"Interest Rate Pass-Through: Mortgage Rates, Household Consumption, and Voluntary Deleveraging"

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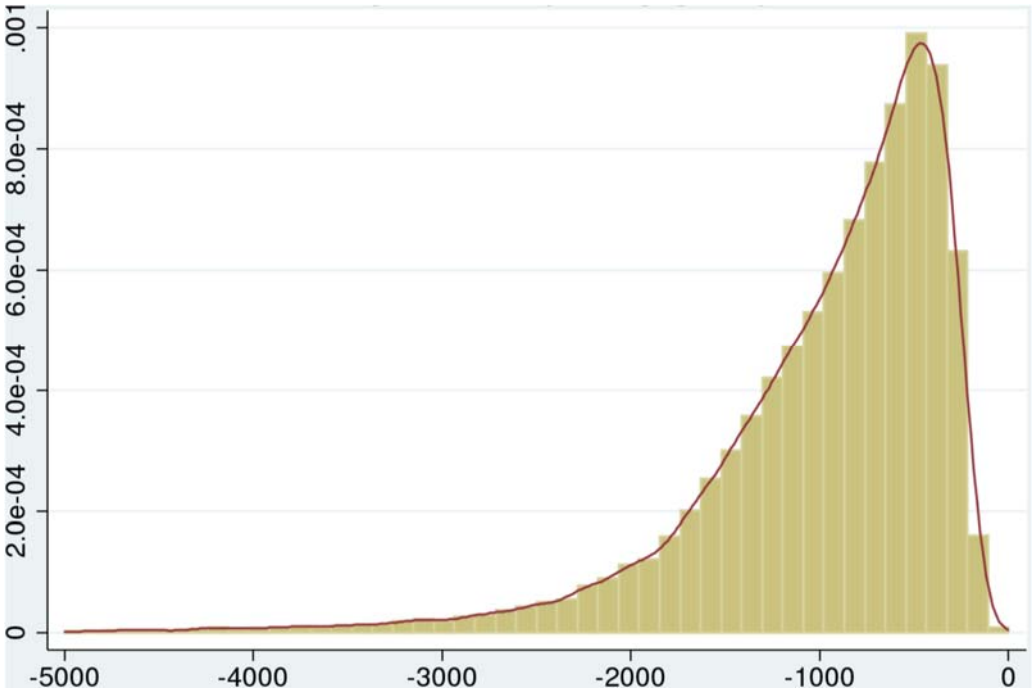
Online Appendix

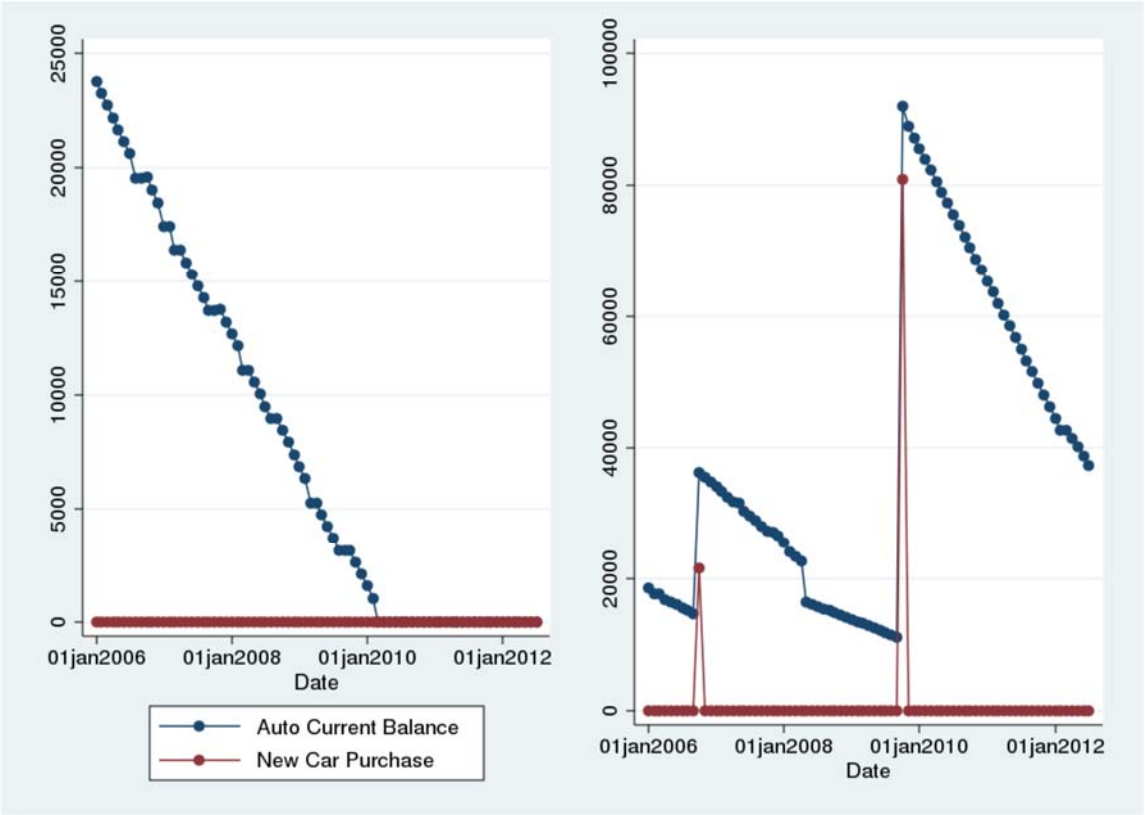
A1: Distribution of Changes in the Monthly Mortgage Payments at the ARM Reset Date

