alpha^i + z_{i,T^r}), \tag{9}$$

where T^r is the final working period. Income is taxed at a constant rate τ_Y.

2.4 Financial Institutions and Mortgage Supply

We assume there is a representative, deep-pocketed, risk-neutral lender supplying mortgages. In t, the lender has a portfolio of mortgages that are chosen by households acting as outlined above. Total lender profit is defined as:

$$\Pi_t(\Phi) \equiv \sum_i \pi(\Phi, S_{i,t}, A_t),$$

where $\Phi = \{\phi_{FF}, \phi_{VF}, \phi_{VV}\}$ are the mortgage premia determined in equilibrium. For each individual household mortgage contract, profit is given by:

$$\pi(\Phi, S_{i,t}, A_t) = E_t \sum_{s=0}^{T_i} M_{t,t+s}(\chi_{i,t+s}, A_{t+s}) \cdot \mathcal{F}(\Phi, (\chi_{i,t+s}, R^M_{i,t+s}), S_{i,t+s}, A_{t+s}).$$

This equation combines two elements. First, the mortgage cashflow to the lender, $\mathcal{F}$, depends on the set of mortgage premia, Φ, the mortgage type and contract rate, (χ_i, R^M_i), and aggregate state variables, A. The cashflow may stem from either a regular mortgage payment or, when refinancing, the full prepayment of the existing contract. When evaluating expected future mortgage cashflows, the lender properly internalizes future refinancing of the contract into either the same or a different type. As such, mortgage cashflows also depend on the household's characteristics, S_i, and these enter as an argument into the cashflow function.

Second, the lender calculates the net present value of these flow payments over time, from the current period until the end of the household's mortgage contract, denoted by T_i. The lender uses the appropriate risk-neutral discount factor, $M_{t,t+s}$, that depends on the type of the mortgage being discounted, χ_i, and the aggregate state of the world, A_{t+s}. The discount factor varies by mortgage type and reflects the appropriate term structure for each contract:

$$M_{t,t+s}(\chi_i, A_t) = \prod_{j=1}^{s} \left(1 + \tilde{R}_{\chi_i,t+j-1}\right)^{-1},$$

where $\tilde{R}_{\chi_i,t} = R_\chi(\{r_{n,t}\}_n, 0)$. This is the mortgage pricing function with the mortgage premium set to zero, leaving only the bond interest rates used to price the mortgage. For example, in the Canadian calibration, this is the 5-year bond for FF mortgages and the 1-year bond for VF and VV mortgages. This formulation captures the rolling forward curve of rates used to discount future cashflows based on the lender's expectations at each point in time. For fixed-rate contracts, the discount factor incorporates the term structure over the length of the contract, while for variable-rate contracts, the discount factor tracks the path of short-term rates.

3 Model Calibration

In this section, we describe the Canadian mortgage market that serves as the empirical foundation for our model and detail how we calibrate the model parameters to match this market's key features. Our model has four key sets of parameters that need to be calibrated: the institutional features of mortgage contracts, the stochastic processes for interest rates and term premia, household income dynamics, and preference parameters. We calibrate the first three sets of parameters using historical market data, loan-level microdata, and household survey evidence from Canada. We then set household preference parameters to match the observed distribution of mortgage type origination shares between 2014 and 2021. The calibrated model successfully replicates key features of the Canadian mortgage market, including the relative shares of different mortgage types and their variation with interest rates and term premia.

3.1 Institutional Details

3.1.1 The Canadian Mortgage Market

The Canadian mortgage market is relatively concentrated in the traditional banking sector, with the dominant "Big 6" banks responsible for the largest share of mortgage originations and balances outstanding. This market offers an ideal laboratory for studying mortgage choice because it features a menu of contract types with significant heterogeneity in household choices over time.

The Canadian mortgage market is characterized by contracts with short terms (2–5 years, with the 5-year term being the most prevalent) and long amortization periods (25–30 years). The term is the length of time over which a financial institution commits to extending a loan to a borrower under certain conditions, while the amortization period is the length of time it takes to pay off a mortgage. Thus, with a mortgage term that is shorter than the amortization period, the contract is amortized only partially.

At the end of the term, borrowers may renew their current mortgage, rolling over the outstanding balance and having their mortgage rate reset to the level of current market rates. The renewal usually takes place with the current lender, which is the case for 90% of borrowers, with the remaining 10% choosing to switch to another lender. Alternatively, if not renewed, the balance must be repaid in full through home sale or from other proceeds (e.g., inheritance). The Canadian system of mortgage renewals at the end of the term eliminates the refinancing inertia observed in other markets.

Unlike the U.S. mortgage market, where long-term fixed-rate mortgages are dominant, households in Canada at origination or renewal of their mortgage can choose between the three types of contracts modelled above: FF, VV, and VF. Prepayment of mortgages in full and refinancing outside of renewal periods is rare in Canada due to significant penalties, especially for fixed-rate mortgages when interest rates fall below the contractual rate. As a result, while it is technically possible for households to switch between mortgage types during a contract term, the overwhelming majority switch only during renewal periods.

Overall, these institutional features make the Canadian mortgage market an excellent setting for studying how households choose between different mortgage contracts in response to changing economic conditions. Appendix A contains more details on the Canadian mortgage market.

3.1.2 Data

Our two main sources of data for the Canadian mortgage market are the administrative mortgage-level data from the Canadian Office of the Superintendent of Financial Institutions (OSFI) and the Survey of Financial Security, which is a Canadian equivalent of the Survey of Consumer Finances in the United States.

The OSFI data provides information for all mortgages originated by federally regulated financial institutions in Canada, where, given the short-term nature of mortgages, originations include not only purchase mortgages but also mortgage renewals, whether with the same or a different lender. The information at origination and switch renewals includes both current borrower and contract characteristics, while same lender renewals get updated contract information, but not borrower characteristics, as in these cases mortgages are not underwritten at renewal and therefore do not require updated borrower information.

We observe loan-level characteristics such as origination date, lender, type of mortgage (in terms of both the duration of the term and interest rate type), balances outstanding, and purchase or appraisal value of a home. We restrict our sample to the Big 6 Canadian banks given their dominant role in the mortgage market in terms of both originations and balances outstanding. We use OSFI data for the period from 2014, which is when its collection started, to end of 2022.

The Survey of Financial Security collects information on household income and different balance sheet items, housing and mortgage tenure, as well as demographic characteristics. We use this information to obtain a picture of the household finances at the time of home purchase, which is not complete when only using OSFI data for mortgage originations.

3.2 Financial Markets

3.2.1 Mortgage Rates

In Canada, mortgage rates are priced directly off the yield curve plus a mortgage premium that differs across types. Specifically, VF and VV mortgage rates are equal to the 1-period bond rate and a fixed mortgage premium:

$$R_{VV,t} = R_{1,t} + \phi_{VV}$$

$$R_{VF,t} = R_{1,t} + \phi_{VF}.$$

On the other hand, the 5-year FF mortgage rate has a premium over the 5-period risk-free bond:

$$R_{FF,t} = R_{5,t} + \phi_{FF}.$$

We calibrate the mortgage premia, i.e., the spread over the government bond, to the average mortgage premia in the data during our sample. For VV and VF contracts we take the average difference between the mortgage rate and the 1-year bond yield. For FF contracts we take the average difference between the mortgage rate and the 5-year bond yield. In all three cases, the spread has been 1.50% on average over the sample period, with very little variance. As a result, we set $\phi_{FF} = \phi_{VF} = \phi_{VV} = 0.0150$. Importantly, when we run counterfactual experiments, the loan premia endogenously adjust so that financial institutions are indifferent between the status quo and the counterfactual world. The mortgage is used to finance the purchase of a house worth 330,000 CAD, which matches the average house purchase for first-time home buyers under 40 years old in the Canadian Survey of Financial Security. We set ϕ_S, the transaction cost of selling a house, to 5% and τ_S, the tax rate on capital gains, to 1%.

While lenders may incorporate other factors into their pricing decisions, we believe the spread relative to government bonds is most relevant for understanding mortgage pricing and origination dynamics. Panel (a) of Figure 1 plots the spread between 5-year and 1-year bond rates compared to the spread between FF and VF mortgage rates. The two move almost in lockstep, with a correlation of 0.71 (which increases to 0.77 if we use VV mortgage rates instead of VF). In Panel (b), we compare the same mortgage spread with the fraction of new mortgage originations into FF. As the spread increases and FF mortgages become relatively more expensive, the fraction of new FF originations decreases. The correlation between these lines is -0.67 (-0.76 for VV mortgages). Altogether, our calibration of mortgage rates exogenously captures that mortgages are primarily priced off of bonds, which will help the model endogenously generate that mortgage choice is a function of these aggregate states.

3.2.2 Bond Rates

We calibrate the stochastic interest rate and term-premia processes in the following manner. We use Canadian 1-year government bond yields (GOC-1) between 1980 and 2023 to estimate equation (1). We estimate the average 1-year risk-free rate to be 2.977%, the persistence parameter of interest rates to be 0.896 and the standard deviation to be 1.21%. Given our estimates of the AR(1) process for interest rates, we can estimate equation (3). We use data on 5-year Canadian government bond yields, the estimated parameters for equation (1) and the expectation hypothesis of interest rates to get a time-series for the term premium. We then estimate the average term premium to be 0.4%, its persistence to be 0.74 and volatility 0.52%. We report all of these parameters in Table 2.

3.3 Mortgage Contracts

We set the mortgage amortization to $N_A = 25$ years for all contracts. The origination cost for each type of mortgage is zero, $\kappa(FF) = \kappa(VF) = \kappa(VV) = 0$, so that each household can originate its preferred mortgage type.

We implement the Canadian "renewal" and "non-renewal" framework in the following way. Households with mortgages must renew their contracts every five years, and we denote these renewal periods as the set $\tau_R = \{6, 11, 16, 21\}$. In all other periods, denoted by the set $\tau_N = \{1, 2, \ldots, 25\} \setminus \tau_R$, households must stay in the same contract.

To model this, we set continuing and refinancing costs in the following way. For each mortgage type χ, the continuing cost is zero in non-renewal periods and infinity in the renewal periods, and, conversely, the refinancing cost is infinity in non-renewal periods and zero in renewal periods:

$$\gamma_t(\chi) = \begin{cases} 0 & \text{if } t \in \tau_R \\ \infty & \text{if } t \in \tau_N \end{cases}, \quad \kappa_t(\chi|\chi_-) = \begin{cases} \infty & \text{if } t \in \tau_R \\ 0 & \text{if } t \in \tau_N \end{cases},$$

where the second equation is for each χ_{-}, which implies that the new mortgage choice is independent of the previous mortgage choice.

3.4 Income and Preferences

The income process is calibrated in two steps. The stochastic component is specified following Guvenen et al. (2021) and uses the estimated parameters from that paper. The deterministic lifecycle component of the income process is estimated using Canadian data from the 2016 Survey of Financial Security for mortgage holders. The full set of parameters for the income process are reported in Table 3.

Household preferences are parameterized with the discount factor, β, coefficient of risk aversion, γ, and the elasticity of intertemporal substitution, ψ. We calibrate these parameters to match the shares of origination into each mortgage type in 2016, given initial mortgage balances, debt-to-income ratios, and financial savings to income ratios from the 2016 Survey of Financial Security. This process yields $\beta = 0.95$, $\psi = 0.75$, and $\gamma = 10$. Finally, we set the scale parameter of the EVT mortgage choice taste shocks, σ, to 0.01. This accounts for stochastic preference shocks and smooths the numerical approximation of the model's policy functions.

To assess the performance of our calibration, we simulate the model using observed interest rates and term premia from 2014 to 2022. Figure 2 plots the share of mortgage originations into Fixed-Fixed (top panel), Variable-Fixed (middle panel), and Fixed-Fixed (bottom panel) mortgage over the sample period. The model matches mortgage originations composition over time fairly well. For most of our sample period, most mortgages originated in Canada were fixed-rate mortgages. There is a significant dip in the proportion of fixed-rate mortgages originated in 2018 and after 2020, consistent with periods when term premia were increasing.

4 Drivers of Mortgage Choice

In this section we use our model to illustrate the economics of mortgage-type choice. The household mortgage choice policy function is the key object of interest that emerges from our model since it allows us to understand the factors driving mortgage choice. The policy function takes as input the aggregate state variables, $A_t \equiv \{R_{1,t}, \omega_t\}$, and the household state variables, $S_{it} \equiv \{Age_{it}, W_{it}, Z_{it}, M_{it}, \chi_{i,t-1}, R^M_{i,t-1}\}$, and we analyze each set of factors separately. We consider a household's initial mortgage choice when the state variable for persistent income is set to the median of the stochastic process.

