Structuring Mortgages for Macroeconomic Stability

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Motivation

- Recent focus on mortgages as a monetary policy transmission mechanism
  - Declining interest rates can stimulate the economy through mortgage effects on household budgets (**mortgage channel** of monetary policy)

The channel:

- Mortgage rate reduction $\rightarrow$ lowers payments by borrowers but also payments received by lenders. Aggregate effects if borrowers increase consumption more than lenders cut theirs.
  - Domestic borrowers and foreign lenders
  - Borrowers have high MPC because they are borrowing constrained and lenders have low MPC because they are unconstrained (works if mortgage payment reduction is temporary)

ARMs, FRMs, and the Mortgage Channel

The mortgage channel works better for ARMs than FRMs (Di Maggio et al. *AER* 2017).

- Mortgage payments decline for all ARM borrowers when the central bank cuts the short rate, but FRM borrowers have to refinance.
  - Underwater borrowers may not be able to refinance
  - Less sophisticated borrowers may not refinance even though they could do so (Campbell 2006, Keys, Pope, and Pope 2016, Andersen, Campbell, Nielsen, and Ramadorai 2018).
- Decline in ARM payments is temporary while the decline in FRM payments is long-lasting, offsetting stimulus

ARMs have problems too ...

- Expose borrowers to interest rate risk
- Ineffective in a ZLB environment

Can we design better mortgage contracts?

Mortgage Design Proposals

- Eberly and Krishnamurthy (2014) propose a system in which borrowers can costlessly refinance from FRM to ARM, with unchanged principal, even when underwater.
- Piskorski and Tchistyi (2010) argue for an option ARM that allows borrowers to defer principal repayment (or even negatively amortize) during a recession.
- A full evaluation of these mortgage systems requires some consideration of default.
  - High-LTV lending or negative amortization can worsen default later in a recession, with possible damage from default externalities.
- We undertake this analysis using a calibrated life-cycle model.

Features of the Model

- Overlapping generations structure with agents entering and exiting the economy every period.
- Two macro states (recession and expansion) and two interest rate states (high and low) correlated with the business cycle.
- Random house prices correlated with the business cycle.
- Real income process of Guvenen, Ozkan, and Song (2014) capturing non-normality and business cycle variation of income growth.
- Constant inflation (or real mortgages).
- Competitive mortgage supply with risk-averse lenders subject to loan-to-value (LTV) constraints.
- Stochastic equilibrium where agents anticipate the occurrence of individual and macro shocks.

Households

- Power utility function, separable in housing and non-housing consumption.
- Each agent i is endowed with a stream of stochastic labor income Y_{it}
- Log real labor income y_{it} is equal to the sum of a transitory ϵ_{it} and persistent components z_{it}:

$$y_{it} = z_{it} + \epsilon_{it}, \tag{1}$$

$$z_{it} = \rho z_{i,t-1} + \eta_{it}, \tag{2}$$

$$\eta_{it} = \begin{cases} \eta^1_{it} \sim \mathcal{N}(\mu_{1,I_t^{cycle}}, \sigma_1), & \text{with probability } p_1 \\ \eta^2_{it} \sim \mathcal{N}(\mu_{2,I_t^{cycle}}, \sigma_2), & \text{with probability } 1 - p_1, \end{cases} \tag{3}$$

- Process captures important deviations from normality:
  - Higher expected growth rate of earnings in expansions vis-a-vis recessions
  - Negative skewness and excess kurtosis (namely in recessions)

Household Decisions

- Initial loan size is a constant fraction of income (housing choice adjusts to prices to accommodate this). After the initial date house size remains fixed.
- After the initial period, borrowers have the options to:
  - **Refinance** to a new mortgage, paying fixed cost, and cash out if LTV constraint permits.
  - **Default** if home equity is negative, paying stigma cost, and move to rental housing.
  - **Sell** the house if home equity is positive, prepaying the loan, and move to rental housing.