This figure shows the distribution of average change in the monthly payment in dollars at the time of the interest rate adjustment for our sample of non-agency borrowers with 5-year ARMs with an interest-only period of 10 years and a reset date 60 months after origination. Negative values signify the drop in monthly payments at the time of the reset.



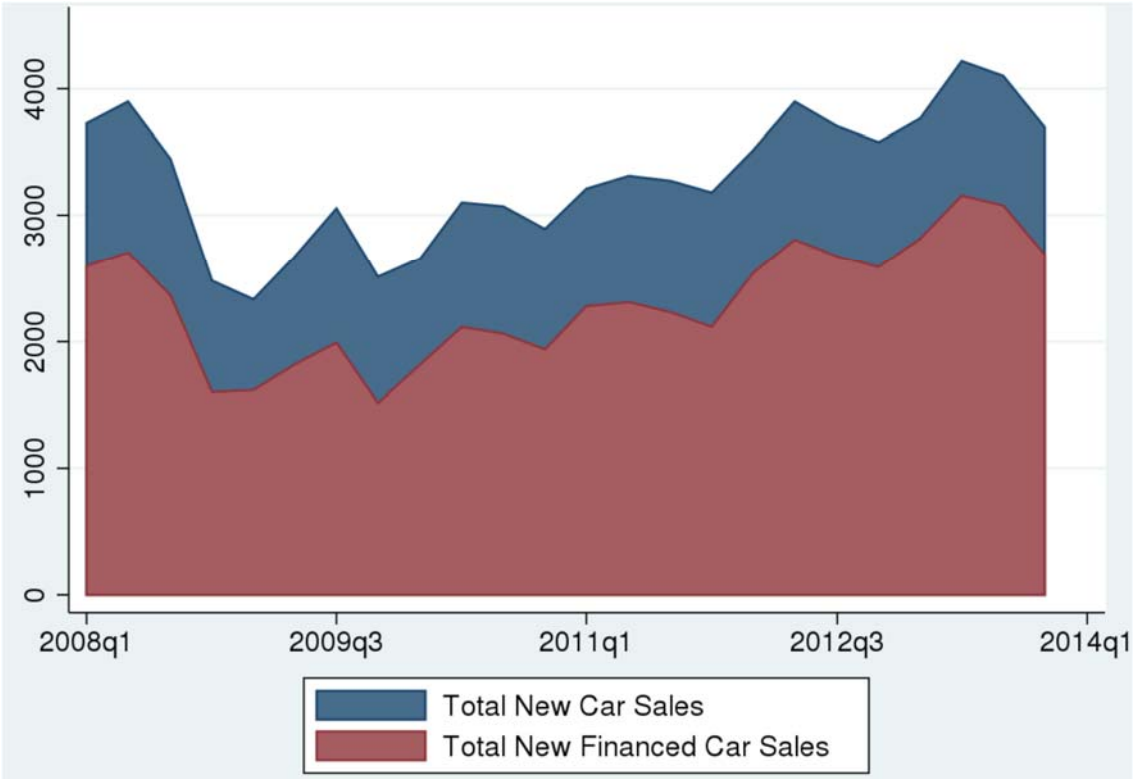
A2: Borrowers' Auto Loan Balances and Construction of New Car Consumption Measure

We plot the monthly auto balance in dollars and the new car consumption measure in the figures below. The left panel is an example of an individual who purchased her car before January 2006 and did not purchase any car until July 2012. The borrower in the right panel purchased two cars during the period. We assume that the value of the net new car spending (our new car consumption measure) to be equal to the change in the auto loan balance at the time of purchase.



A3: Total New Auto Sales and Auto Sales Financed by Auto Debt

This figure shows the total new car sales and new car sales financed by auto loans (in 1000s of units) as provided by R. L. Polk & Company.



