

# Unconventional Monetary Policy and Consumption\*

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## Abstract

This paper provides empirical evidence on the role played by home mortgages in transmission of unconventional monetary policy. Using household level panel data on consumption, I show that the ability of households to refinance their mortgages and extract home equity, determines the efficacy of monetary policy in stimulating consumption. Homeowners who refinance their loan in response to an expansionary monetary policy shock consume more than other households. This heterogeneity is conditioned by local home prices. I find that mortgage owners who refinance their loan in states with higher house prices have higher consumption growth following an expansionary shock.

**JEL Classification:** E21, E520, E60.

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# I. Introduction

At the peak of the financial crisis of 2008, the Federal Reserve lost its direct influence over the economy with the policy rate hitting its effective lower bound. The Fed then shifted to using unconventional monetary policy in an attempt to lower long term rates and to stimulate demand. Two of the most significant policies used by the Fed during this period are the Large Scale Asset Purchases (LSAP) and Forward Guidance.

A growing literature on the transmission of unconventional monetary policy suggests that these policies were successful in influencing both financial markets and the real economy. Swanson (2021, 2018) show that LSAPs and Forward Guidance had a large and significant effect on medium and long term treasury yields, corporate bond yields and interest rate uncertainty. Evidence of the effect of these measures on the aggregate real economy can be found in Gertler and Karadi (2015) and Zhang (2019b). This paper builds on the literature of effectiveness of unconventional policy shocks, measured by high frequency identification, on the real economy. I specifically focus on the heterogeneous transmission of these policy on household consumption via the mortgage market. I find that the channels of transmission of LSAP shock, in particular, vary across households depending on their decision to refinance their existing mortgages.

Housing debt is an important channel of transmission of monetary policy to consumption.<sup>1</sup> Monetary policy affects interest rates and, hence, the mortgage costs faced by homeowners and their transitory income. Homeowners with positive home equity can respond to lower mortgage rates by refinancing their mortgages. This allows households with mortgages to lower their interest payments or to increase the size of their loan without affecting their monthly payment (known as cash-out refinancing). However, since refinancing requires collateral, only households with sufficient home equity can increase their income and consumption via the refinancing channel. In this paper, I argue that households who refinance their loans after a monetary policy shock, increase their consumption more than households who choose not to refinance and households who do not own houses.

The heterogeneity in response to monetary policy shocks are further influenced by regional variation in housing prices.<sup>2</sup> Borrowers are constrained in their capacity to buy and refinance mortgages by the value of their collateral. Low house prices result in low value of collateral and tighter borrowing constraints. Thus, households that suffer large decrease in their home equity are unable to take advantage of expansionary monetary policy and low mortgage rates. The second part of this paper aims to understand how efficacy of monetary

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<sup>1</sup>See Fuster and Willen (2010), Auclert (2019), Cloyne et al. (2019), Garriga et al. (2017) for research on housing market and monetary policy.

<sup>2</sup>Zhang (2019a) finds a strong positive relation between house prices and consumption using Dutch data. She also shows that the response is heterogeneous depending on home ownership where homeowners consume significantly more than renters to changes in home prices. I find that the differential response in the U.S. is due to the refinancing channel.

policy varied with the severity of 2008 housing market crash across different states in the U.S.

In this paper, I focus on the unconventional policies used by the Federal Reserve during the financial crisis. This is an important period to explore the housing channel for two main reasons. First, the Fed intervened in the mortgage market directly during the crisis by using Large Scale Asset Purchases (LSAP) of mortgage-backed securities.<sup>3</sup> Hence, the unconventional monetary policy had a significant effect on the market for housing loans. Second, this period was also characterized by low house prices and high regional variation in the housing market across the U.S. While households in some regions of the U.S. suffered with low or negative equity, households in other regions were relatively better off. This allows me to study the response of households across regions to unconventional policy shocks.