4.1 Aggregate State Variables

Figure 3 shows the policy functions of mortgage-type choice as a continuous function of the aggregate state variables, short-term interest rate (x-axis), and term premium (y-axis) for four combinations of household leverage and cash-on-hand. We focus on extreme cases of leverage (high and low) and cash-on-hand (high and low) since they help convey intuition for household behavior.

In the figure, for a given combination of state variables, each color represents the household's optimal mortgage choice: blue is FF, red is VF, yellow is VV. The optimal choice of exiting the homeowner market and becoming a renter is represented by the color green.

The four panels in the figure illustrate the stark role that the term premium plays in driving mortgage choice. For essentially all households, when the term premium is small or negative, the optimal mortgage choice is FF. A low term premium makes the FF mortgage very competitively priced relative to the VF and VV mortgages, whose pricing is independent of the term premium. In other words, a low term premium decreases the spread between FF and both variable-rate mortgages, and thus locking in the low interest rate over the contract term is better for all households, regardless of cash-on-hand or leverage.

In each panel, as the term premium increases, the FF mortgage is dominated for all households by one of the variable-rate mortgages. In Figure 3, Panel (a), when households have low cash-on-hand and low leverage, a low interest rate motivates households to choose VV mortgage, while a higher interest rate makes it optimal to choose VF mortgage. While the same pattern holds true in Panels (c) and (d), the opposite is true in Panel (b).

Overall, aggregate factors are crucial for determining the choice between FF versus the variable-rate mortgage types. This is consistent with the well-documented empirical fact that the spread between mortgage rates, which in our model is governed primarily by the term premium, is a key driver of mortgage choice. The choice between the two types of variable-rate mortgages then depends on household-specific factors and we turn to these in the next section.

4.2 Household State Variables

Figure 4 shows the policy functions of mortgage-type choice as a continuous function of the household state variables, cash-on-hand (x-axis), and leverage (y-axis) for four combinations of the 1-year bond rate and term premium. We again focus on extreme cases of the 1-year rate and term premium to help convey intuition behind household behavior in the model. As above, each color represents an optimal choice: blue is FF, red is VF, yellow is VV, and green is rent.

The top two panels of Figure 4 show the choices when the term premium is low. For low levels of cash-on-hand the agent moves to the rental market. These are the agents who do not have enough liquidity to make their mortgage payments. As discussed in the previous section, when the term premium is low the agent always prefers a fixed-rate mortgage for both high and low levels of interest rate and for any level of cash-on-hand.

Figure 5 helps us to understand the mortgage choices for different levels of interest rate and term premium. The left panels of this figure show the average paths of payments (interest and principal) agents can expect over the next five years. The right panels show the speed of debt repayment or deleveraging.

When the term premium is low and interest rate is low (Figure 5, Panel (a)-i), the fixed-rate mortgages allow agents to make smaller payments compared to VF and VV mortgages. Because interest rates increase (in expectation), the VV contract payments increase over time. The VF mortgage payments are constant, but due to increasing interest rates, deleveraging is much slower under this contract compared to the FF contract (Panel (a)-ii). Thus, agents trivially opt for the FF contract, which is the one with lowest payments in expectation over the next five years and which provides the fastest deleveraging. This contract is the best in terms of liquidity and wealth effects (lower payments and fastest deleveraging).

Panels (b)-i and (b)-ii of 5 show a similar result. When interest rates are high but term premium is low (possibly negative), an FF contract has lower payments over five years (in expectation) and provides fast deleveraging for households (VF provides faster deleveraging, but this effect is not strong enough for this contract to be chosen).

Panels (c) and (d) of Figure 4 show the choices of the agent when the term premium is high. This is the most interesting case. When the term premium is high, agents never choose the FF contract. This is intuitive, since mortgage payments, when the slope of the term structure is high, are very large for a fixed-rate contract. This can be clearly seen in Figure 5: the FF contract has the largest payments (Panels (c)-i and (d)-i) and provides the slowest deleveraging (Panels (c)-ii and (d)-ii). The choice between a VV contract and a VF contract is more subtle. As Panels (c) and (d) of Figure 4 show, when the interest rate is low, poorer agents choose a VF contract and richer agents a VV contract. The opposite happens when the interest rate is high: poorer agents choose a VV contract and richer agents a VF contract.

Panels (c) and (d) of Figure 5 help understand why this is the case. When interest rates are low (Panel (c)), the VV contract has increasing expected payments (because interest rates are expected to increase), but it also has increasing principal payments and thus provides fast deleveraging. On the other hand, as the VF contract has fixed total payments, expected increasing interest payments mechanically result in decreasing principal payments. Therefore the VF contract provides much lower total payments over the 5-year horizon, but much slower deleveraging as well. As poorer agents value liquidity more, they would pick the VF contract, while richer agents would prefer the VV contract. When the level of interest rates is high (Panel (d)), in expectation interest payments decrease. Thus payments for the VV contract decrease over time. Total payments for the VF contract are fixed (and higher than the payments for the VV contract), but interest payments decrease over time, which mechanically implies that this contract provides faster deleveraging. As a result, liquidity-constrained poorer agents pick the VV contract, while richer agents would prefer the VF contract.

4.3 Discussion

Our analysis of the household mortgage choice policy function yields two main insights related to aggregate and household factors. At the macroeconomic level, a low term premium makes FF mortgages attractive for all households, regardless of idiosyncratic conditions. Conditional on a high term premium, household factors take a central role in determining the optimal choice between VF and VV mortgages.

To understand this latter choice, it is useful to think of mortgages as a form of risk management, with each type of mortgage insuring against different combinations of risk. In our model, there are two forms of mortgage-related risk: payment (liquidity) risk and balance (wealth) risk.

Payment risk is the traditional form of risk associated with any security in which the interest rate used to price payments is indexed to a non-deterministic market interest rate. In our case, only VV mortgages have payment risk, since FF and VF mortgage contracts codify the interest rate that will be used to construct payments. We define balance risk as uncertainty about the outstanding level of mortgage debt that the household will need to refinance at the end of each term. This form of risk exists only because the contract term is shorter than the maturity of the mortgage. Balance risk is directly related to uncertainty regarding principal payments. If principal payments are known with certainty, then the outstanding balance in the renewal period is known with certainty.

Clearly, FF mortgages have no balance risk since the total, interest, and therefore principal payments are all calculated according to the contract rates. VV mortgages also have no balance risk. Although total payments and interest payments in each period both depend on stochastic interest rates, by construction, the total ratio between principal and interest payments remains the same, and therefore the total principal paid over the term is known with certainty. The only mortgage type exposed to balance risk is VF, which has contractual total payments and market-varying interest payments. Since principal payments are the residual total payments after interest is paid, they too are stochastic, and thus the total outstanding balance at the end of the term depends on the realization of interest rates.

Subsequently, each mortgage provides a different form of insurance. The traditional FF mortgages insure against both payment risk and balance risk, while traditional VV mortgages insure only against balance risk. VF mortgages complete the menu of options by insuring only against payment risk.

This interpretation of mortgage contracts as forms of insurance can help us reframe the analysis in the previous section. As discussed, poorer households value liquidity more, and therefore they prefer the VF contract more than the VV contract (conditional on the aggregate state variables). In other words, a poorer household's welfare is much more sensitive to its immediate liquidity than its long-term wealth, and therefore if it can afford only one form of insurance, it chooses to remove liquidity risk as opposed to wealth risk. In the context of mortgage choice, this means preferring VF to VV mortgages. As liquidity increases, the household can afford to take a more long-sighted approach and consider the implications of its choices for lifetime wealth.

5 The Value of Mortgage Choice

The policy functions show some of the economic drivers of mortgage choice for extreme levels of term premia and interest rates. We highlight some more nuanced drivers of the mortgage choice by simulating our model. We simulate 250 economies, each with 9,000 agents, using an overlapping generations approach. To better understand the main effects, we start by examining four different scenarios: (i) the baseline model, in which agents can endogenously choose any of the three contracts (FF, VF, and VV) in reset periods; (ii) a model with FF contracts only; (iii) a model with VF contracts only; and (iv) a model with VV contracts only. Thus, the first scenario is the one where agents have a larger contract space available. For all the remaining scenarios the loan premia endogenously adjust such that lenders have the same net present value as in the baseline model.

5.1 Sources of Value in Mortgage Choice

5.1.1 Aggregate Risk

Table 8 shows average income, consumption, savings, and proportions of mortgage types outstanding as a function of the aggregate state of the economy (the two aggregate state variables in our model are the level of interest rates and the term premium). By construction, income is the same across aggregate states of the world. As standard, consumption growth is higher when interest rates are high and lower when interest rates are low. This result comes straight from the Euler equation for consumption. When interest rates are high, agents save more today and consume more tomorrow.

The final three rows of the table show the proportions of agents in each type of contract. The first thing to notice is that there is a mass of agents in each type of contract for all aggregate states of the world. This is due mainly to the overlapping generation feature of the model, which implies that households are able to change their mortgage type in different periods (and thus different aggregate states) and then have to stick with the contract until the next reset period. Thus unlike Black (1998), who argued that a VF contract would dominate any other type of contract, we show that endogenously there is scope for the three types of contract to co-exist. Consistent with the policy function analysis in the previous section, the second result we note is the predominance of FF contracts in periods of low term premia, relative to the predominance of VF and VV contracts in periods of high term premia. When the term premium is low, the FF contract delivers lower payments over the horizon of the contract and faster deleveraging. Third, VF contracts are more likely to be picked when interest rates are high, whereas VV contracts are more likely to be picked when interest rates are low (for any level of term premium, high or low).

5.1.2 Idiosyncratic Risk

Table 9 shows household characteristics as a function of the current type of mortgage contract outstanding. These figures allow us to study how differences across households, driven by heterogeneous realizations of idiosyncratic income risk, shape mortgage choice.

Households that pick fixed-rate mortgages (first column) tend to have lower income, lower savings and higher debt outstanding (rows 1 to 3 of the table). These agents have a lot of leverage compared to their income and savings and therefore value the fixed payments that an FF contract delivers. Rows 5-6 show the standard deviation of the ratio of total payment to mortgage debt outstanding and interest payment to mortgage debt outstanding, respectively. Trivially, the FF contract delivers the lower standard deviation of mortgage payments (total and interest). The choice between the two variable-rate contracts is more subtle. Households prefer variable-rate fixed payment contracts when interest rates are very high. This is because in expectation, interest rates are likely to decrease going forward and therefore the fixed payment implies principal payments are increasing over time, and thus this contract delivers fast deleveraging. When interest rates are lower, agents opt for VV contracts.

The main tradeoff faced by households when choosing between the three mortgage contracts is total interest cost versus benefits of smoothing consumption volatility. To illustrate this, we compare the the simulated economies when only one mortgage contract is available. In each panel of Figure 7, the value for VF mortgages is normalized to unity, allowing for direct comparisons to FF and VV mortgages. Panel (a) compares total interest costs across the three mortgage types. On average across all simulations, mortgages in the economy with only FF mortgages are roughly 8.7% more expensive than in the economy with only VF mortgages, reflecting the higher mortgage term premium associated with the full insurance provided by FF mortgages. On the other hand, VV mortgages are approximately 0.7% less expensive than VF mortgages.

Panels (b) and (c) demonstrate the consumption trade-off in light of higher mortgage costs. In panel (b), consumption levels are roughly the same across all three mortgages. Panel (c) illustrates the main benefit to households in return for higher mortgage costs: significantly less consumption growth volatility. Specifically, relative to the VF economy, the standard deviation of consumption growth is 1.7% less in the FF economy. This represents a significant reduction in consumption volatility. In contrast, in the VV economy, consumption growth volatility is 1.0% higher than the VF economy, indicating an increase in consumption volatility.

Altogether, households in the FF economy pay a large premium relative to the VF economy in order to reduce consumption volatility while maintaining roughly the same level of consumption. Alternatively, households in the VV economy receive a discount relative to the VF economy but face slightly higher consumption volatility. The VF economy lies strictly between the two extremes, with an intermediate level of consumption volatility at an intermediate mortgage cost.

5.1.3 Lifecycle Dynamics

Table 6 shows consumption, savings, and leverage over the lifecycle for each of the four scenarios under consideration (an economy with all mortgage contracts available, and economies with only one mortgage contract available). The first column of the table shows income over the lifecycle. Income in our model is exogenous and independent of the type of mortgage contracts available, and thus identical for all four scenarios.

Columns 2 to 5 show consumption over the lifecycle for each scenario. Consumption is lower than income and inherits the same hump-shape pattern. This is standard in life-cycle models as agents save for retirement.[2] More importantly, over the entire lifecycle the level of consumption is higher when all contracts are available. This happens because agents do less precautionary saving when they have more flexibility in the mortgage contract they can choose, and they can optimally choose contracts that minimize their overall debt burden (more on this below).