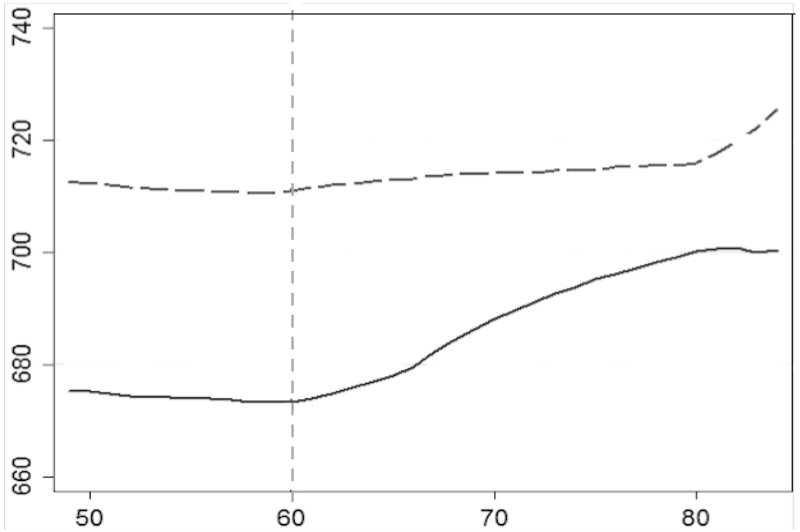
A4: Additional Evidence on External Validity

The table reports descriptive statistics for the main variables employed in our analysis, but for different types of mortgages as provided by Lender Processing Services. This dataset covers about 64% of the origination count reported under the Home Mortgage Disclosure Act (HMDA) over the period 2005–07. We first report the statistics for the whole sample at origination, and then we focus on two different subsamples comprising of fixed-rate mortgages and adjustable-rate mortgages (ARMs). We only consider mortgages for owner-occupied houses.

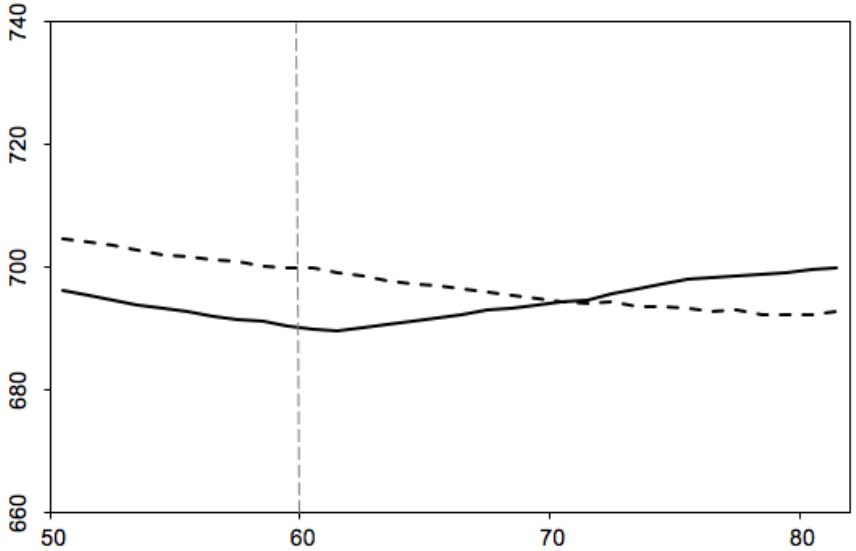
	Observations	Mean	St. Dev.
Mortgages Originated between 2005 and 2008			
FICO	15,520,963	703.7	68.5
Interest Rate	19,104,660	6.27	1.23
Loan-to-Value Ratio	18,452,315	74.53	17.51
Mortgage Size	19,106,272	239,043	202,721
Average Monthly Payment	17,300,637	1,654	1,514
Fixed-Rate Mortgages (FRMs) Originated between 2005 and 2007			
FICO	10,754,081	705.1	68.6
Interest Rate at Origination	13,263,190	6.30	0.89
Loan-to-Value Ratio	12,729,960	74.23	19.05
Mortgage Size	13,264,696	196,125	139,312
Initial Monthly Payment	11,812,181	1,485	1,258
Adjustable-Rate Mortgages (ARMs) Originated between 2005 and 2007			
FICO	2,039,025	687.9	73.2
Interest Rate at Origination	2,521,322	6.06	2.35
Loan-to-Value Ratio	2,441,813	76.06	13.77
Mortgage Size	2,521,297	312,466	271,243
Initial Monthly Payment	2,426,317	1,765	1,770