Contract types:

We study model outcomes for two types of mortgage contracts: ARM and FRM

- The interest rate on the ARM loan:

$$R_{it}^{ARM} = R_{1t} + \psi_{i,t_i}^{ARM} \tag{4}$$

- The interest rate on the FRM loan:

$$R_{it}^{ARM} = R_{T,t_i} + \psi_{i,t_i}^{FRM} \tag{5}$$

- The period t installment due on the loan taken by agent i is given by:

$$L_{it}^{LoanType} = R_{it}^{LoanType} D_{it} + \Delta D_{i,t+1} \tag{6}$$

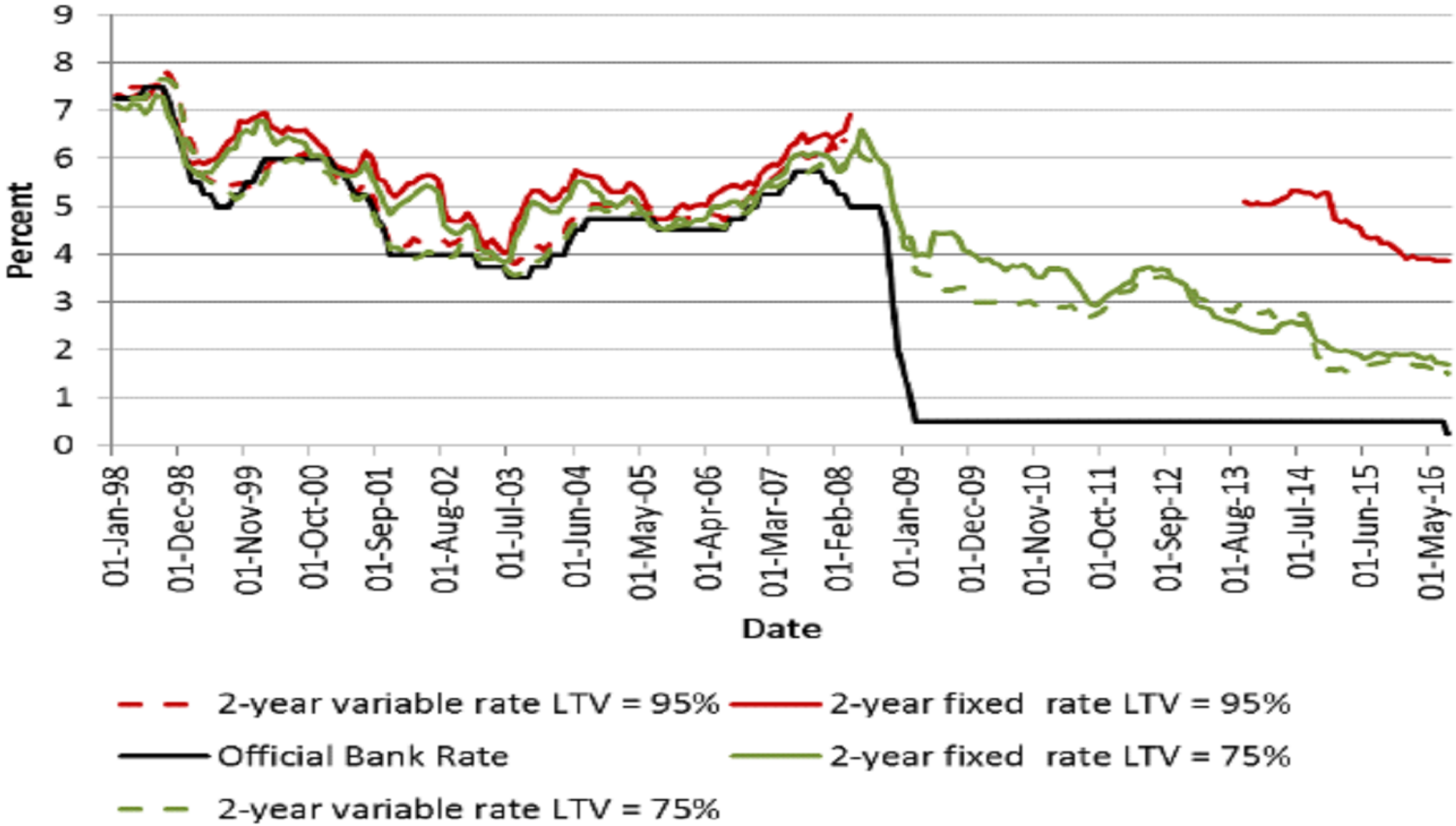
  where $LoanType \in \{ARM, FRM\}$

- Loan premia are endogenous and a function of refinancing, prepayment and default

Mortgage Pricing

- We assume that mortgage lenders are agents like those in our model, but without mortgages and with substantial financial assets.
- We derive a pricing kernel from the consumption of such agents.
- Mortgage premia are conditioned on the initial state (recession or expansion) but not other state variables, and are fixed for the life of the mortgage.
- Mortgage premia deliver zero risk-adjusted profits to lenders, given the default and prepayment behavior of borrowers.
  - Since default and prepayment decisions depend on mortgage premia, we must solve a fixed point problem.
  - There may be no fixed point for high-LTV loans (Stiglitz and Weiss 1981).
- We find higher mortgage premia in recessions, consistent with data.