Interestingly, VF contracts allow agents to have higher consumption early in their lifecycle and lower consumption later in life compared to FF and VV, implying better consumption smoothing (and therefore higher ex-ante welfare). Despite the varying interest payments under this contract, agents know that payments are fixed and can consume more early in life. This contrasts with the FF contract, which despite the fixed payment and rate, yields the lowest consumption for agents early in life. This is because the average term premium is positive in our economy and therefore a fixed-rate contract is more expensive, on average.

Columns 6 to 9 show the average financial savings of agents over the lifecycle. Liquid savings, on average, increase over the lifecycle as agents save for retirement. This is true for all scenarios under consideration. They are on average lower when all contracts are available (since agents do less precautionary saving) and higher in economies where only

[2] Income in the first column is gross of any income taxes.

VV contracts are available. In these economies, agents are very exposed to interest rate risk and thus save more for precautionary reasons.

The last four columns of the table show average leverage over the lifecycle. Average leverage in the economy is the lowest when all contracts are available. This is because agents can endogenously choose the contract that helps them minimize interest payments and deleverage the quickest.

Table 7 helps illustrate why agents do more precautionary saving when they have a limited contract choice available. It shows averages and standard deviations of consumption growth, as well as levels of interest payments and total mortgage payments, conditional on agents having a mortgage outstanding. Average consumption growth is the lowest (6.0%) when all contracts are in the choice set of agents, and the highest (6.7%) when only the VV contract is in the choice set. This is consistent with the previous results: having all the contracts available helps agents smooth consumption over the lifecycle (and thus lowers consumption growth), whereas the VV contract is the riskiest of all, forcing agents to save more early on in the lifecycle. Interestingly, on average, total payments are highest under an FF contract (18.7 thousand dollars) and lowest when all the contracts are available (17.8 thousand dollars). Therefore, an FF contract is in dollar terms much more expensive than a VF contract or a VV contract even after the representative lender endogenously adjusts equilibrium loan premia. The benefit of an FF contract is the certainty of total payments, and thus this is the contract with the lowest standard deviation of total payments. Note that the standard deviation of total payments is not zero under an FF contract because agents renew the contract every five years, and therefore the interest rate resets and so does the total payment.

5.2 Welfare Losses from Limited Mortgage Choice

Building on the analysis in the previous section, we turn to quantifying the trade-offs between mortgage types in consumption equivalent units. Panel (a) of Table 4 reports welfare losses in economies with only one mortgage contract available compared to economies with all three contracts available. The first column shows the unconditional welfare losses and the remaining columns show the welfare losses conditional on the aggregate state of the economy in terms of interest rates and term premia.

Welfare losses are economically large, ranging from between 1% to 6% of annual consumption. If agents had to pick only one contract to be available, they would pick the VF contract. Unconditionally, as shown in the first column, the economy with this contract suffers a welfare loss of 1.82% compared to an economy where all contracts are available. This contrasts with the higher welfare losses in economies with only FF contracts available (3.18% loss) and economies with only VV contracts available (2.79% loss).

These welfare gains from Panel (a) of Table 4, take into account the equilibrium repricing of loans by the representative lender. In particular, compared to the baseline loan premia, loan premia decrease when the menu of contracts available for households to choose from is larger. More specifically, in an economy with only FF loans, equilibrium loan premium decreases 7 basis points; in an economy with VF only loans, equilibrium loan premium decreases 10 basis points; and in an economy with VV only loans, equilibrium loan premium decreases 9 basis points. Panel (b) of the same table shows the welfare gains if loan premia were unchanged compared to the baseline; as expected, welfare losses are much larger when lenders do not endogenously adjust the premia on loans when they change the menu of contracts they offer.

5.2.1 Decomposition of Welfare Losses

To better understand the value of mortgage choice, we decompose welfare gains along the three dimensions described in the previous section: aggregate risk, idiosyncratic risk, and lifecycle dynamics. We use the Shapley (1953) method for decomposing welfare changes. This method generates an additive decomposition that, by construction, sums to one, and allows for a straightforward interpretation of how the different factors individually contribute to welfare.

Table 5 contains the decomposition for each mortgage type relative to the full menu of contracts. We follow Audoly et al. (2025) in applying this methodology, which is typically used in empirical analysis, to understanding welfare in a fully structural model. To fully span the differences across mortgage types, we include two additional factors described in Appendix **??**, and present only the three factors as a share of their total contribution.

Relative to the benchmark model with all three contracts, the economy with only fixed-fixed contracts generates a 3.77% welfare loss. The Shapley decomposition attributes 39.3% of this loss to the aggregate risk factor, 71.5% to the idiosyncratic risk factor, and -10.8% to the lifecycle dynamics factor. Intuitively, the largest contributor to welfare loss is idiosyncratic risk because fixed payments over the life of the mortgage allow no adjustment when idiosyncratic shocks affect household income. Lifecycle dynamics work against this to provide a form of built-in hedging since the deterministic component of income is increasing at the beginning of the lifecycle, coinciding with the life of the 25-year mortgage. In other words, when households are forced to hold fixed-fixed mortgages, the fact that their lifecyle income is increasing works in their favor, which generates a negative contribution to the welfare loss. Notably, the aggregate risk component is also important for understanding welfare losses, since the five-year renewal period still exposes households to aggregate risk at the renewal periods. The three-contract menu allows households to switch to a different mortgage contract when, as discussed above, the shape of the yield curve makes the fixed-fixed mortgage less desirable.

With only variable-variable mortgages, aggregate risk accounts for 56.4% of the welfare loss relative to the economy with all three contracts. Payments fluctuate directly with aggregate interest rates and this exposure is the primary contributor to welfare losses since households cannot insure against it. Idiosyncratic risk contributes a sizable 40.3% of the welfare loss since households may face large idiosyncratic shocks at the same time they face expensive interest rates. For both variable products, lifecycle dynamics do not contribute materially to welfare losses since these contracts shift either payments or balances over the lifecycle.

Interestingly, the primary driver of welfare loss in the economy with only variable-fixed contracts is also aggregate risk, contributing to 61.4% of the welfare loss, compared to only 37.5% for idiosyncratic factors. While variable-fixed mortgages insure against cash flow changes when aggregate factors change, this decomposition illustrates the costliness of exposing the renewal balance to aggregate risk. Since households cannot shift this rate risk intertemporally, aggregate risk is the primary contributor of welfare losses, even more so than with only variable-variable contracts. This is consistent with the earlier analysis dictating that variable-fixed contracts induce larger total interest costs at the benefit of more stable payments.

6 The U.S. Mortgage Market

The structure of the U.S. mortgage market differs significantly from that of the Canadian mortgage market. Our model is designed to easily accommodate the key features of the U.S. mortgage system. There are three main differences between these two markets: first the menu of mortgage contract types is different between the two markets. In Canada, households can choose from a variety of mortgage types, including fixed-rate fixed-payment, variable-rate variable-payment, and variable-rate fixed-payment mortgages. In contrast, in the United States, the predominant mortgage type on offer is the fixed-rate fixed-payment mortgage. Second, amortization and contract lengths are usually the same in the United States, but not in Canada. In particular, in Canada, the typical fixed-rate fixed-payment mortgage has an amortization period that exceeds the contract length. For example, the average Canadian mortgage has a 25-year amortization period but only a 5-year contract length. Third, fixed-rate contracts in Canada often include severe prepayment penalties, making it costly for households to refinance or prepay their mortgages if the contract has not reached its term end. In the United States, however, prepayment costs are generally very low. This enables households to refinance their mortgages at lower rates when interest rates drop, creating significant prepayment risk in the U.S. mortgage system. These differences highlight why it is meaningful to quantitatively compare the United States and Canadian mortgage markets.

6.1 Model Calibration

We specify the continuation and refinancing fees to reflect these features of the U.S. mortgage market. To focus exclusively on FF contracts, we set all costs for VF and VV mortgages to infinity. In each period, households with FF mortgages can pay a finite cost, $\kappa(FF|FF)$, to refinance into a new FF mortgage. We calibrate this refinancing cost to match the refinancing rate in the United States of 7% as in Chen et al. (2020).

In addition to matching the average refinancing rate, we verify the model's ability to generate the correct distribution of non-refinancing. Figure 8 summarizes the distribution of rates paid on 30-year fixed-rate mortgages in 2019 and 2023 in the data and in the model. We follow Campbell (2006) and use data from the American Housing Survey (AHS) to calculate this distribution. For each spread over the current mortgage rate, the figure shows the fraction of households that pay more than this rate. We simulate the model and feed into it the specific path of risk-free interest rates and term premia between 1971 and 2025 in the United States and compute for 2019 and 2023 the model counterpart of the distribution of rates paid on fixed-rate mortgages. These are moments that were not targeted in our calibration.

The model generates a distribution of mortgage spreads that is comparable to the data. In 2021 mortgage rates were at historical lows. The fraction of households in the model and in the data with mortgage rates above the current rate was significant. This is due to either refinancing costs or inattention. In stark contrast, in 2023 mortgage rates were significantly higher, with a quick increase from the 2019 lows. This led many households to stay put and not refinance their mortgages both in the data and in the model; this "lock-in effect" may have negative implications for mobility and household welfare that outweigh the benefits of lower interest rate payments (Fonseca and Liu, 2024; Aladangady et al., 2024; Fonseca et al., 2024).

6.2 Welfare Analysis

Table 11 shows the ex-ante difference in welfare of the Canadian mortgage system versus the U.S. mortgage system, and decomposes the welfare change into the key main differences between the two mortgage markets. The baseline model is the Canadian system where all three types of mortgage contract are available. The first row of the table shows the welfare change, and the second row of the table shows the loan premia for each scenario under consideration.

The first column of the table shows the welfare change when moving from an economy where FF, VF, and VV contracts are available with 5-year contract lengths to an economy where only FF mortgages with 5-year contract lengths are offered. In this scenario, we assume that the representative lender does not adjust the equilibrium loan premia. The welfare loss from having a smaller contract menu to choose from is 3.77% in annual consumption equivalent terms. When fewer mortgage options are available, households lose the ability to endogenously choose the contract that allows them to deleverage quickly (if they have liquidity) or that minimizes interest payments. As a result, in equilibrium, the mortgage premium decreases. The second column of the table illustrates this effect: the loan premium decreases 0.07 p.p., making the representative lender indifferent between offering all three contracts or only the FF contract. Consequently the welfare loss is reduced to 3.19%. The third column of the table highlights the welfare gain of an economy where only a long-term fixed-rate contract is available compared to the baseline economy with multiple short-term contracts available, assuming no adjustment in the equilibrium loan premium. In this economy, households optimally exercise their option to refinance their mortgages to benefit from lower interest rates. As a result, the welfare gains are substantial: approximately 7 p.p. However, this type of mortgage structure is very risky for lenders due to this refinancing risk. Our representative lender accounts for households' expected prepayment behavior and demands a higher loan premium in equilibrium. The last column of the table shows precisely this. In particular, the mortgage premium over the long-term bond increases by 1.48 p.p., which is almost double the premium of the baseline economy. This large increase in premium makes households worse off in equilibrium. In particular, a mortgage system close to the U.S. system leads to a decrease in welfare of around 4%, compared to the Canadian system.

7 Mortgage Contracts and Monetary Policy

Mortgages serve as an important conduit for the transmission of monetary policy from financial markets to household spending and therefore inflation. Naturally, the type of mortgage contract that is predominant in the economy has important impact on monetary policy passthrough. In economies with predominantly fixed-rate mortgages, such as the United States, monetary policy shocks will have very different affects than economies dominated by variable-rate contracts. To the extent that the monetary policy authority values passthrough to mortgages, it will also have preferences over the different menus of mortgage contracts available to households.

7.1 Conventional Monetary Policy

To understand the impact of monetary policy shocks on the economy depending on the mortgage market structure, we estimate impulse response functions of consumption using local projections (Jordà, 2005). Since we use simulated data from the model, we do not require an instrumental variable as is standard in the empirical literature. Within the model, we know exactly each agent's expectations of future interest rates, and therefore computing the surprise (shock) component of an interest rate change is trivial.

We construct conventional monetary policy shocks through unexpected changes in the one-year bond rate, R_1, where a positive (negative) monetary policy surprise is a contractionary (expansionary) shock:

$$s_t^R = R_{1,t} - E_{t-1}[R_{1,t}]. \tag{10}$$

To construct the full impulse response function over H periods, we estimate the following equation for each type of shock (Jordà, 2023):

$$\Delta c_{t+h} = \alpha_h + \beta_h^R s_t^R + v_{t+h}, \tag{11}$$

where $h \in \{0, 1, 2, \ldots, H\}$ is the horizon, Δc_{t+h} is the percentage change in consumption between periods t and $t + h$, and s_t^R is the conventional monetary policy shock in period t.

Panel (a) of Figure 9 plots the estimated β_h^R from equation (11). This illustrates the cumulative consumption change due to a 1 percentage point unexpected increase in the 1-year bond rate (i.e., a contractionary monetary shock). The black line shows changes in consumption when all three contracts are available and each of the colored lines shows changes in consumption for economies where only one type of mortgage contract is available.