A5: Evolution of Borrowers' Credit Scores

This figure shows the evolution of the mean current FICO credit scores for borrowers with ARMs in our sample as a function of the loan's age expressed in months. Panel (a) shows the results for borrowers with non-agency ARMs. The solid line shows the results for borrowers with 5-year non-agency ARM contracts, while the dashed line shows the results for borrowers with 10-year non-agency ARM contracts. Panel (b) shows the results for borrowers with conforming ARMs. The solid line shows the results for borrowers with 5-year conforming ARM contracts, while the dashed line shows the results for borrowers with 7-year conforming ARM contracts. The vertical dashed line mark the first timing of the reset on 5-year ARM contracts, which results in a substantial reduction of monthly mortgage payments for these loans. We note that the mean FICO credit scores follow similar evolution across the loan types prior to the first rate adjustment on 5-year ARMs (i.e., there are parallel trends among the two groups of borrowers in both the agency and non-agency market before the reset). Following the first reset at the loan's age of 60 months, there is a gradual, relative improvement of FICO credit scores of borrowers with 5-year ARMs.



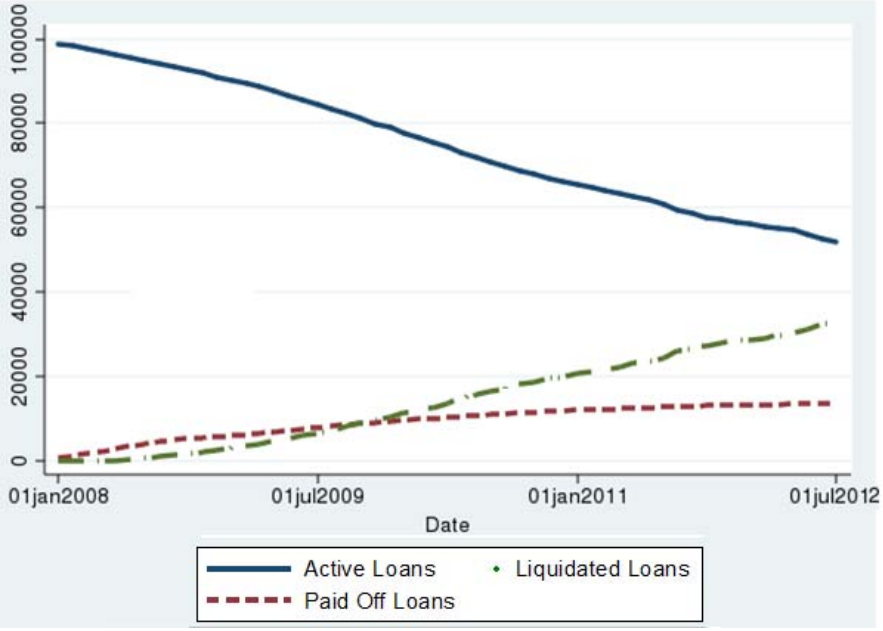
(a) Borrowers with non-agency ARMs



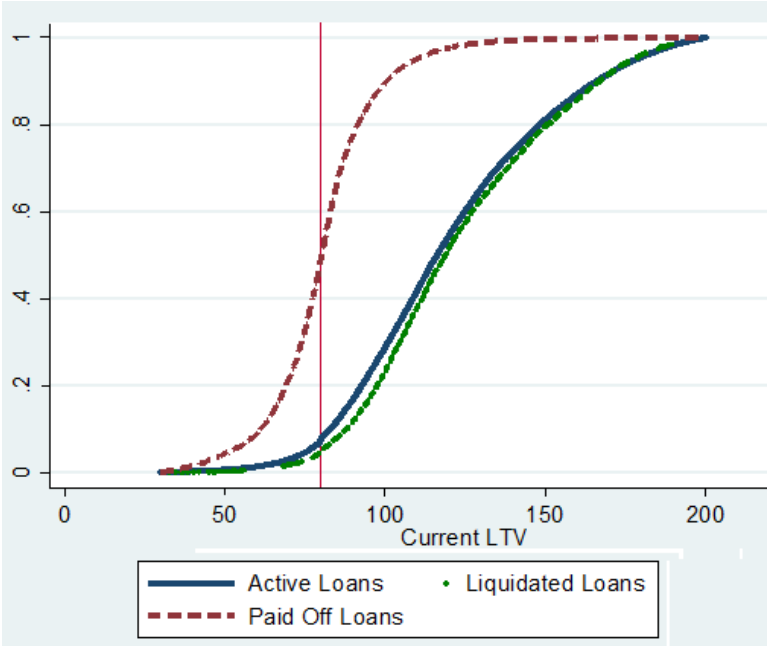
(b) Borrowers with conforming ARMs

A6: Attrition

Panel (a) of this figure shows the number of active loans (solid line), liquidated loans due to foreclosure, bankruptcy or real estate owned (dash line) and paid off mortgages due to prepayment or refinancing (dash-dot line) over time in our sample of borrowers with 5-year non-agency ARMs. Panel (b) shows the cumulative distribution of the number of active loans, liquidated loans, and paid off mortgages as a function of the current loan-to-value ratio (LTV) in our sample of borrowers with 5-year non-agency ARMs. The vertical line shows a current LTV of 78%, which corresponds to the median of the current LTV for the paid off loans.