As a measure of unconventional monetary policy shocks, I use the shocks identified in Swanson (2021). To construct the series, Swanson (2021) takes the 30-minute change in asset prices to each FOMC announcement for the period 1991-2015. Using principal component analysis along with identifying assumptions, he extracts the three factors with highest explanatory power of the asset price changes and identifies them as the change in federal funds rate, forward guidance and LSAP, respectively. The high frequency changes in asset prices is a popular approach to measure unanticipated monetary policy shocks.<sup>4</sup>

In the first part of the paper, I study the heterogeneity in behavior of households who choose to refinance their mortgages in response to a monetary policy shock against all other households. To understand consumption response, I exploit the information in Consumer Expenditure Survey in the U.S., which includes detailed consumption and mortgage information, for a panel of households, at quarterly frequency. I find that homeowners who refinance their mortgages enjoy higher consumption as a result of an expansionary monetary policy shock in comparison to renters and all other homeowners. This effect is very strong for LSAP measures used by the Fed during the zero lower bound period. The response of consumption to Forward Guidance on the other hand, is relatively homogeneous across all household categories.

Next, I compare the consumption response of households in states where households suffered heavy erosion of home equity during the housing market crash in 2008, to states where households faced a less severe decline in home prices. Following an expansionary LSAP shock, I find no significant difference in consumption among homeowners who refinance their mortgages relative to other homeowners and renters in the distressed states. On the other hand, after an expansionary LSAP shock, homeowners who refinanced their mortgages in non-distressed states, responded with higher consumption, relative to other households.

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<sup>3</sup>Fuster and Willen (2010) shows that mortgage cost significantly dropped across the U.S. (but heterogeneous across borrowers based on creditworthiness) following the announcement for LSAP in November 2008 and March 2009.

<sup>4</sup>Other studies using this approach include Gurkaynak et al. (2005), Krishnamurthy and Vissing-Jorgensen (2011) and Gagnon et al. (2011)

The structure of this paper is as follows. In section II, I review the related literature on transmission of monetary policy. In section III, I discuss the data and the empirical methodology. Section IV discusses the results. Section V concludes.

## II. Literature Review

The central bank's policy does not directly respond to inequality but affects macro variables unequally, which can result in greater inequality.<sup>5</sup> There is a growing interest, in departure from the canonical New Keynesian models, to recognize the role of household heterogeneity in transmission of monetary policy. Coibion et al. (2017) show that inequality in earnings, consumption and expenditure across households in the U.S. increases following a contractionary monetary policy shock.

This paper connects to many strands of the literature studying household heterogeneity, monetary policy and inequality. I study how household's debt liability affect the transmission of unconventional monetary policy used by the Federal Reserve during the financial crisis. My paper is closely related to Beraja et al. (2019), who study the role of regional heterogeneity of housing equity in transmission of the first LSAP announcement by the Fed in November, 2008. They use micro data to show that the first LSAP episode did not transmit to the most distressed regions due to low refinancing activity. They argue that monetary policy affects household wealth by lowering mortgage rates. This allows households with sufficient home equity to refinance and extract housing equity, whereas underwater households are unable to take advantage of lower rates.

My work in this paper builds on their work in two important ways. First, I expand their analysis to focus on all Forward Guidance and LSAP shocks during the period between 1996 - 2018 rather than the first LSAP shock. Although the first LSAP announcement had important implications for the mortgage market, its effectiveness could have been dampened by the weak lending market at the peak of crisis. Considering all unconventional policy shocks is important in understanding the impact of monetary policy during the period of recovery. Second, they measure the response of refinancing activity while I focus on the growth of household consumption. Measuring the response of consumption allows me to study the impact of unconventional policy on the real economy. This paper is also related to Maggio et al. (2016), who identify three channels through which refinancing affects consumption after a LSAP shock. They find that LSAP helped household via higher credit availability and lower interest rates on mortgages and other debts. Their finding complements Beraja et al. (2019),

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<sup>5</sup>For example, Albanesi (2007) and Doepke and Schneider (2006) show that unexpected inflation increases inequality.

that borrowers who benefited from LSAP disproportionately lived in the least affected areas.<sup>6</sup>

The refinancing channel of transmission of monetary policy is also explored in Wong (2021). She uses the Consumer Expenditure Survey dataset to show that households that adjust mortgages following a monetary policy shock, consume more than households that are not homeowners or those who do not adjust loans. The mechanism is similar- households that readjust their mortgages after a monetary policy shock enjoy lower interest rate and thus, have higher disposable income and consumption. While her paper looks at the conventional monetary policy shocks, I study unconventional policy shocks. Heterogeneity arising from refinancing of mortgages is also explored in Eichenbaum et al. (2019).