In the model with all contracts, consumption declines immediately after the contractionary monetary policy shock and has not fully recovered even after four years. Analyzing each of the single-contract economies in isolation can help us understand this effect. The VV-only economy has the strongest response to a conventional monetary policy shock: an unexpected 1 percentage point monetary policy shock leads to a 1.1% decline in consumption on impact. Since interest rates are autocorrelated, even after four years consumption has not fully recovered.

On the other hand, conventional monetary policy passthrough is weakest in economies dominated by FF contracts. The intuition for this is straightforward: if all contracts in the economy have fixed rates, then a change in the level of interest rates impacts only the level of payments on new mortgages or mortgages being renewed, and thus a 1 percentage point increase in the level of the risk-free rate leads to a decline of only around 0.2% in consumption on impact.

Economies with VF contracts lie in-between FF and VV. In these economies, an increase in interest rate means that households with mortgages outstanding will see their payments unchanged. However, a higher fraction of their payments will go towards interest (and a lower fraction towards principal), which is still a negative wealth shock, and thus consumption declines 0.8% on impact.

7.2 Unconventional Monetary Policy

Our model also allows us to study unconventional monetary policy that aims to affect interest rates on the longer end of the yield curve. We consider a forward guidance or quantitative easing program that aims to lower term premium, ω, and construct the surprise component as above:

$$s_t^{\omega} = \omega_t - E_{t-1}[\omega_t]. \tag{12}$$

We re-estimate equation (11) using this shock series and obtain a set of coefficients, β_h^{ω}, for the IRF of consumption to an unconventional monetary policy shock. Panel (b) of Figure 9 shows the impact of a 1 percentage point increase in term premium on consumption. When only VV and VF contracts are available, consumption is unaffected, since interest rates for these mortgages depend only on the short rate.

In economies where only FF contracts are available, a 1 percentage point shock to the term premium leads to an almost 1.0% decrease in consumption. This effect operates through households that are financing new mortgages in the period of the shock and remains constant over the next four years. In the economy with all three contracts, consumption declines by almost 0.4%, working exclusively through FF mortgages.

Overall, our analysis shows that both conventional and unconventional monetary policy can be effective but work through different mortgage contracts. Conventional monetary policy operates on both VF and VV mortgages and has a stronger impact than unconventional policy when all three contracts are available, while unconventional monetary policy operates exclusively through FF mortgages.

7.3 Comparisons to U.S. Mortgage Market

In Figure 10, we compare the U.S. consumption response to conventional and unconventional monetary policy shocks relative to the single and multi-contract economies. In Panel (a), we plot the percentage point differences between the consumption IRFs to a conventional monetary policy shock in the U.S. calibration of the model and the benchmark calibration with either all contracts, $(\beta_h^{R,US} - \beta_h^{R,All})$, or only FF contracts, $(\beta_h^{R,US} - \beta_h^{R,FF})$.

Conventional monetary policy is less effective in the U.S. economy by 0.7 percentage points relative to the multi-contract economy due to the absence of variable-rate mortgages. Even relative to the FF-only economy, the U.S. consumption response is smaller by around 0.2 percentage points from the first period after the shock onward. This is because in the U.S. economy, households are locked into their long-term fixed-rate mortgages and choose not to refinance, whereas households in the benchmark economy with 5-year fixed-rate contracts must refinance, despite higher rates.

Panel (b) plots the differences between the consumption IRFs to an unconventional monetary policy shock in the U.S. relative to the two other economies. Recall that unconventional monetary policy affects only the term premium and therefore only the interest rate on fixed-rate mortgages. Now, the impact of contractionary monetary policy in the U.S. calibration of the model is stronger than in the benchmark economy with all contracts since borrowers in the U.S. economy cannot substitute away from fixed-rate contracts to the relatively less expensive VV and VF contracts. Compared to the FF-only economy, however, unconventional monetary policy in the U.S. economy is less effective due to the same lock-in effect as in the case of a conventional monetary policy shock. When interest rates rise in the U.S. economy, households simply avoid refinancing, whereas in the FF-only economy they must still refinance at the end of their 5-year fixed-rate contracts.

Overall, monetary policy is typically less effective in the U.S. economy with long-term fixed-rate mortgages for two reasons: limited pass-through of conventional monetary policy shocks to fixed mortgage rates and long-term contracts that allow households to avoid refinancing when either conventional or unconventional monetary policy increases interest rates. These findings highlight how institutional features of mortgage markets fundamentally shape the transmission of monetary policy. In economies with predominantly long-term fixed-rate mortgages, central banks may need to rely on larger policy adjustments or alternative tools to achieve similar macroeconomic effects as their counterparts in more flexible mortgage market environments.

8 Conclusion

We use quantitative dynamic model of borrower behavior in the presence of multiple mortgage contract types. In our model, households face income, interest rate risk, and term premia risk and endogenously choose between three types of mortgages: a fixed-rate fixed-payment contract, a variable-rate fixed-payment contract, and a variable-rate variable-payment contract. We find that endogenously all contracts can coexist in equilibrium and their existence improves household welfare. We show that macroeconomic factors (e.g., interest rates and term premia) and individual characteristics (e.g., wealth, leverage, and income) both play crucial roles in driving mortgage choices.

When all three mortgage options are available, households can optimize their contract selection. Our analysis reveals that economies that restrict households to a single type of mortgage experience notable welfare losses, ranging from 1% to 6%, depending on the prevailing economic conditions. Fixed-rate mortgages, while offering payment certainty, tend to impose higher long-term costs, especially in environments with high term premia. Conversely, variable-rate mortgages provide better consumption smoothing and allow faster deleveraging, though at the expense of higher payment volatility.

Our results have important implications for monetary policy transmission. Economies dominated by variable-rate mortgages experience stronger and faster passthrough of interest rate changes, while economies with a larger share of fixed-rate mortgages are more sensitive to forward guidance. This highlights the need for policymakers to consider the composition of mortgage contracts when designing monetary policies aimed at influencing household consumption and debt dynamics.

Overall, the availability of diverse mortgage contract options enhances household welfare by allowing more efficient consumption smoothing and debt management. Limiting these options not only leads to higher consumption volatility but also results in slower debt reduction. Our findings underscore the importance of maintaining flexibility in mortgage contract offerings, particularly in the face of changing economic conditions.

References

Aladangady, Aditya, Jacob Krimmel, and Tess Scharlemann, 2024, Locked in: Rate hikes, housing markets, and mobility, *Finance and Economics Discussion Series* 1–59.

Allen, Jason, and Shaoteng Li, 2024, Dynamic competition in negotiated price markets, *The Journal of Finance* 80, 561–614.

Andersen, Steffen, John Y Campbell, Joao Cocco, Chris Hansman, and Tarun Ramadorai, 2023, Heterogeneous mortgage choice: Evidence from Denmark, Working paper.

Audoly, Richard, Rory McGee, Sergio Ocampo-Diaz, and Gonzalo Paz-Pardo, 2025, A practitioner's note on the shapley-owen-shorrocks decomposition, Staff Report 1163, Federal Reserve Bank of New York.

Beraja, Martin, Andreas Fuster, Erik Hurst, and Joseph Vavra, 2019, Regional heterogeneity and the refinancing channel of monetary policy, *The Quarterly Journal of Economics* 134, 109–183.

Berger, David, Konstantin Milbradt, Fabrice Tourre, and Joseph Vavra, 2021, Mortgage prepayment and path-dependent effects of monetary policy, *American Economic Review* 111, 2829–2878.

Berger, David, Konstantin Milbradt, Fabrice Tourre, and Joseph Vavra, Forthcoming, Optimal refinancing with inattention, *American Economic Review: Insights* .

Black, Fischer, 1998, Hedging, speculation, and systemic risk, *Journal of Derivatives* 2.

Campbell, John Y, 2006, Household finance, *The Journal of Finance* 61, 1553–1604.

Campbell, John Y, Nuno Clara, and Joao F Cocco, 2021, Structuring mortgages for macroeconomic stability, *The Journal of Finance* 76, 2525–2576.

Campbell, John Y, and Joao F Cocco, 2003, Household risk management and optimal mortgage choice, *The Quarterly Journal of Economics* 118, 1449–1494.

Chen, Hui, Michael Michaux, and Nikolai Roussanov, 2020, Houses as ATMs: mortgage refinancing and macroeconomic uncertainty, *The Journal of Finance* 75, 323–375.

Cocco, Joao F, Francisco J Gomes, and Pascal J Maenhout, 2005, Consumption and portfolio choice over the life cycle, *The Review of Financial Studies* 18, 491–533.

Di Maggio, Marco, Amir Kermani, Benjamin J. Keys, Tomasz Piskorski, Rodney Ramcharan, Amit Seru, and Vincent Yao, 2017, Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging, *American Economic Review* 107, 3550–88.

Elenev, Vadim, and Lu Liu, 2024, A macro-finance model of mortgage structure: Financial stability and risk sharing, Working paper.

Epstein, Larry G, and Stanley E Zin, 1989, Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework, *Econometrica* 57, 937–969.

Fonseca, Julia, and Lu Liu, 2024, Mortgage lock-in, mobility, and labor reallocation, *The Journal of Finance* 79, 3729–3772.

Fonseca, Julia, Lu Liu, and Pierre Mabille, 2024, Unlocking mortgage lock-in: Evidence from a spatial housing ladder model, Working paper.

Greenwald, Daniel L, 2018, The mortgage credit channel of macroeconomic transmission, Working paper.

Greenwald, Daniel L, Tim Landvoigt, and Stijn Van Nieuwerburgh, 2020, Financial fragility with SAM?, *Journal of Finance* 76, 651–706.

Guren, Adam M, Arvind Krishnamurthy, and Timothy J McQuade, 2021, Mortgage design in an equilibrium model of the housing market, *The Journal of Finance* 76, 113–168.

Guvenen, Fatih, Fatih Karahan, Serdar Ozkan, and Jae Song, 2021, What do data on millions of US workers reveal about lifecycle earnings dynamics?, *Econometrica* 89, 2303–2339.

Ho, Anson TY, Mikael Khan, Monica Mow, and Brian Peterson, 2019, Home equity extraction and household spending in Canada, Working paper, Bank of Canada.

Jordà, Òscar, 2005, Estimation and inference of impulse responses by local projections, *American Economic Review* 95, 161–182.

Jordà, Òscar, 2023, Local projections for applied economics, *Annual Review of Economics* 15, 607–631.

Keys, Benjamin J., Devin G. Pope, and Jaren C. Pope, 2016, Failure to refinance, *Journal of Financial Economics* 122, 482–499.

Koijen, Ralph SJ, Otto Van Hemert, and Stijn Van Nieuwerburgh, 2009, Mortgage timing, *Journal of Financial Economics* 93, 292–324.

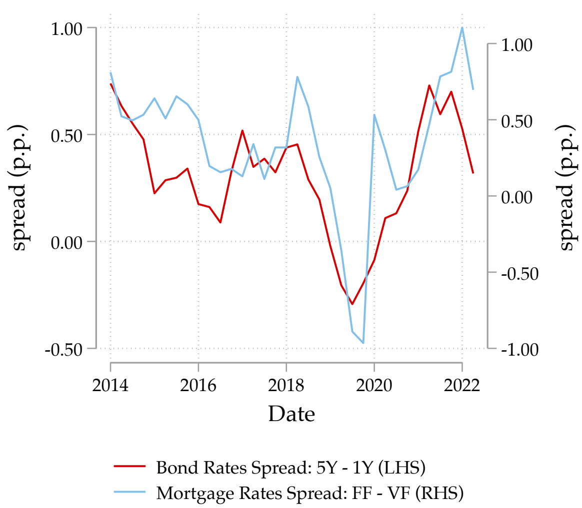
Liu, Lu, 2022, The demand for long-term mortgage contracts and the role of collateral, Working paper.

Shapley, L. S., 1953, *A Value for n-Person Games*, 307–318 (Princeton University Press).

Figure 1: Bond and Mortgage Rates

This figure plots the relation between bond rates, mortgage rates, and mortgage originations. In panel (a), the spread between 5- and 1-year government bonds is very strongly positively correlated with the spread between fixed-rate fixed-payment (FF) and variable-rate fixed-payment (VF) mortgage rates. In panel (b), the spread between FF and VF mortgage rates is negatively correlated with the fraction of new mortgage originations into FF contracts. These figures justify our choices for calibrating mortgage interest rates as fixed premiums over corresponding bond rates. See Section 3.2.1 for more details.