(a) Attrition over time



(b) Attrition and current LTV

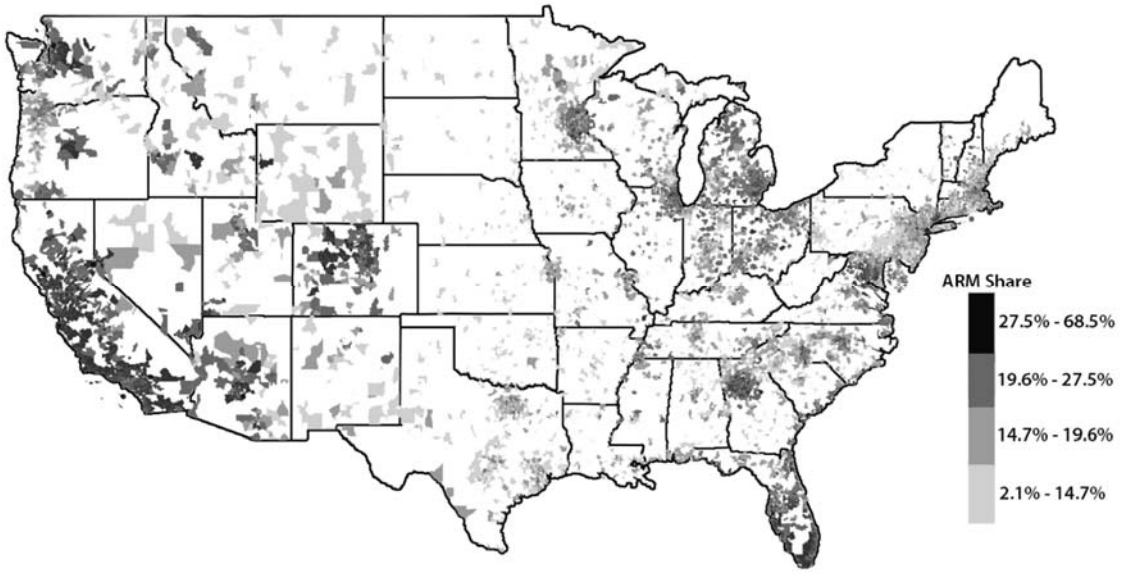
A7: Additional Evidence on Consumption and Voluntary Deleveraging Response

The table reports coefficient estimates of least square regressions relating the monthly spending on store cards and voluntary repayment of home equity loans to the reset of interest rate 5 years after the origination. The dependent variables are computed based on the households' balance of each type of loan as provided by Equifax. Columns (1)-(2) analyze the effect of the interest rate reset on store credit card spending, while Columns (3)-(4) focus on voluntary repayment of home equity loans. In Column (2) and (4) we normalize the dependent variable by the initial mortgage payment. The main independent variables are dummies identifying different time periods before and after the reset date. "Other Controls" include a variety of borrower, mortgage, and regional characteristics including borrower FICO credit score, loan origination time fixed effects, and zip-code level house price controls similar to those in Table 2. The sample includes mortgages originated between 2005 and 2007 provided by BlackBox Logic. Standard errors in parentheses.

	Store Card Spending	Store Card Spending (Normalized)	Equity Loan Repayment	Equity Loan Repayment (Normalized)
	(1)	(2)	(3)	(4)
Four Quarters Before	1.170	0.000343	-1.063	-0.000396
	(2.649)	(0.00194)	(1.349)	(0.00105)
Three Quarters Before	3.174	1.05e-05	-0.120	0.000646
	(3.194)	(0.00234)	(1.642)	(0.00128)
Two Quarters Before	0.451	-0.000841	-0.880	0.00142
	(3.760)	(0.00276)	(1.946)	(0.00151)
One Quarter Before	10.01	0.00358	-1.732	0.00178
	(4.324)	(0.00317)	(2.254)	(0.00175)
One Quarter After	14.25	0.00733	7.465	0.0102
	(4.926)	(0.00362)	(2.574)	(0.00200)
Two Quarters After	15.32	0.00795	7.767	0.0111
	(5.564)	(0.00409)	(2.912)	(0.00226)
Three Quarters After	15.22	0.00516	7.442	0.0126
	(6.191)	(0.00455)	(3.252)	(0.00253)
Four Quarters After	20.87	0.0113	3.157	0.0109
	(6.919)	(0.00508)	(3.648)	(0.00284)
Two Years After	27.85	0.0147	2.278	0.0131
	(7.877)	(0.00579)	(4.195)	(0.00327)
Other Controls	Yes	Yes	Yes	Yes
N. of Observations	1,158,492	1,124,408	532,163	513,391
R-squared	0.060	0.049	0.357	0.342