This paper also relates to the literature connecting household balance sheet with heterogeneity in marginal propensity to consume (MPC) across households, and its effect on transmission of monetary policy. Eggertsson and Krugman ((2012) use a New Keynesian model with heterogeneous agents to show that the aggregate effect of monetary or fiscal policy is higher if it eases the borrowing constraint of constrained households. Auclert (2019) finds that an expansionary monetary policy increases inequality because it eases the borrowing constraint for households with debt. The higher MPC of debt constrained households results in higher aggregate effects. Cloyne et al. (2019) use the Consumer Expenditure Survey data to provide evidence on how households with mortgages respond differently to monetary policy shocks compared to the home owners and renters. Their study provides further evidence that households with debt have higher MPC. Other papers that find high MPC for debt constrained households include, Kaplan et al. (2014) and Hedlund et al. (2016) who use the Panel Study of Income Dynamics data to show that high income, high debt households have higher MPC out of transitory income. More evidence on refinancing and effectiveness of monetary policy is discussed in Agarwal et al. (2019) and Fuster and Willen (2010).

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<sup>6</sup>The transmission of unconventional monetary policy to mortgage rate has also been studied using high frequency data in Gertler and Karadi (2015) and Fuster and Willen (2017).

### III. Empirical Methods

In this section, I discuss the empirical specification and the data used. For my analysis, I use the Consumer Expenditure Survey (CEX) dataset from the Bureau of Labor Statistics (BLS) for the period 1996 - 2018 combined with the unconventional monetary policy shock series from Swanson (2021). The analysis is at the household level for the period of 1996 Q1 - 2018 Q2.

#### III.A. Data

**III.A.1 Consumer Expenditure Data:** The Consumer Expenditure Survey dataset is a household level data published quarterly by the BLS, available since 1980. The dataset contains details on expenditure by households on a vast number of goods and services along with individual level demographic characteristics. I use the classification used in Krueger and Perri (2006) and Wong (2021) to classify household expenditure into durable, non-durable and service expenditure. All variables are deflated with category-wise CPI.<sup>7</sup> The final dataset has 122,990 unique households.

I classify households between homeowners with mortgages who refinance their loan, homeowners who do not refinance their loan, and households that are renters. CEX data records the date and amount of new loans and any change in loan activity which resulted in a new loan i.e. refinancing. I categorize a household as having refinanced their loan if for a household in the dataset, the quarter and year of loan change matches the current quarter and year. Table 1 shows the distribution of households across homeowners with mortgages, homeowners without mortgages, and renters. Approximately 7% of all homeowners with mortgages in the sample have refinanced their loan within the sample period.<sup>8</sup>

Table 1: Distribution of households by category

	Homeowners with mortgages	Homeowners without mortgages	Renters
Percentage of total households	48.31%	21.68%	30.01%
Homeowners who refinance loan	6.64%	-	-

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<sup>7</sup>I discuss the data adjustments in more detail in Appendix A.

<sup>8</sup>This distribution is similar across states.

**III.A.2 Monetary Policy Shocks:** For LSAP and Forward Guidance shocks, I use the series of shocks from Swanson (2021). This paper uses high frequency identification which decomposes the effect of a monetary policy announcements on yield rates within a 30-min window around the shocks and separates it into federal funds rate, Forward Guidance and LSAP factors.<sup>9</sup> I sum the factors to obtain a continuous series of shocks at quarterly level. This series is from 1991Q2 - 2018Q2 which overlaps with my data on household consumption. Table 2 shows the similarity in the moments of aggregated shocks and the raw shocks.