UK Mortgage Rates 1998-2016



Optimization Problem

The Bellman equation for household optimization:

$$V_{it}(\Omega_{ti}) = \max\{U(C_{it}) + \beta \mathrm{E}_t \max[V_{i,t+1}(\cdot), V_{i,t+1}^{Rental}(\cdot)]\}.$$

- State variables (Ω_{ti}): Time, business cycle, interest rate, house prices; cash-on-hand, permanent income, debt, mortgage loan premium, whether agent has moved to the rental market before. FRM contracts have an additional state variable, the interest rate at mortgage origination.
- Choices: Borrowers decide whether to make the scheduled mortgage payments, refinance (s.t. LTV constraint), default, or prepay the loan. Both borrowers and renters decide how much to consume and save.
- We simulate the model with 400 different paths for the aggregate variables. We have 550 agents per period, distributed across overlapping generations.

Calibration (Table 1)

Panel A: Business Cycle Transition Probabilities		
P(recession | recession)		0.37
P(recession | expansion)		0.18
Panel B: Real interest rate		
Mean log real rate	μ_r	0.01
St. dev. of real rate	σ_r	0.025
High value log real risk-free		0.035
Low value log real risk-free		-0.015
P(high rate | recession)		0.38
P(high rate | expansion)		0.52
Panel C: House prices		
Mean log house price change	μ_H	0
St dev log house price change	σ_e	0.162
High log house price growth		0.162
Low log house price growth		-0.162
P(increase in house prices | recession)		0.39
P(increase in house prices | expansion)		0.52

Calibration (Table 1)

Panel D: Time and preference parameters		
Subjective discount factor	β	0.98
Risk aversion	γ	2
Number of periods	T	20
Utility of terminal wealth	b	10
Panel E: Labor income process		
Log permanent income AR(1) coefficient	ρ	0.979
Prob. aggregate/idiosyncratic shock	p_1	0.49
Mean log earnings growth expansion (1)	μ_{1E}	0.119
Mean log earnings growth expansion (2)	μ_{2E}	-0.026
Mean log earnings growth recession (1)	μ_{1R}	-0.102
Mean log earnings growth recession (2)	μ_{2R}	0.094
St. dev permanent income shock (1)	σ_1	0.325
St. dev permanent income shock (2)	σ_2	0.001
St. dev. temporary shock	σ_ϵ	0.186
Tax rate	ϕ	20%

Calibration (Table 1)

Panel F: Loan and rental market parameters		
Initial loan to income	*lti*	3.5
Initial loan to value expansion (recession)	*ltv*	0.9 (0.8)
Loan premium (ARM, recession)	ψ^{ARM}	0.03
Servicing costs (as % of loan outstanding)		0.0025
Loan maturity	τ	20 years
Default utility penalty	λ	0.1
Prepayment cost	θ_P	0
Refinancing cost	θ_R	\$1000
House sale commission	θ_c	0.06
Property taxes	τ_p	0.015
Maintenance expenses	m_p	0.025
Rental premium	ε	0.01

Mortgage Designs Considered

1. Standard ARM (benchmark case).
2. Option ARM with a free option to extend maturity in a recession.
3. Standard FRM.
4. Option FRM with a free option to switch to an ARM in a recession with no home equity constraint (Eberly-Krishnamurthy proposal).

Real Interest Rate Regimes

1. Benchmark (post-1985): Mean real rate of 1.0%, standard deviation of 2.5%, procyclical real rate.
2. Low real rate (post-2000): mean real rate of -1.0%, standard deviation of 2%, acyclical real rate.