(a) Bond and Mortgage Rate Spreads



(b) Mortgage Spreads and FF Originations

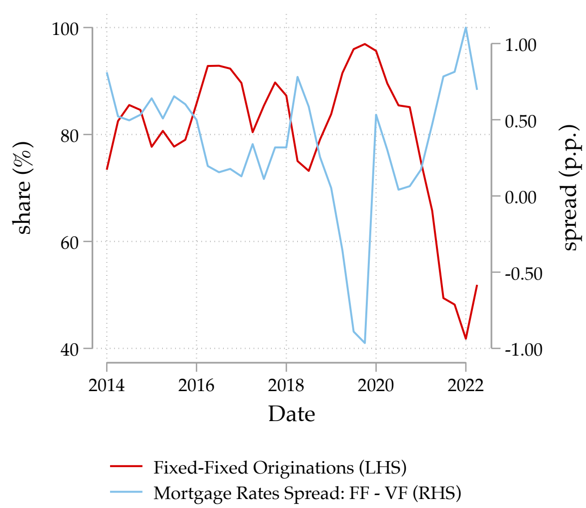
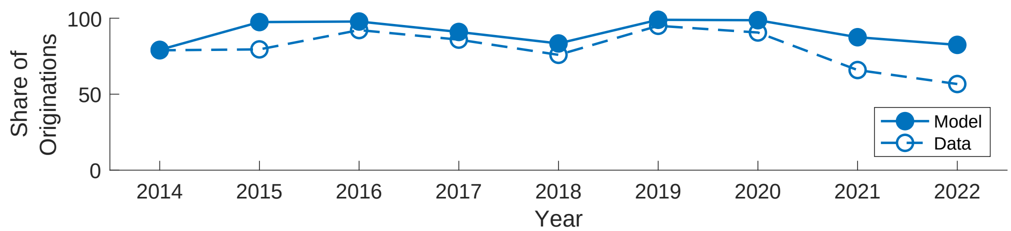


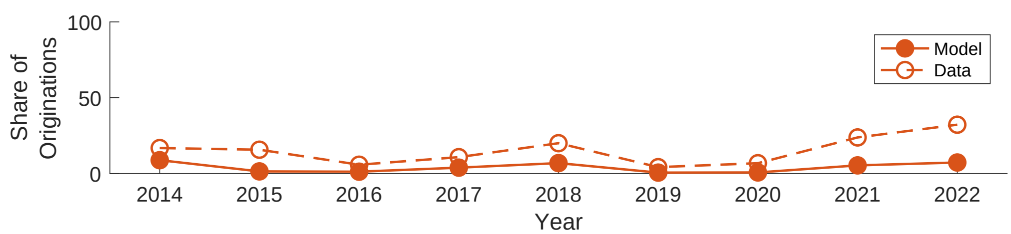
Figure 2: Data versus Model

This figure plots the fraction of households choosing to originate Fixed-Fixed, Variable-Fixed, and Variable-Variable mortgages between 2014 and 2022. For each year, we simulate the model using observed interest rates and calculate the share of originations into each type of mortgage.

(a) Fixed-Fixed



(b) Variable-Fixed



(c) Variable-Variable

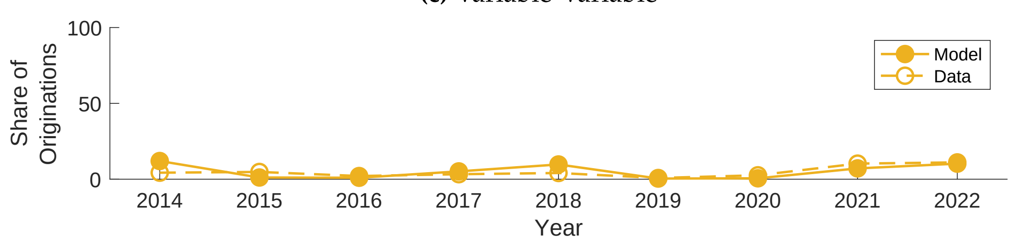


Figure 3: Illustration of Mortgage Choice Policy Functions over Aggregate Factors

This figure shows the policy functions for mortgage-type choice as continuous function of the aggregate factors, term premium and 1-year bond rate, for four combinations of household leverage and cash-on-hand. The top two panels show the policy functions when cash-on-hand is low and leverage is low or high. The bottom two panels show the policy functions when leverage is high and cash-on-hand is low or high. The green color shows when agents leave the housing market and become renters, the blue color shows when households opt for a fixed-rate fixed-payment (FF) mortgage, the red color shows when households opt for a variable-rate fixed-payment (VF) mortgage and the yellow color when households opt for a variable-rate variable-payment (VV) mortgage.

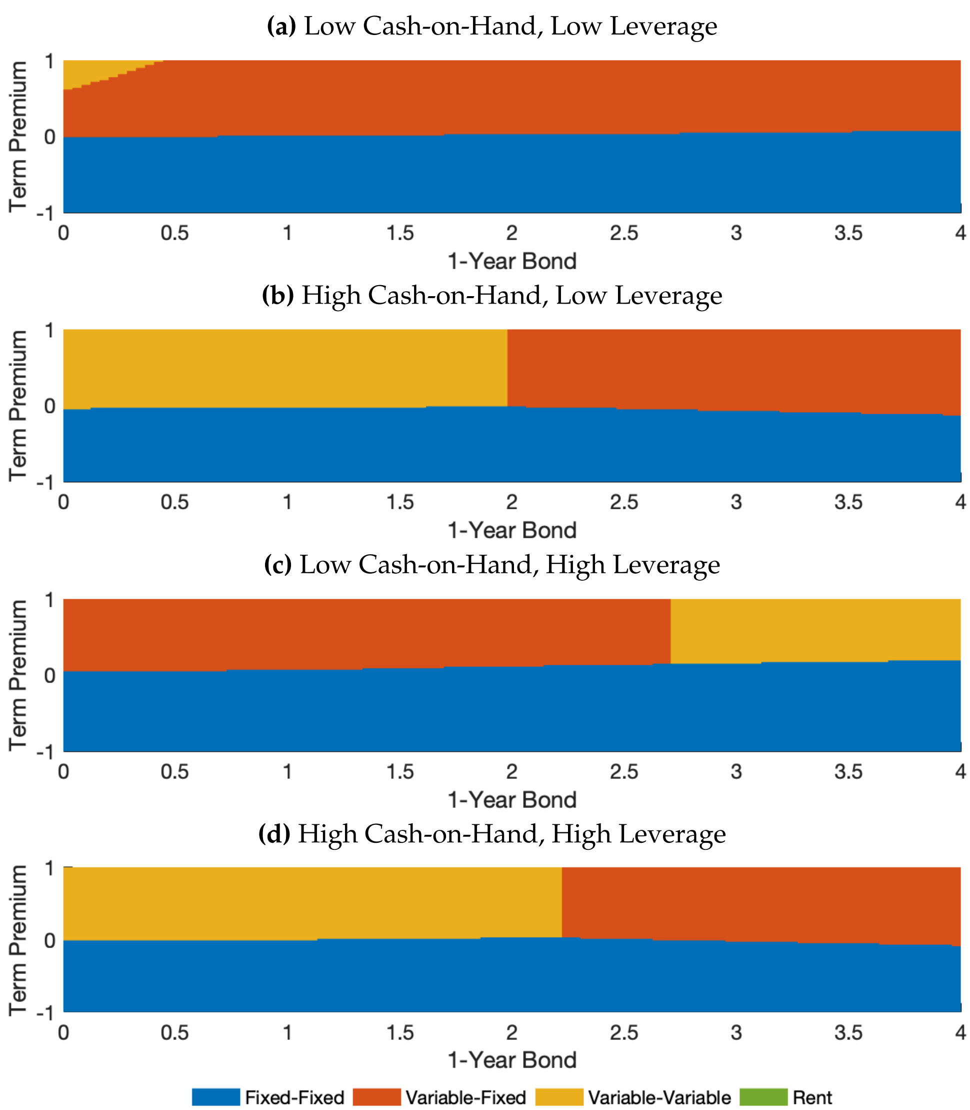
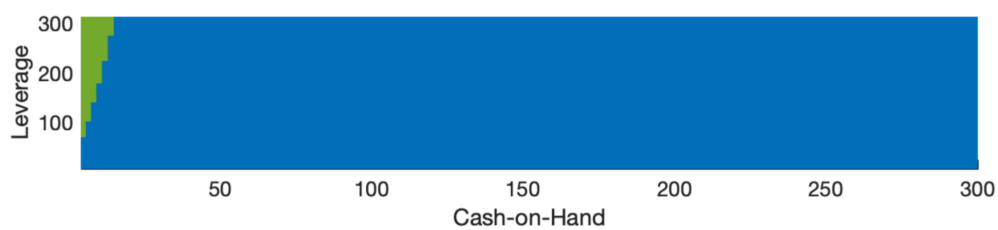


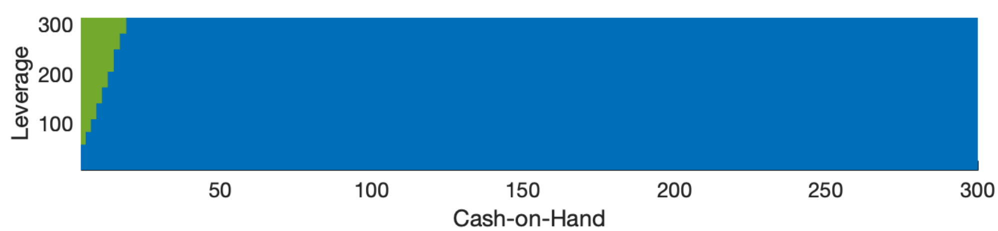
Figure 4: Illustration of Mortgage Choice Policy Functions over Household Factors

This figure shows the policy functions for mortgage-type choice as continuous function of the household factors, leverage and cash-on-hand, for four combinations of the term premium and 1-year bond rate. The top two panels show the policy functions when term premium is low and interest rates are low or high. The bottom two panels show the policy functions when term premium is high and interest rates are low or high. The green color shows when agents leave the housing market and become renters, the blue color shows when households opt for a fixed-rate fixed-payment (Fixed-Fixed) mortgage, the red color shows when households opt for a variable-rate fixed-payment (Variable-Fixed) mortgage and the yellow color when households opt for a variable-rate variable-payment (Variable-Variable) mortgage.

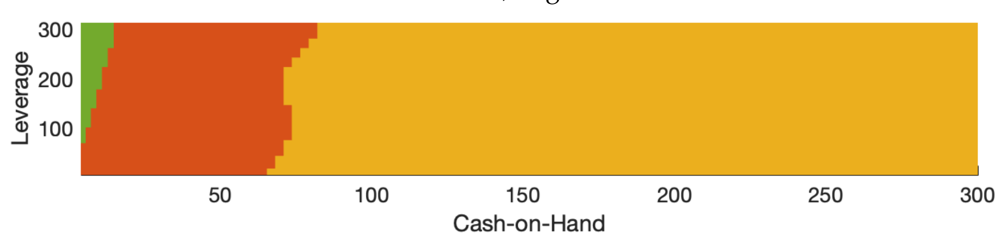
(a) Low Interest Rate, Low Term Premium



(b) High Interest Rate, Low Term Premium



(c) Low Interest Rate, High Term Premium



(d) High Interest Rate, High Term Premium

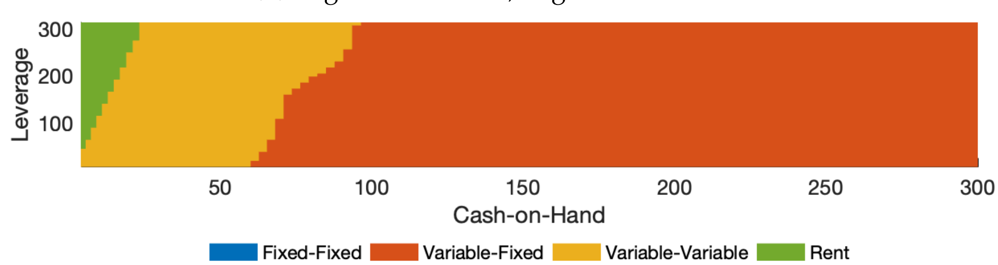
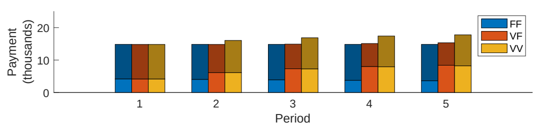


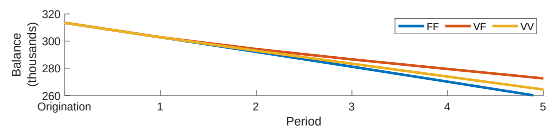
Figure 5: Mortgage Payments Composition and Deleveraging

The left panel of this figure shows for a given level of interest rate and term premium the composition of payments for the three types of mortgage contracts under consideration (fixed-rate fixed-payment (FF) in blue, variable-rate fixed-payment (VF) in red and variable-rate variable-payment (VV) in yellow) for a household that took a mortgage of a given type in period 0 (origination period). Each bar shows the total payments in each year of the 5-year term. The darker areas correspond to principal payments, the lighter ones show interest payments. The right panel shows mortgage balances outstanding at the end of the period for the three types of mortgage. The top two panels show these effects when term premium is low and interest rates are low/high. The bottom two panels show these effects when term premium is high and interest rates are low/high.