Table 2: Summary statistics for monetary policy shocks

	Raw Shocks			Quarterly Shocks		
	Fed Funds Rate	Forward Guidance	LSAP	Fed Funds Rate	Forward Guidance	LSAP
Median	0.1567	-0.0007	-0.02	0.2893	-0.0010	-0.0195
Mean	0.0113	-0.0031	-0.0043	0.0244	-0.0067	-0.0092
Standard Deviation	0.8301	0.9773	0.5857	1.1582	1.2640	0.8942
Min	-5.54	-3.37	-5.63	-5.33	-3.20	-5.31
Max	1.78	4.16	1.97	2.03	5.13	2.19
N	234	234	234	108	108	108

**III.A.3 Other Macro Data:** I also use the state-wise housing price index dataset from the Federal Housing Finance Agency (FHFA). The data is available in monthly and quarterly frequency. I use the house price dataset to identify the states most affected by the crisis. A state is recorded to have faced a severe effect if the house price changes in the state between 2007Q1 - 2008Q4 was “large enough”. I define a “large enough” change as the 75th percentile of the change in house prices in all states between 2004Q1 - 2005Q4.<sup>10</sup> I identify 4 states- California, Arizona, Nevada, and Florida, as states which were severely affected by the housing market crash. I use this variable to identify the channel of refinancing, following Beraja et al. (2019) who show that refinancing activity during the crisis was highly regional specific. I define a dummy variable prime effect which takes the value one for states which were severely affected by the crash and zero for states that were not as severely impacted. Table 3 shows the proportion of mortgage owners who adjust loan, who did not adjust loan

<sup>9</sup>See Swanson (2021) for more details on identifying strategy and assumptions.

<sup>10</sup>In Appendix B, I redefine the cut-off as median of the change in house prices in all states between the year 2004Q1 - 2005Q4 and re-run the specification. The results are similar to ones reported in the paper.

and renters, by the prime effect variable for the period 2007Q1 - 2018Q2.

Table 3: Summary statistics by prime effect variable

	Severely affected states	States not severely affected
Homeowners who refinance	2.55%	2.87%
Homeowners who did not refinance	60.23%	67.91%
Renters	37.22%	29.23%

### III.B. Empirical Specification

This section of the paper discusses the empirical methodology used in this paper. To study the effect of monetary policy on consumption, I run a household level regression with state, month and year fixed effects. The baseline specification is:

$$\begin{aligned} \Delta \ln C_{h,t} = & \alpha_0 + \alpha_1 D1_{h,t} + \alpha_2 D2_{h,t} + \sum_{i=1}^k \beta_i S_{t-i}^f + \sum_{i=1}^k \gamma_{1i} D1_{h,t} S_{t-i}^f \\ & + \sum_{i=1}^k \gamma_{2i} D2_{h,t} S_{t-i}^f + \alpha_3 X_{h,t}^{(1)} + \alpha_4 X_{s,t}^{(2)} + \lambda_s + \lambda_y + \lambda_m + u_{h,t} \end{aligned} \quad (1)$$

where  $\Delta \ln C_{h,t}$  is the growth in real consumption for each household in quarter  $t$ . Household consumption composes of non-durable expenditure, durable expenditure excluding housing, and expenditure on services.  $D1_{h,t}$  is a dummy variable which takes value one for all households that own home (with or without mortgages) and do not refinance mortgages, and zero otherwise.  $D2_{h,t}$  is a dummy variable which takes value one for households that rent the housing unit and zero otherwise. The loan adjustment dummies are interacted with the monetary policy shock denoted by  $S_{t-i}^f$  which is a  $2 \times T$  vector of Forward Guidance and LSAP shock, where  $T$  denotes the total time period. The coefficients of interest are  $\gamma_1$  and  $\gamma_2$ . These coefficients tells us the difference in percentage change in real consumption based on a household's decision to adjust loan following a monetary policy shock. I include 12 lags of the monetary policy shocks. The sample is weighted by the sample weights calculated by BLS.