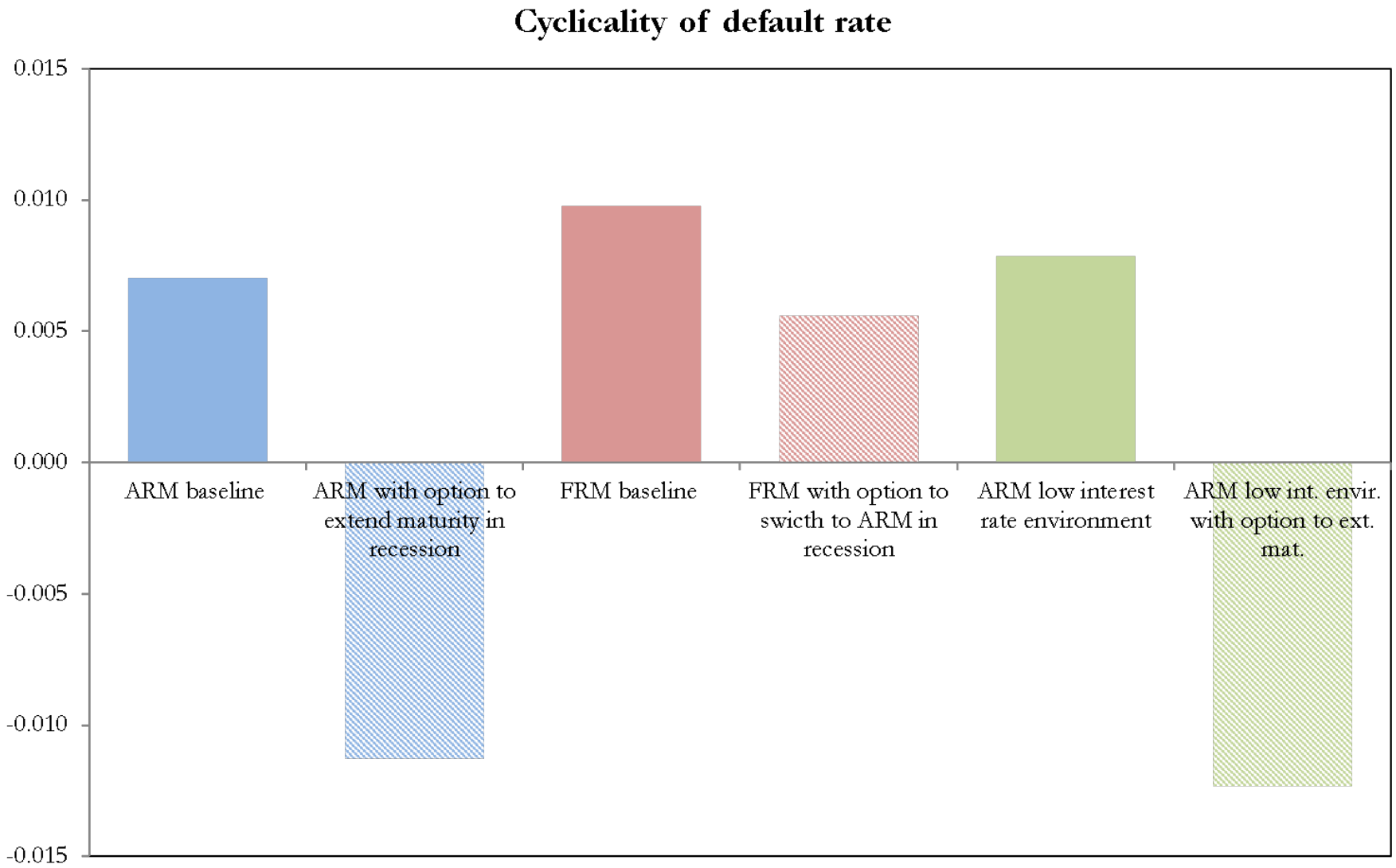
- A stable and acyclical real rate reflects the impact of the zero lower bound on the nominal rate.
- A plain-vanilla ARM is less satisfactory in this environment.

Comparison of Plain and Option ARMs (Tables 3 and 4)