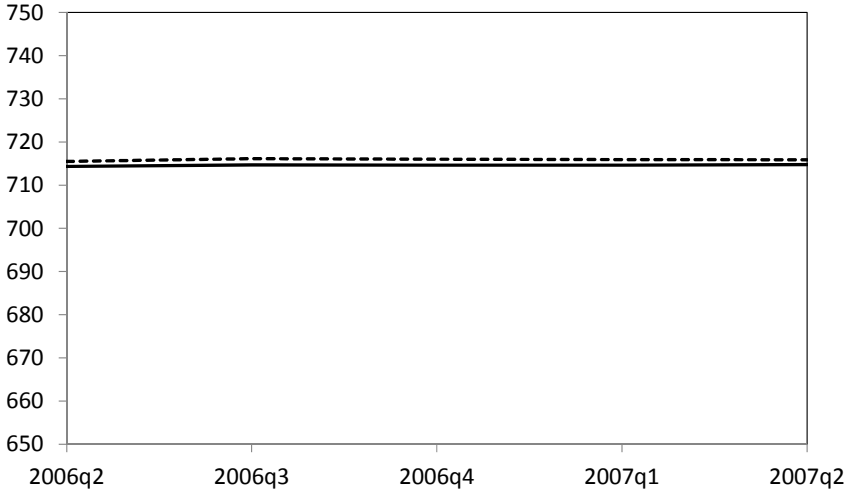
A8: Geographic Distribution of Zip Codes

This figure presents the geographic distribution of zip codes in our overall sample across the United States. In addition, the figure displays the percentage of loans in a zip code which are of ARM type (the zip code ARM share). As we observe, there is a significant variation in the ARM share across zip codes ranging from just few percent of loans being of ARM type in a zip code to more than 60%.

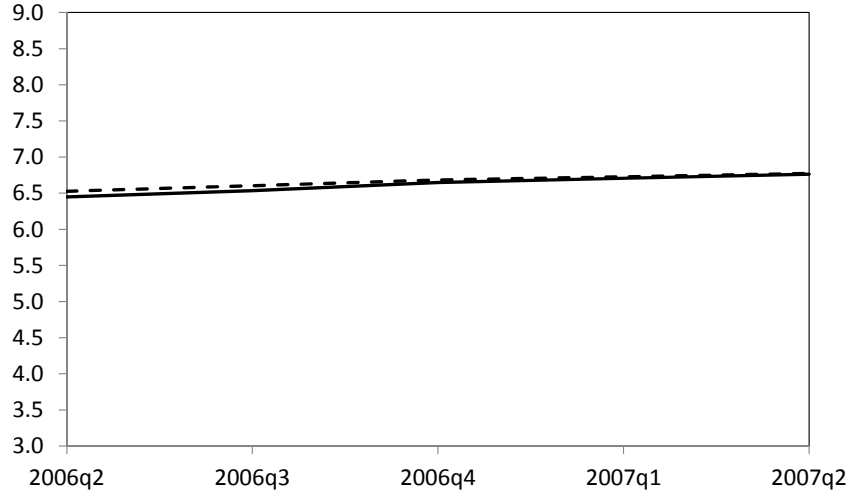


A9: Evolution of Observables in High and Low Exposure Zip Codes

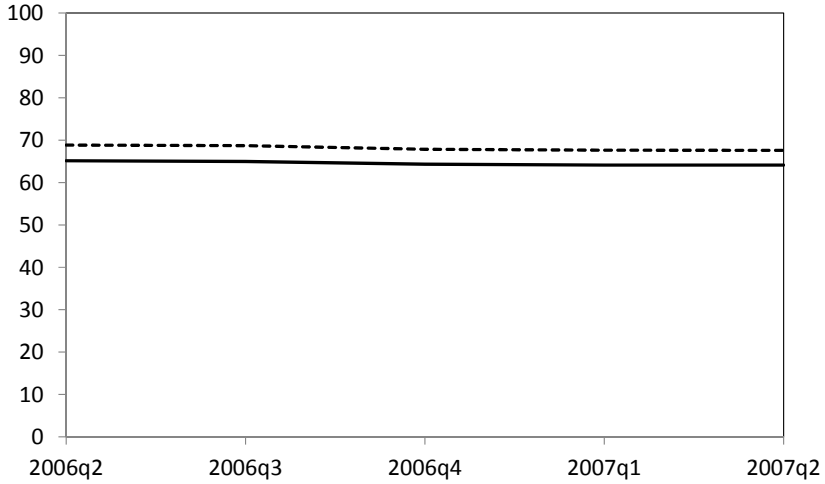
The figure shows the evolution of the mean origination FICO credit score (panel a), current mortgage interest rate (panel b), and LTV ratio (panel c) of outstanding mortgages in high and low exposure zip codes prior to the decline in interest rate indices. The high and low exposure groups are defined based on the share of loans that are ARMs in a zip code. The high exposure group is represented by the solid line and the low exposure group is represented by the dashed line.