(a) Low Interest Rate, Low Term Premium

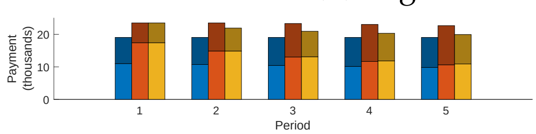


(i) Payments

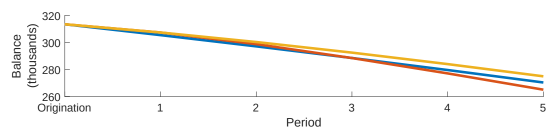


(ii) Balances

(b) High Interest Rate, Low Term Premium

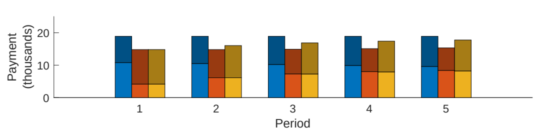


(i) Payments

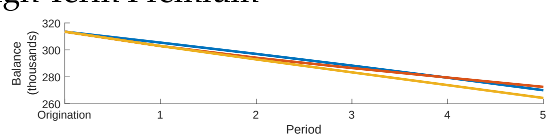


(ii) Balances

(c) Low Interest Rate, High Term Premium

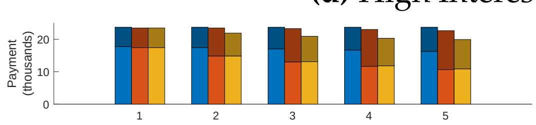


(i) Payments

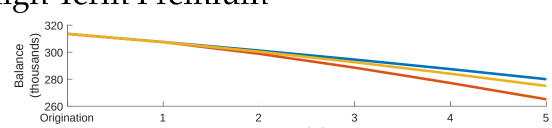


(ii) Balances

(d) High Interest Rate, High Term Premium



(i) Payments



(ii) Balances

Figure 6: Comparison of Key Outcomes over Mortgage Types

Each panel of this figure compares one key outcome related to household welfare across the economies with only fixed-rate fixed-payment (FF) mortgages, only variable-rate fixed-payment (VF) mortgages, and only variable-rate variable-payment (VV) mortgages. The value in the VF economy is normalized to unity and the values in the FF and VV economies are presented relative to the VF economy. The first panel compares average total interest cost, i.e., the sum of all interest payments made over the life of the mortgage. The middle panel compares average consumption. The final panel compares the standard deviation (SD) of consumption growth.

(a) Total Interest Cost (Mean) **(b)** Consumption (Mean) **(c)** Consumption Growth (SD)

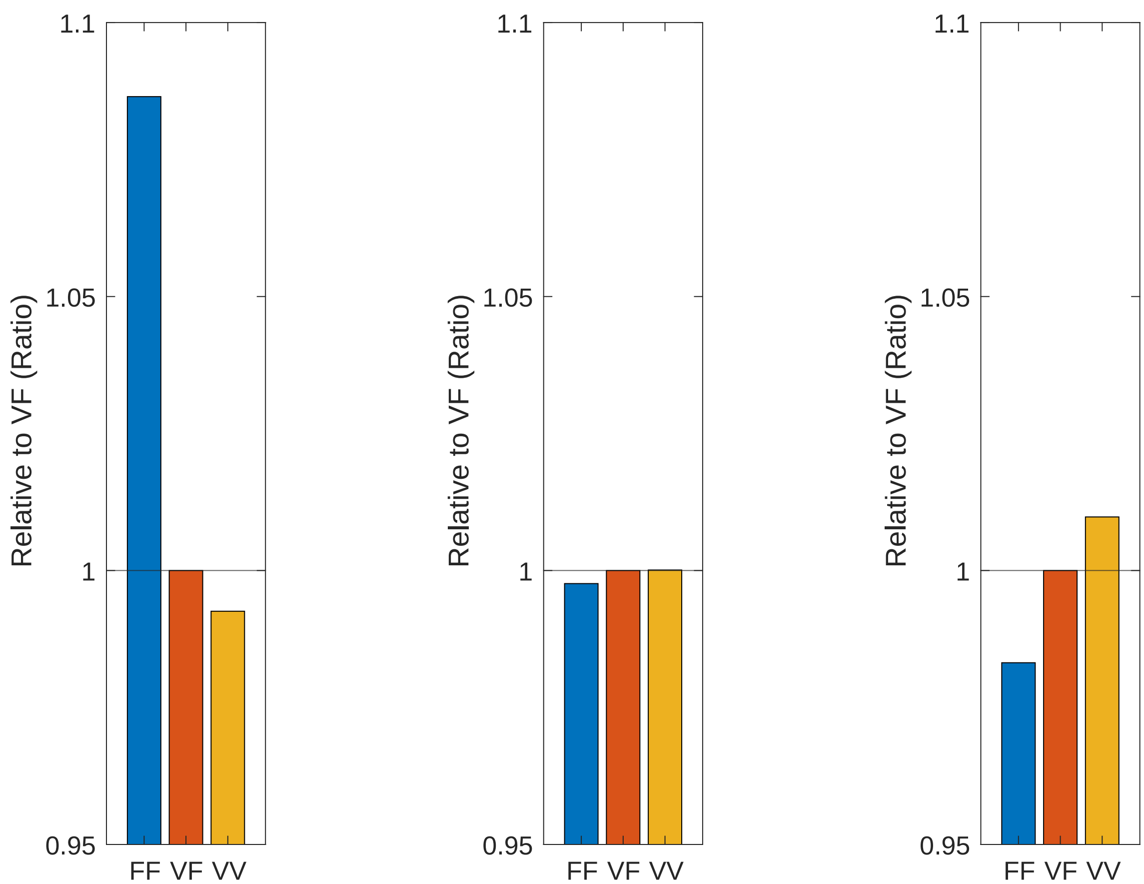


Figure 7: Transitions Between Mortgage Contracts at Renewal Periods

Each panel of this figure plots transitions between mortgage contracts at each of the five renewal periods in the baseline calibration with mortgage contracts that have 5-year terms and 25-year amortizations. The first panel shows transitions for borrowers with fixed-fixed (FF) mortgages, the second panel for variable-fixed (VF) borrowers, and the third panel for variable-variable (VV) borrowers. At each renewal period, borrowers may transition into a new FF, VF, or VV mortgage, and thus the three bars sum to 100%.

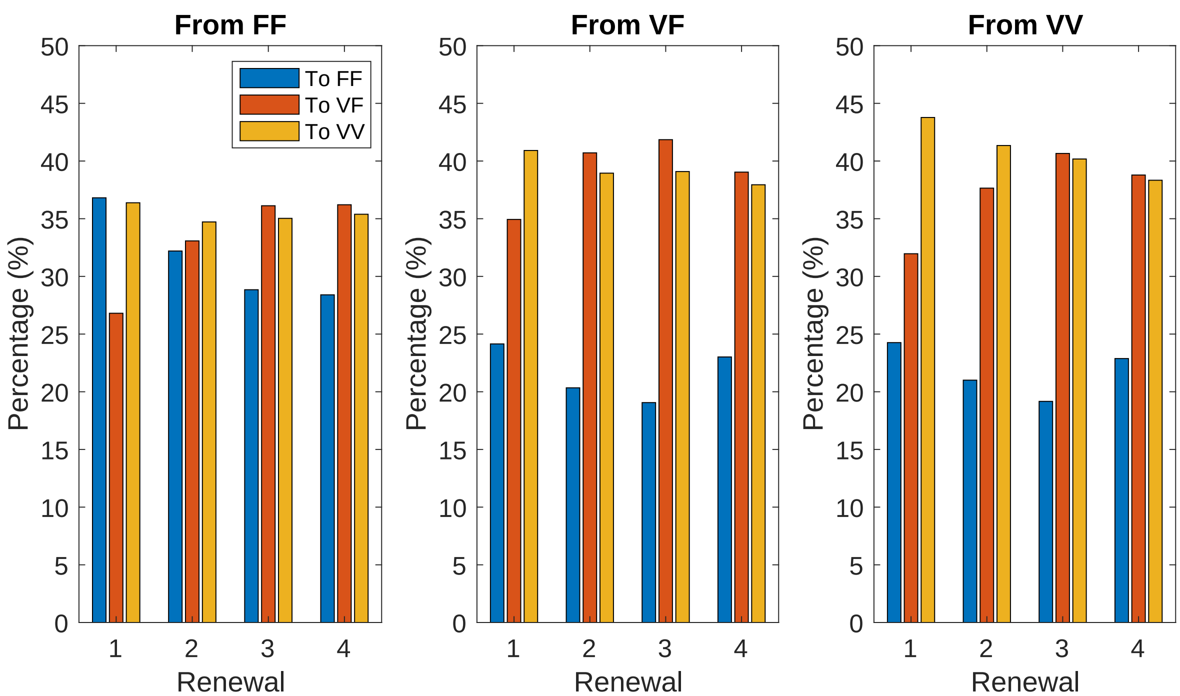


Figure 8: Distribution of Mortgage Spreads in U.S. Calibration (Model and Data)

This figure plots in dashed lines the distribution of the mortgage spreads using the self-reported mortgage rates from 2019 and 2023 American Housing Surveys relative to the currently prevailing Federal Home Loan Mortgage Corporation rates in the respective survey years. This is an update of Figure 5 from Campbell (2006). The solid lines plot the counterparts in the U.S. calibration of the model detailed in Section 6. We feed the time-series of long-term government bond yields and term premia into our model and simulate an overlapping generation set of agents. For 2019 and 2023 simulated years, we plot the data counterparts of the model.

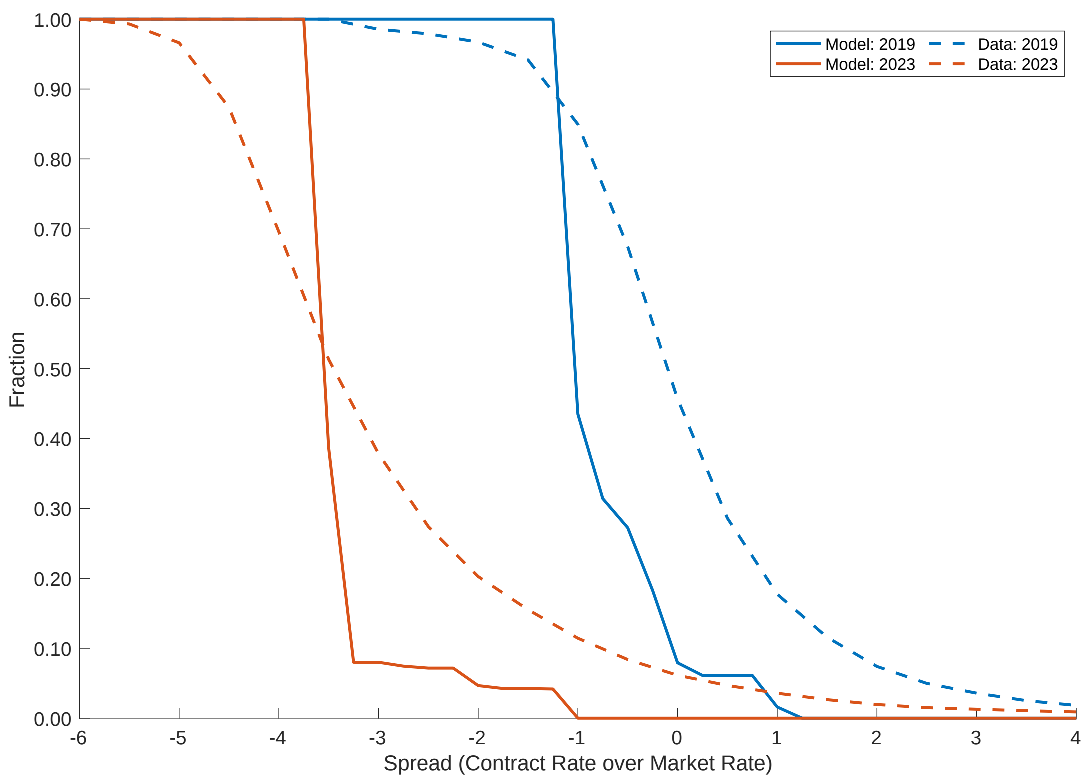
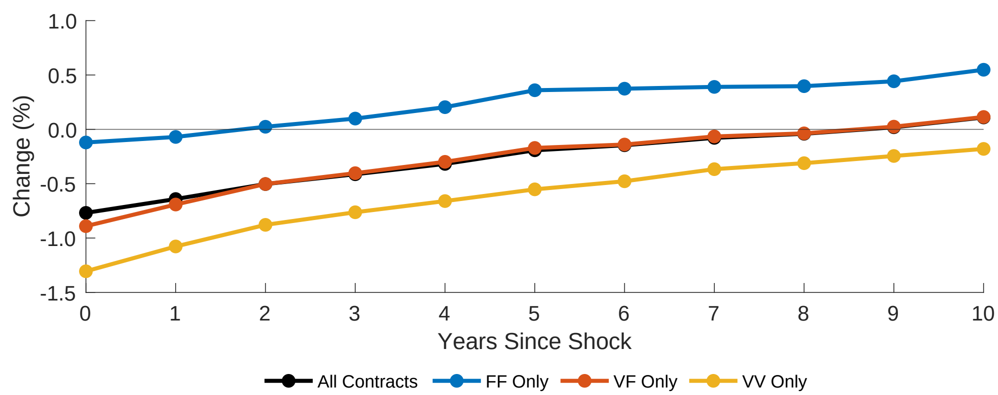


Figure 9: Impulse Response Functions of Consumption to Monetary Policy Shocks

This figure shows the consumption response to monetary policy shocks that act through interest rates. The top panel shows the impulse response function (IRF) to a conventional monetary policy shock that increases the short-term 1-year bond rate by 1 percentage point. The bottom panel shows the IRF to an unconventional monetary policy shock that increases the term premium by 1 percentage point. In each panel, the black line represents the benchmark economy with all three mortgage types available, while the other lines represent economies in which only the fixed-rate fixed-payment (FF), variable-rate fixed-payment (VF), or variable-rate variable-payment (VV) mortgage is available.