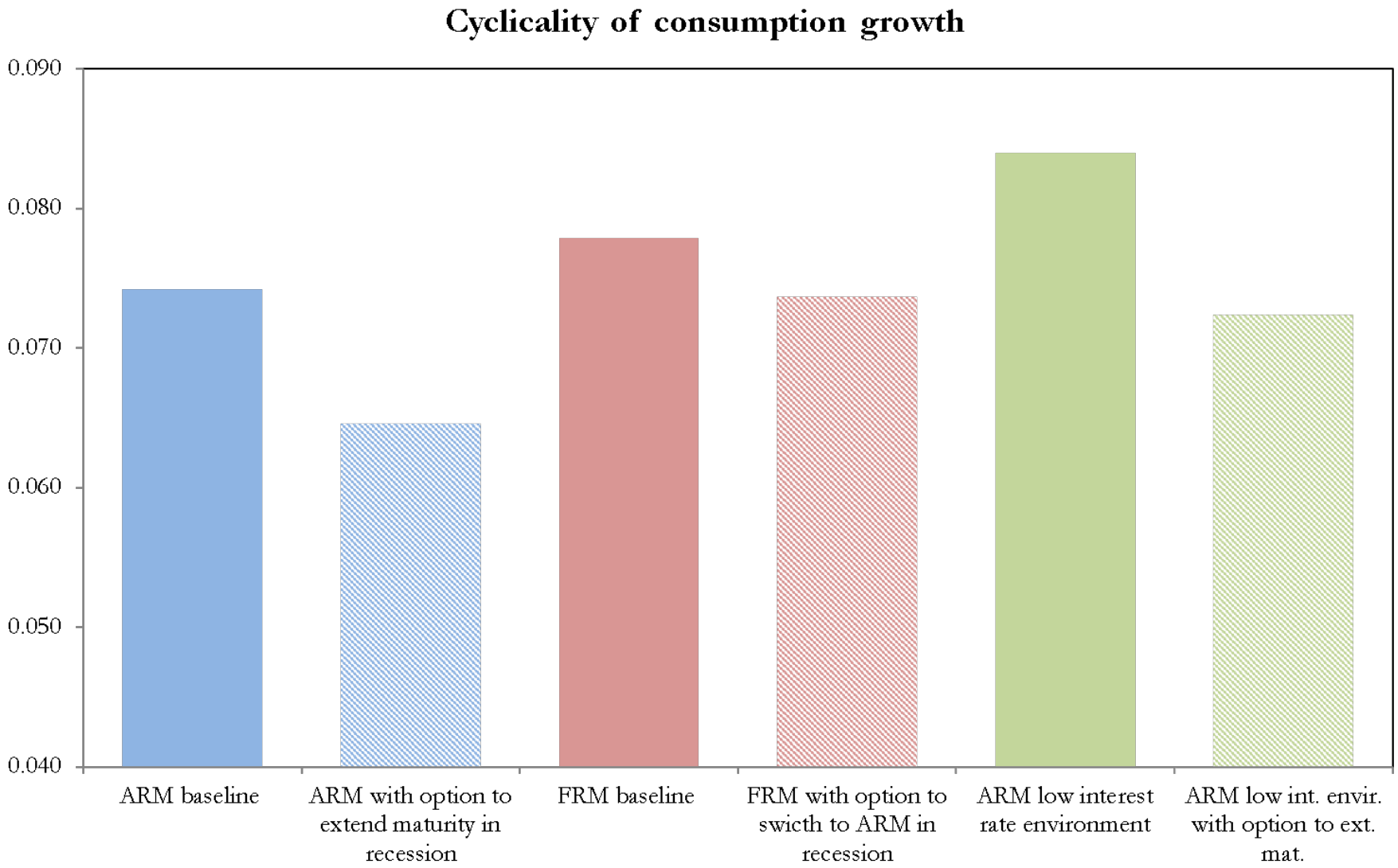
Plain ARM	Unconditional	Recession	Expansion
Loan premia	0.016	0.030	0.012
Average log cons. growth	0.042	-0.016	0.059
Log change in income	0.027	-0.009	0.038
Incidence			
Default	0.013	0.019	0.012
Refinance	0.093	0.014	0.115
Pay	0.883	0.953	0.863

Option ARM	Unconditional	Recession	Expansion
Loan premia	0.015	0.026	0.012
Average log cons. growth	0.040	-0.010	0.055
Log change in income	0.027	-0.009	0.038
Incidence			
Default	0.013	0.005	0.016
Refinance	0.085	0.006	0.108
Pay	0.748	0.340	0.865
Extend	0.142	0.639	n/a