(a) FICO Credit Score

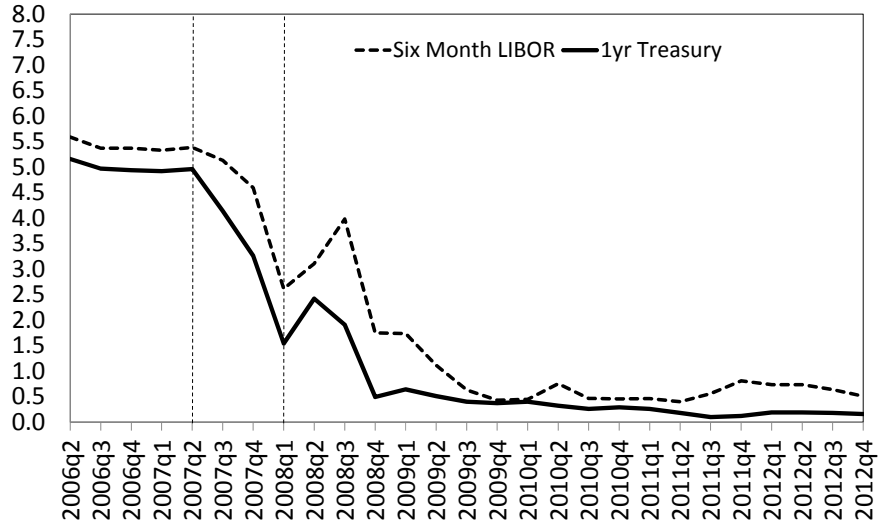


(b) Mortgage Interest Rate

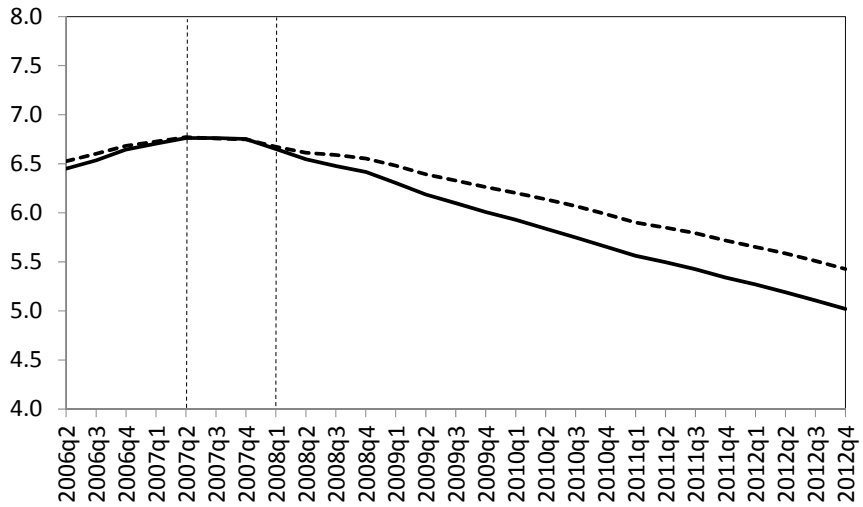


Appendix A10: Interest Rate Indices and Mean Mortgage Interest Rates in High and Low ARM Share Zip Codes

This figure presents the evolution of index interest rates (panel a) and the evolution of average zip code mortgage interest rates (panel b). The high and low exposure groups in panel (b) are defined based on the share of loans that are ARMs in a zip code. In panel (b), the high exposure group is represented by the solid line and the low exposure group is represented by the dashed line. The first vertical dashed line (at 2007:Q2) marks the period of the beginning of the rapid decline in interest rate indices, while the second (at 2008:Q1) marks the beginning of the period when we start observing the divergence in mortgage interest rates across high and low exposure zip codes.



(a) 6-month LIBOR and 1-year Treasury



(b) Zip Code Mortgage Interest Rates

A11: Change in Mortgage Rates, Mortgage Delinquency Growth, House Price Growth, Auto Sales Growth, Employment Growth, and Instrumented Zip Code ARM Share

In this we instrument the region ARM share with the percentage of house transactions in each zip code in years 1998-2002 that had a price below 1.25 times the conforming loan limit in this period (*Below CLL*). We use the sample of more than 4,000 zip codes with available data -- not just matched ones. Column (1) shows the results for the first stage of the instrumental variable analysis. Columns (2)-(6) show the results of the second stage of our analysis: the relationship between the instrumented zip code ARM share and the change in the average mortgage interest rate, the quarterly mortgage delinquency growth rate (Column 3), the house price growth rate (Column 4), the auto sales growth rate (Column 5), and the employment growth rate (Column 6) between the period of low rates and the preceding period. "Zip Code Controls" include the average zip code mortgage LTV ratios, interest rates, house price controls, socio-economic variables capturing a profile of the zip code population, and the average credit score of households. "State FE" are fixed effects for the state corresponding to the location of the zip code. The estimates are expressed in percentage terms; standard errors are in parentheses.