(a) Conventional Monetary Policy
(Shock to 1-Year Bond Rate)



(b) Unconventional Monetary Policy
(Shock to Term Premium)

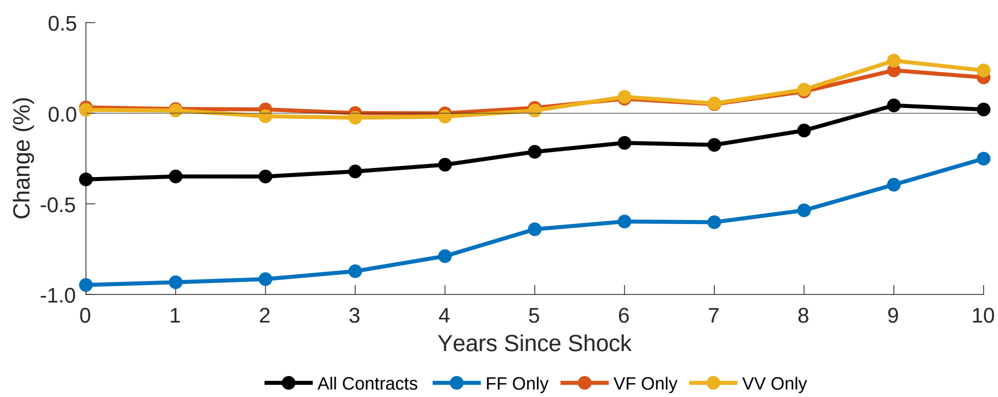
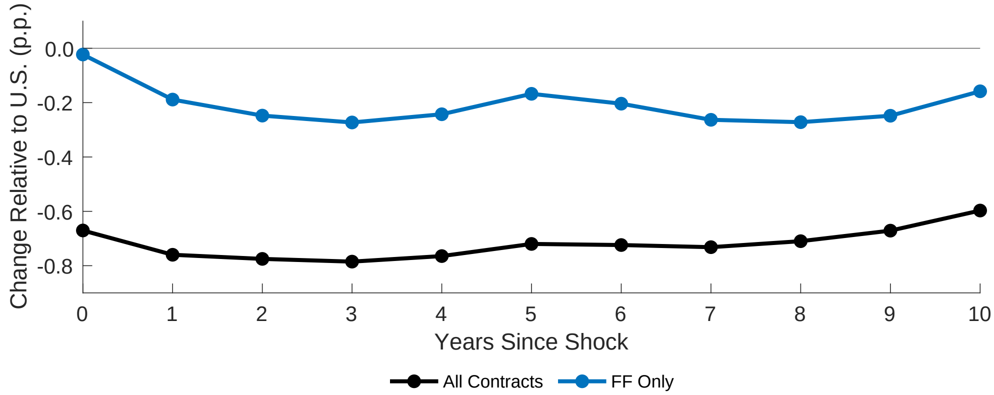


Figure 10: Comparison Between Consumption Responses to Monetary Policy Shocks

This figure compares the consumption responses to monetary policy shocks that act through interest rates in the U.S. model calibration relative to the benchmark calibration with all contracts and the FF-only calibration. The top panel is the difference between the impulse response functions (IRF) to a conventional monetary policy shock that increases the short-term 1-year bond rate by 1 percentage point. The bottom panel is the difference between the IRFs to an unconventional monetary policy shock that increases the term premium by 1 percentage point. In each panel, the black line represents the difference between the U.S. economy calibration and the benchmark economy with all three mortgage types available, and the blue line represents the difference between the U.S. economy and the economy in which only the fixed-rate fixed-payment (FF) mortgage is available.

(a) Conventional Monetary Policy
(Shock to 1-Year Bond Rate)



(b) Unconventional Monetary Policy
(Shock to Term Premium)

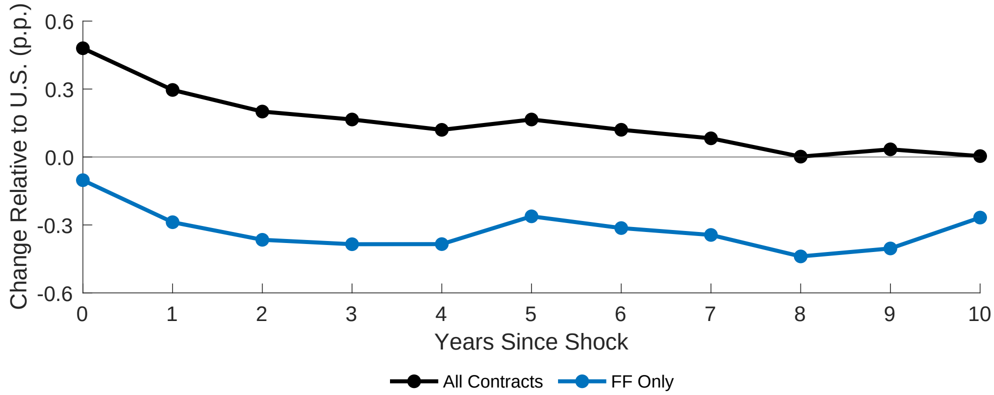


Table 1: Summary of Mortgage Types and Interest Rates

This table shows how interest payments and total payments are defined for each of the three mortgage contract types. A fixed-rate fixed-payment (Fixed-Fixed) mortgage, a variable-rate fixed-payment (Variable-Fixed) mortgage, and a variable-rate variable-payment mortgage (Variable-Variable).

Mortgage	Interest payment R_I	Total payment R_{TP}
Fixed-Fixed	Contract rate	Contract rate
Variable-Fixed	Market rate	Contract rate
Variable-Variable	Market rate	Market rate

Table 2: Interest Rates

This table shows parameters governing the interest rates detailed in Sections 2.1 and 2.2. Panel (a) contains parameters for the 1-period bond. Panel (b) contains parameters for the term premium. Panel (c) contains parameters for mortgage premia.

(a) 1-Period Bond

Parameter	Value
$\bar{r}$	0.0298
ρ_r	0.8965
σ_r	0.0121

(b) Term Premium

Parameter	Value
$\bar{\omega}$	0.0042
ρ_ω	0.741
σ_ω	0.0052

(c) Mortgage Terms and Premia

Parameter	Value
N_M	5
ϕ_{FF}	0.015
ϕ_{VF}	0.015
ϕ_{VV}	0.015

Table 3: Income Process Parameters

This table shows parameters governing the income process detailed in Section 2.3.4. Panel (a) contains parameters for the deterministic components of income: the household fixed effect, the life-cycle age profile, and the retirement replacement rate. Panel (b) contains parameters for the unemployment shock, such as the replacement rate. Panels (c) and (d) contain parameters for the persistent and transitory shocks, respectively. The income process and parameters follow closely Guvenen et al. (2021) for the working life and Cocco et al. (2005) during retirement. Over the working life, the variance of the persistent income process is scaled down to match that in Cocco et al. (2005).

(a) Deterministic Type & Life-cycle Components

Parameter	Value
α_i	0.99
a_0	-2.0317
a_1	0.3194
a_2	$-0.0577/10$
a_3	$-0.0033/100$
ω	0.94

(b) Unemployment Shock

Parameter	Value
λ	0.52
a_ν	-2.495
b_ν	-1.037
c_ν	-5.051
d_ν	-1.087

(c) Persistent Process

Parameter	Value
ρ	0.991
p_z	0.176
$\mu_{\eta,1}$	-0.524
$\sigma_{\eta,1}$	0.113
$\sigma_{\eta,2}$	0.046
κ_η	0.470

(d) Transitory Shock

Parameter	Value
p_ϵ	0.044
$\mu_{\epsilon,1}$	0.134
$\sigma_{\epsilon,1}$	0.762
$\sigma_{\epsilon,2}$	0.055

Table 4: Welfare Gains

This table shows the ex-ante welfare gains (losses) in consumption equivalent units for economies with only fixed-rate fixed-payment (FF) mortgages available (first row), only variable-rate fixed-payment (VF) mortgages available (second row) or only variable-rate variable-payment (VV) mortgages available (third row) compared to an economy where all three types of mortgages are available. The first column shows the gains (losses) unconditionally and the remaining columns show them conditional on the term premium (TP) and the level of interest rates (Rf).

Panel (a): Welfare (Equilibrium Loan Premium)

		High Rf		Low Rf	
	Unconditional	High TP	Low TP	High TP	Low TP
FF only	-3.18%	-6.11%	-1.93%	-3.43%	-1.48%
VF only	-1.82%	-0.26%	-3.74%	-0.50%	-2.76%
VV only	-2.79%	-1.51%	-4.95%	-1.23%	-3.52%

Panel (b): Welfare (Baseline Loan Premium)

		High Rf		Low Rf	
	Unconditional	High TP	Low TP	High TP	Low TP
FF only	-3.77%	-6.88%	-2.60%	-3.92%	-1.90%
VF only	-2.71%	-1.36%	-4.78%	-1.23%	-3.47%
VV only	-3.58%	-2.49%	-5.88%	-1.86%	-4.14%

Table 5: Decomposition of Welfare Gains

This table shows the Shapley decomposition of baseline welfare loss in Table 4 into the three channels detailed in Section 5.1: aggregate risk, idiosyncratic risk, and lifecycle dynamics. These percentages sum to 100% after a normalization to exclude the other two factors in the Shapley decomposition (mortgage pricing functions and taste shocks). See Section 5.2.1 for more details.

	Aggregate Risk	Idiosyncratic Risk	Lifecycle Dynamics
FF only	39.3%	71.5%	-10.8%
VF only	61.4%	37.5%	1.11%
VV only	56.4%	40.3%	3.35%

Table 6: Income, Consumption, Wealth, and Leverage over the Lifecycle

This table reports average income, consumption, financial wealth, and leverage over the lifecycle, for the four scenarios under consideration. In scenario "All," households can choose any of the three mortgage types available (and switch among them); in "FF," households can choose only a fixed-rate fixed-payment mortgage; in "VF," households can choose only a variable-rate fixed-payment mortgage; and in "VV" households can choose only a variable-rate variable-payment mortgage.

	Income	Consumption				Financial wealth				Leverage			
Age group		All	FF	VF	VV	All	FF	VF	VV	All	FF	VF	VV
26 - 30	100.91	41.82	40.907	41.512	41.33	191.55	191.86	193.13	194.11	249.06	249.86	249.05	249.09
31 - 35	119.38	71.263	70.428	71.466	71.502	271.21	272.6	272.81	273.56	212.71	215.39	213.1	213.05
36 - 40	134.73	89.119	88.37	89.187	89.156	300.4	302.02	300.75	301.68	168.55	172.41	169.29	169.22
41 - 45	145.35	98.139	97.475	98.087	98.149	307.69	308.73	307.7	308.5	114.46	118.19	115.17	115.1
46 - 50	150.38	105.52	104.96	105.45	105.55	305.87	306.18	305.68	306.17	47.342	49.25	47.65	47.624
51 - 55	148.98	114.29	114.16	114.19	114.28	297.37	297.35	297.14	297.34	0.000	0.000	0.000	0.000
56 - 60	141.75	109.96	109.92	109.95	109.96	304.15	304.37	304.12	304.11	0.000	0.000	0.000	0.000
61 - 65	129.31	103.12	103.09	103.12	103.12	313.92	314.13	313.92	313.89	0.000	0.000	0.000	0.000

Table 7: Mean and Volatility of Consumption and Mortgage Payments

This table reports averages and standard deviations of consumption growth, as well as levels of interest and total mortgage payments (in thousands) for the four scenarios under consideration. In scenario "All," households can choose any of the three mortgage types available (and switch among them); in "FF," households can choose only a fixed-rate fixed-payment mortgage; in "VF," households can choose only a variable-rate fixed-payment mortgage; and in "VV" households can choose only a variable-rate variable-payment mortgage. The statistics reported are conditional on households having a mortgage outstanding.