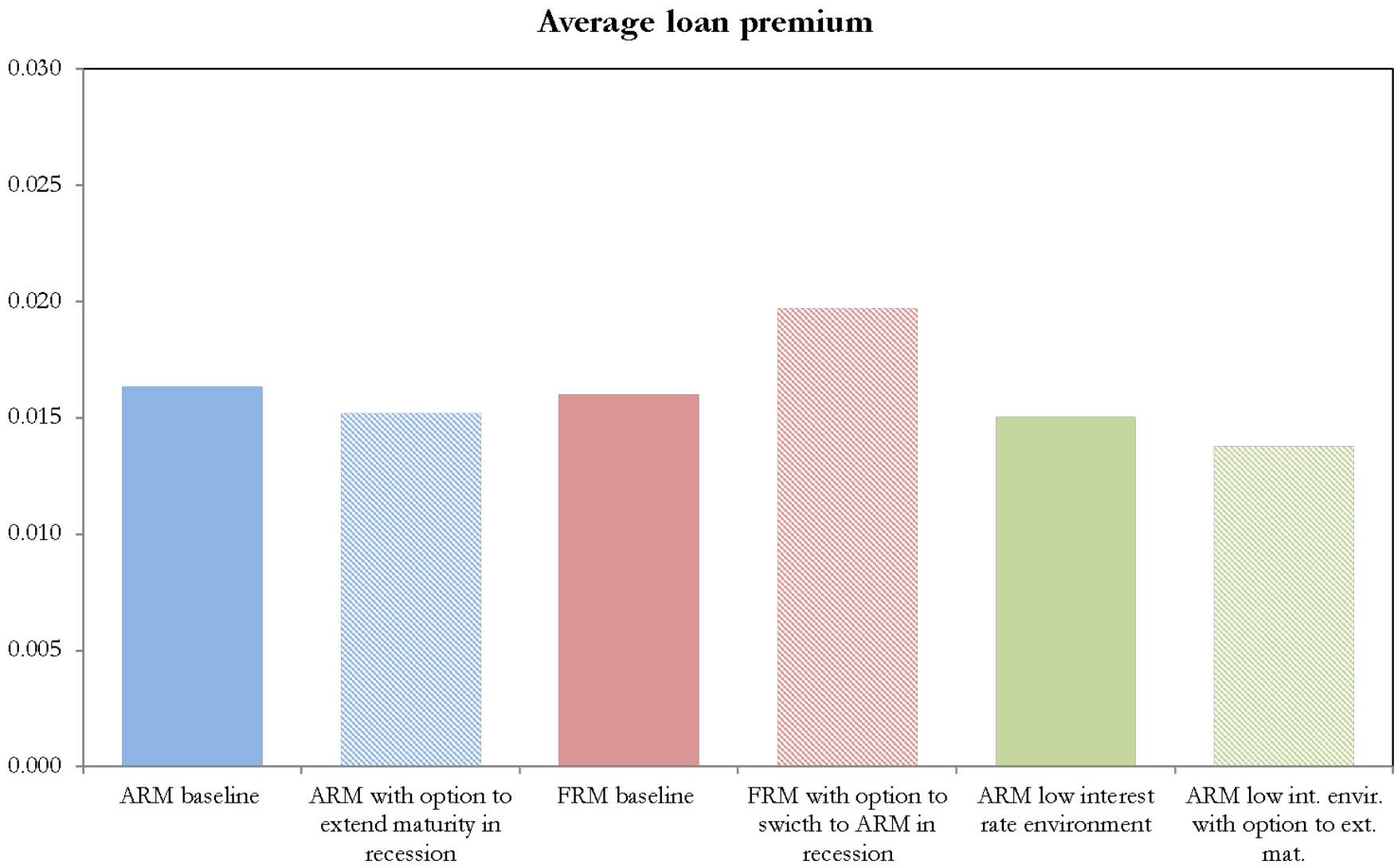
Option ARM Reduces Defaults During Recessions