	ARM Share	Mortgage Interest Rate	Mortgage Delinquency Growth Rate	House Price Growth rate	Auto Sales Growth Rate	Employment Growth Rate
	(1)	(2)	(3)	(4)	(5)	(6)
	First Stage					
Below CLL	-0.229					
	(0.0076)					
		Second Stage				
Predicted ARM Share		-0.0113	-0.302	0.008	0.029	0.008
		(0.0007)	(0.0570)	(0.005)	(0.012)	(0.007)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Squared	0.52	0.69	0.289	0.20	0.094	0.028

A12: Extrapolating the Total Consumption Response

One limitation of our consumption results is that we only observe the durable spending response based on the new consumption of cars. To obtain a more comprehensive measure of consumption response, we assess how auto sales growth and total consumption growth respond to local shocks and use these elasticities to scale the response of total consumption to auto consumption for our shock. Toward this end, we will use estimates from Di Maggio and Kermani (2015) (DMK henceforth) who investigate how heterogeneity in unemployment insurance generosity might affect local responses to labor demand shocks. As instrument for changes in local labor demand, DMK follow Bartik (1991) and Blanchard and Katz (1992) in constructing an index by interacting cross-sectional differences in industrial composition with national changes in industry employment shares -- the "Bartik shock" strategy. The Bartik shock is defined as follows

$$\text{Bartik}_{i,t}=\sum_{k=1}^{K} \varphi_{i,k,\tau} \frac{v_{-i,k,t}-v_{-i,k,t-1}}{v_{-i,k,t-1}},$$

where $\varphi_{i,k,\tau}$ is the employment share of industry k in area i in the base year τ=1998, and $v_{-i,k,t}$ is the national employment share of industry k excluding area i in year t.[1]

The baseline specification employed by DMK is:

$$\Delta Y_{i,t}=\beta_1(\text{Bartik}_{i,t}\times UI_{i,\tau})+\beta_2\text{Bartik}_{i,t}+\beta_3\text{Bartik}_{i,t}\times X_i+\eta_i+\gamma_t+\varepsilon_{i,t},$$

where $\Delta Y_{i,t}$ represents the growth in total consumption and car sales. DMK estimate this specification using as weights the population in 2000 and control for a number of state-level characteristics (X_i), such as the fraction of employees in construction, manufacturing, government (which includes federal, military, state and local government), self-employed and services industries as well as the log of median income, democratic share and the fraction of individuals with high-school and college degree as well as their interaction with the Bartik shocks. DMK also include state and year fixed effects to allow for any general trend (such as changes in demographics) at the state level. Since the main source of variation is at the state level, the standard errors are clustered at the state level.

One of the main advantages of this Bartik research design is that there is no need to take a stand on the specific underlying shocks determining the changes in employment in any given period, such as changes in trade policy, technology or consumer tastes. Rather, this strategy summarizes the effects of the combination of these shocks for employment trends employing the evolution of employment shares nationally.

[1] Each four-digit ISIC code is one industry. We also repeated our analysis with three-digit ISIC codes and the results are quantitatively and qualitatively the same. Please see the technical appendix for a detailed description of how we construct the main variables.

The main coefficient of interest for our calculation of the overall consumption response from car spending, which is similar in spirit to the one in Blundell, Pistaferri, and Preston (2008) is β_2. It measures the direct effect of the Bartik shocks on total consumption and car sales. We find that β_2=0.7 for total consumption and is equal to 2.3 for car sales, that is, auto sales growth is more than three times as responsive to Bartik shocks as total consumption growth. Moreover, in the BEA data, auto sales account for about 4.5% of overall household consumption. We can then compute the change in total consumption as follows:

$$\Delta(Total\ Consumption) = \frac{Total\ Consumption}{Car\ Sales} \times \frac{\beta_{TotCons}}{\beta_{CarSale}} \times \Delta(Car\ Sales)$$

$$= \frac{1}{0.045} \times \frac{0.7}{2.3} \times \$110 = \$744$$

where \$110 is the increase in car spending we found in response to the decrease in the mortgage monthly payment. In other words, we find that a \$940 decrease in monthly mortgage payments per borrower that is associated with an about \$110 increase in the monthly car spending, would result in an about \$744 increase in the total household consumption.