	All	FF only	VF only	VV only
Av. consumption growth	0.060	0.062	0.063	0.067
Std. consumption growth	0.262	0.257	0.276	0.269
Av. interest payments	7.335	8.129	7.438	7.389
Std. interest payments	6.203	6.135	6.537	6.434
Av. total payments	17.827	18.611	17.931	17.873
Std. total payments	5.427	5.200	5.838	5.493

Table 8: Drivers of Mortgage-Type Choice

This table reports income, income growth, consumption, standard deviation of consumption, average financial savings and the proportion of mortgages outstanding by type of mortgage conditional on the aggregate state of the world (levels of interest rates (Rf) and term premia (TP)).

	High Rf		Low Rf	
	High TP	Low TP	High TP	Low TP
Income	130.08	130.21	130.23	130.19
Income growth	0.014	0.014	0.014	0.014
Av. consumption growth	0.071	0.070	0.052	0.048
Std. consumption growth	0.296	0.281	0.234	0.227
Savings	183.71	183.18	169.84	168.14
Mtg. type proportion:				
Fixed-fixed	0.145	0.425	0.165	0.446
Variable-fixed	0.471	0.310	0.387	0.251
Variable-variable	0.384	0.265	0.448	0.303

Table 9: Mortgage-Type Choice—Additional Statistics

This table reports average income, savings, leverage, debt-to-income, standard deviation of mortgage payments and average levels of risk-free rate and term premium conditional on the mortgage type the household has outstanding in an economy where all mortgage types are available to choose from. The first column shows these statistics conditional on the household having a fixed-rate fixed-payment (FF) mortgage outstanding, the second column shows the statistics conditional on a variable-rate fixed-payment (VF) mortgage outstanding, and the last column shows them conditional on a variable-rate variable-payment (VV) mortgage outstanding.

	FF	VF	VV
Av. income	122.400	131.420	135.510
Av. savings	163.480	177.070	186.320
Av. leverage	175.350	152.300	150.660
Debt-to-income	1.967	1.641	1.545
Std. total mortgage payments	0.192	0.210	0.212
Std. total interest payments	0.022	0.028	0.028
Risk-free rate	0.029	0.034	0.028
Term premia	-0.000	0.006	0.006

Table 10: Preference Heterogeneity

This table shows average consumption growth, standard deviation of consumption growth, average savings, and proportion of mortgages outstanding by type of contract for different preference parameters. Panel (a) shows the results for subjective discount factor, Panel (b) for risk aversion, and Panel (c) for the elasticity of intertemporal substitution. The middle column in all the panels is our baseline specification.

Panel (a): Different Subjective Discount Factors			
	$\beta = 0.93$	$\beta = 0.95$	$\beta = 0.97$
Av. consumption growth	0.059	0.060	0.060
Std. consumption growth	0.255	0.262	0.266
Savings	169.320	176.330	186.340
Mtg. type proportion:			
Fixed-fixed	0.308	0.294	0.274
Variable-fixed	0.355	0.356	0.356
Variable-variable	0.336	0.350	0.370
Panel (b): Different Degrees of Risk Aversion			
	$\gamma = 5$	$\gamma = 10$	$\gamma = 15$
Av. consumption growth	0.037	0.060	0.091
Std. consumption growth	0.249	0.262	0.353
Savings	131.380	176.330	199.210
Mtg. type proportion:			
Fixed-fixed	0.298	0.294	0.286
Variable-fixed	0.333	0.356	0.370
Variable-variable	0.368	0.350	0.343
Panel (c): Different Degrees of Intertemporal Substitution			
	$\psi = 0.6$	$\psi = 0.75$	$\psi = 0.9$
Av. consumption growth	0.062	0.060	0.059
Std. consumption growth	0.253	0.262	0.271
Savings	187.030	176.330	168.350
Mtg. type proportion:			
Fixed-fixed	0.307	0.294	0.298
Variable-fixed	0.359	0.356	0.339
Variable-variable	0.333	0.350	0.363

Table 11: Welfare Comparison between Canadian and U.S. Systems

This table shows the ex-ante difference in welfare between the Canadian and U.S. mortgage systems. The baseline model is the Canadian system where all three types of contracts are available. The first row is the welfare change and the second row is the difference in loan premia for each scenario. ″FF only″ refers to an economy where only fixed-rate fixed-payment (FF) mortgages with 5-year contract lengths are offered and representative lender does not adjust loan premia. ″FF only (equilibrium rate)″ refers to the same economy, but where lenders do adjust loan premia.

	FF only	FF only (equilibrium rate)	U.S. FRM	U.S. FRM (equilibrium rate)
Welfare (vs baseline)	-3.77%	-3.19%	7.04%	-4.08%
Δ Loan Premium	0.00%	-0.07%	0.00%	1.48%

A Detailed Institutional Background on the Canadian Mortgage Market

The Canadian mortgage market is relatively concentrated in the traditional banking sector, with the dominant Big 6 banks responsible for the largest share of mortgage originations and balances outstanding. In this section, we describe the Canadian market in great detail, but the most pertinent details may be summarized as follows. The standard mortgage contract has a 5-year term and structures to amortize the total balance over 25 years. Households can choose between a rich menu of mortgage contracts, and we observe significant heterogeneity both across time and in the cross-section. Prepayment and home equity extraction are virtually nonexistent due to a fee structure that strongly disincentivizes mortgage adjustment within the contract term. As a result, we argue that the Canadian system is an ideal laboratory to study the drivers of different mortgage types.

A.1 Contract Term and Amortization

Unlike the U.S. mortgage market, where long-term fixed-rate mortgages are dominant, the Canadian mortgage market is characterized by contracts with short terms (2 to 5 years, with the 5-year term being the most prevalent) and long amortization periods (25 to 30 years). Term is the length of time over which a financial institution commits to extending a loan to a borrower under certain conditions. The amortization period is the length of time it takes to pay off a mortgage. Thus, with a mortgage term that is shorter than the amortization period, the contract is amortized only partially.

At the end of the term, a borrower is faced with a number of options. The most common option for the borrower is to renew the mortgage with their current lender by rolling over at most their balance outstanding and having their mortgage rate reset to the current level of market interest rates. Typically, by the end of the amortization period, a mortgage contract would have been renewed several times. Alternatively, if the mortgage is not renewed with the current lender, the balance outstanding needs to be repaid in full, either with the proceeds of a home sale or with another lender taking over the mortgage at renewal.[3] Unlike

[3] About 90% of borrowers renew with their original lender (Allen and Li, 2024). These are borrowers who either prefer the convenience of renewing with their lender and do not shop for a more competitive rate at renewal, or those who do shop around but stay with their original lender as it price matches an outside offer. These outside offers do need to be generated through a qualification process, while only the history of past

in the United States, where households are faced with non-trivial refinancing decisions and the resulting inertia, this issue is not present in Canada since all borrowers have to renew their mortgages at the end of the term.

A.2 Mortgage Types

Households in Canada can choose between three types of contract: (i) a fixed-rate fixed-payment (FF) mortgage, akin to a fixed-rate mortgage in the United States; (ii) a variable-rate variable-payment (VV) mortgage, akin to an adjustable-rate mortgage in the United States; and (iii) a variable-rate fixed-payment (VF) mortgage. Fixed-rate mortgages have both their rate and payment fixed over the length of the term. Variable-rate mortgages have their interest payments determined by the current level of short-term rates. However, the total payment depends on whether a mortgage is a variable-payment (VV) mortgage or a fixed-payment (VF) mortgage. With VV mortgages, the total payment changes as often as the interest rate used to calculate interest payments.

With VF mortgages, the level of total mortgage payments does not change with the current interest rate and the most popular rate used to set the level of payments is the short-term interest rate at origination.[4] With two different interest rates used for setting a level of interest and a level of payments, whenever the two differ from each other, the principal portion of the total payment absorbs the differences.

In particular, if interest rates increase over the length of the term relative to the initial interest rates, the interest portion of the payment would increase and the principal portion decrease, resulting in a slower repayment of principal. The opposite is true when interest rates fall below the level of initial interest rate.[5] Absent any other adjustments, a change

payments matters for renewal with the original lender.

[4]Other interest rates, such as a 5-year mortgage rate, can also be used to set the level of total payments. However, since March 2018 all lenders offering this type of contract in Canada use the short-term rate at origination. It is possible for borrowers to request their payments to be set at a level exceeding that implied by the current interest rate, but this is not very common. In particular, until May 2018 one Big 6 bank offered its variable-rate borrowers a choice between variable payments and fixed payments with the level of the former set using the 5-year fixed mortgage rate. The variable-rate mortgages with fixed payments, however, had almost no take-up at this lender.

[5]Borrowers have the option to increase the level of regular installments or make lump-sum payments within allowed limits. This can offset the decreased principal payments when interest rates rise. Most borrowers rarely exercise these options. In extreme cases, interest rates may rise to the point where the lender forces the

in the interest rate immediately changes the effective amortization of the loan. At renewal, given market interest rates, payments are calculated to maintain the original 25-year amortization period. As a result, unexpectedly higher interest rates over the current mortgage contract, which lead to lower principal payments, imply larger payments in the next contract. In contrast, Black (1998) envisioned a contract with fully variable amortization periods, where interest rate increases resulted in longer amortizations and interest decreases in shorter amortizations, with no changes in monthly payments. To be clear, this is not the contract offered in Canada, although in 2024, the Canadian government offered some relief to renewers by allowing them to increase amortizations due to the large interest rate increases in 2022 and 2023.

A.3 Prepayment and Equity Extraction

Prepayment of mortgages in full and refinancing (outside of renewal periods) is rare in Canada. Partial prepayments through lump-sum payments, are limited to between 10 and 20% of the initial balance of the mortgage per year. However, unlike in the United States, where full prepayment is often penalty-free, in Canada full prepayment of a mortgage within a term involves a penalty, whose size depends on the type of the mortgage and the direction of the change in interest rates. For variable-rate mortgages of both types, the penalty is three months of interest payments on the balance outstanding at the time of prepayment. The same penalty applies to fixed-rate mortgages when interest rates at the time of prepayment exceed the contract rate in effect, but the incentives to prepay in the rising rate environment may be limited.

On the contrary, when interest rates decrease relative to the contractual rate, the penalty is calculated using the interest rate differential between the contractual and current rates and is applied over the remainder of the term.[6] From the borrower's perspective, this eliminates

household to adjust regular payments and/or make a lump-sum payment to maintain regulatory constraints such as maximum loan-to-value ratios. When rates fall, however, borrowers cannot adjust payments to make smaller principal payments. Only prepayments in excess of the regular installments can be reborrowed under certain conditions.

[6]More precisely, for all of the Big 6 banks, the penalty is calculated using the posted interest rate at the time of origination and the current posted rate on the term closest to the remaining term to renewal. Contractual interest rates for most borrowers feature a discount relative to posted rates. Some smaller lenders keep the penalty at three months of interest regardless of the direction of changes in interest rates.

any gains from ending the term early to take advantage of lower interest rates.[7] Thus, early renewal is not at all common in Canada in either periods of low or periods of high interest rates.

The existence of prepayment penalties also reduces the incentive for Canadian consumers to extract their home equity through cash-out refinancing that involves paying off the current balance and originating a new loan secured by the same property with a higher balance.[8] Cash-out refinancing is most likely to happen when consumers approach their scheduled renewal date and when prepayment penalties do not apply. However, taking out equity through home equity lines of credit does avoid prepayment penalties and is more flexible in the amount that consumers can borrow. Hence, it is more prevalent in Canada compared to cash-out mortgage refinancing (Ho et al., 2019), which is used much more widely in the United States.

[7]There may still be a benefit of terminating a contract early and renewing a mortgage with a lower interest rate outside of the traditional banking system.

[8]Borrowers may be able to avoid prepayment penalty when increasing the size of the mortgage with their current lender (porting in place to increase the mortgage amount), but there is still a cost associated with doing so. While the existing portion of the loan may conserve the current interest rate, the amount of the increase is assessed at a rate of interest equal to the current posted rate that is about 200 basis points higher than the average contractual interest rate.