Option ARM Stabilizes Consumption



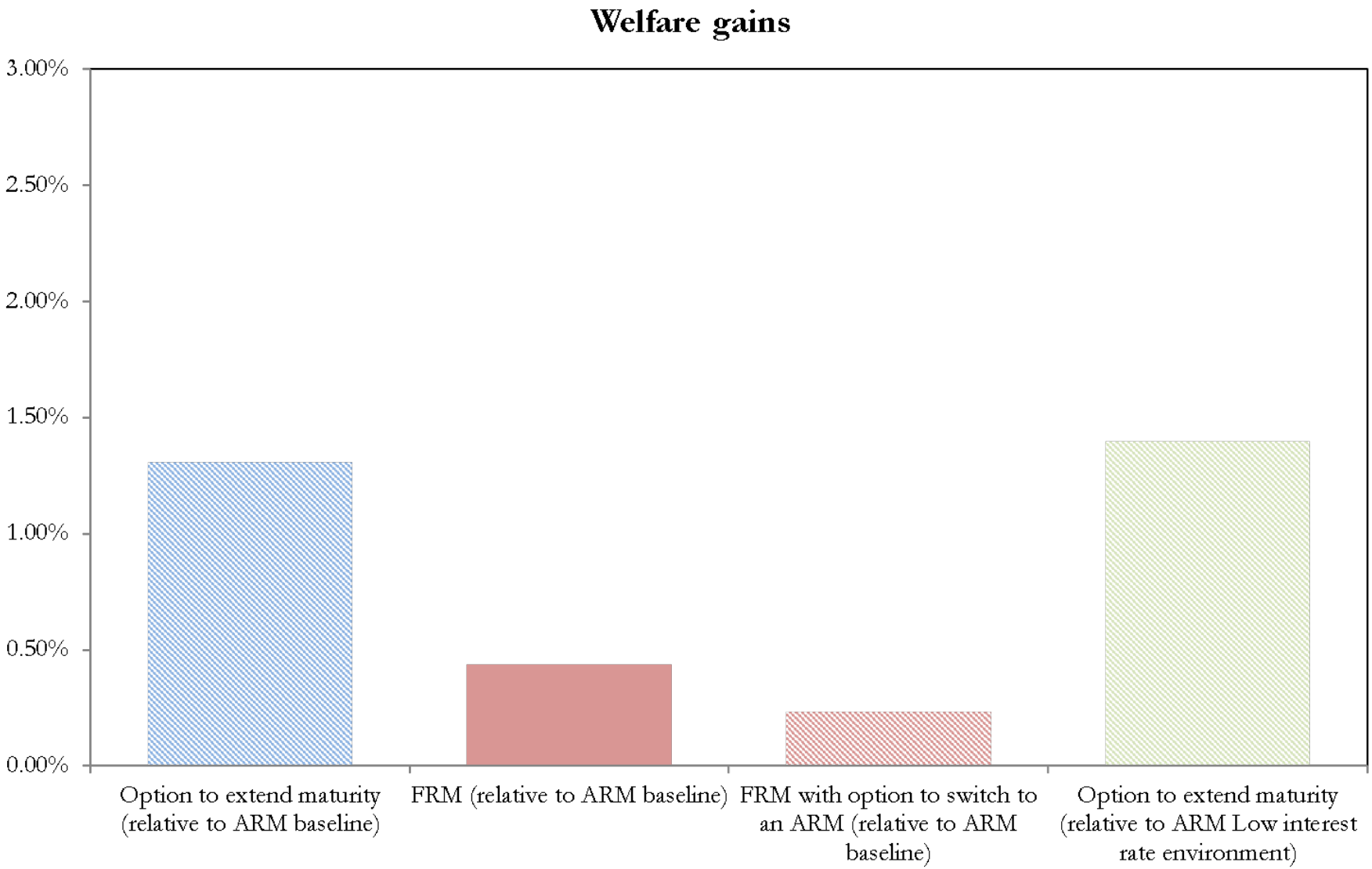
Option ARM is Not That Expensive



Summary of Cyclicality and Pricing Results

- Relative to a standard ARM, an option ARM
  - stabilizes consumption growth over the business cycle,
  - shifts defaults to expansions,
  - and has a lower premium because cash flows to lenders are more stable and less cyclical.
- Relative to a standard FRM, an option FRM
  - modestly stabilizes consumption growth over the business cycle,
  - modestly reduces defaults in recessions,
  - but has a higher premium because lenders lose payments in recessions.

Welfare Gains from an Option ARM



Summary of Welfare Results

- In our model, borrowers prefer FRMs to ARMs despite the good macroeconomic properties of ARMs:
  - they dislike the risk of interest rate increases.
- But an option ARM is even more strongly preferred:
  - it is attractively priced and reduces risk during recessions,
  - and in a low interest rate environment, it does even better.
- These results hold while lenders make equal risk-adjusted profits.

Conclusion

- The option ARM has many advantages in our analysis.
- And all the more so in a low and stable real interest rate environment where the standard ARM delivers less budget relief in a recession.
- Like the option FRM, the system depends on a disinterested party declaring a recession in a timely and credible manner.
- We ignore household inertia, but this may be less of an issue in this context since the option is exercised by distressed borrowers.
- We plan to extend our analysis to consider other mortgage designs and factors not considered yet such as inflation risk.