**III.B.1 Control Variables:**  $X_{h,t}^{(1)}$  denotes the household level controls which includes:



change in the family size, age of the reference person, age of the reference person squared, education of the head of household, number of earning members in the household, number of vehicles owned by household and number of quarters for which the household was interviewed<sup>11</sup>.  $X_t^{(2)}$  denotes the macro controls which includes quarterly change in unemployment rate at the state level, quarterly change in house prices at the state level, dummy variable for NBER recession dates (following Tenreyro and Thwaites (2016)) and dummy variable for the financial crisis. To measure the financial crisis effect, I construct a binary variable which is one for the periods between 2008 Q4 and 2009 Q2, and zero otherwise. The regressor  $\lambda_s$  denotes state fixed effects,  $\lambda_y$  denotes the year fixed effects and  $\lambda_m$  denotes the month fixed effects.  $u_{h,t}$  is the error term.

## IV. Consumption Response to Monetary Policy

I begin by discussing the heterogeneous effect of LSAP and Forward Guidance shocks on household consumption based on the household’s decision to refinance their loan. Table 4 shows the effect of monetary policy over the full sample period of 1996Q1 - 2018Q2. All shocks are normalized to one standard deviation expansionary shock. The results include household level controls, and month, year and state fixed effects.

On average, household consumption increases by 4% in response to one standard deviation expansionary LSAP shocks over last four quarters. Households in all categories respond significantly to LSAP shocks over the full sample. However, the response is largest for households who refinance their loan. In section IV.A, I focus on the effect of LSAP shocks on consumption post-2007. I find that households who adjust their loans respond much more significantly and immediately to LSAP policy shocks. For Forward Guidance shocks, the response of consumption to past four quarters of the shock suggest that on average, all households reduce their consumption following the shocks. The puzzling negative response however is being driven by the observations during the high volatility period of 2007 - 2009 as discussed in section IV.B. The cumulative impact of shocks for lags greater than four is small and insignificant, suggesting a diminishing impact of monetary policy on household consumption.

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<sup>11</sup>More details in Appendix A.2

Table 4:  
Differential effect of monetary policy shock on consumption growth

Dep. Var: $\Delta \log(C_{h,t})$		Refinance their Loan	Do not Refinance	Renters
LSAP	1st year impact	4.72*** (1.702)	3.95*** (0.958)	3.29*** (1.108)
	2nd year impact	2.94 (2.28)	2.38* (1.33)	2.84* (1.46)
Forward Guidance	1st year impact	-1.404 (2.21)	-1.47* (0.888)	-2.01* (1.069)
	2nd year impact	1.74 (1.93)	1.36 (1.09)	0.99 (1.23)

*Note:* The table shows the consumption response of households who refinance their loan and the differential response against households who do not refinance and renters to a lagged one standard deviation expansionary LSAP shock. The sample period is 1996Q1 to 2018Q2. 1 year response is calculated as:  $\beta_1 + \beta_2 + \beta_3 + \beta_4$  while 2 year response is calculated as:  $\beta_5 + \beta_6 + \beta_7 + \beta_8$ . All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-values are calculated using delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.

## IV.A. LSAP Policy Shocks

In this section, I focus on how heterogeneity across households affect their consumption response to LSAP shocks. LSAP shocks became a key component of monetary policy after the beginning of financial crisis. To study the effect of LSAP shocks on consumption, I restrict the sample period to 2007Q1-2018Q2. The key heterogeneity that I exploit in this paper is the decision of homeowners with mortgages to refinance their mortgage. Households who refinance their loan following an expansionary shock enjoy lower monthly payments and thus, higher disposable income as against homeowners who do not refinance their loan and households who are renters. Table 5 shows the incremental consumption growth of households who choose to refinance their mortgage over homeowners who do not refinance after an expansionary LSAP shock. The variable “Refinance - Do not Refinance” measures the differential response of households who refinance against households who do not refinance. Similarly, the variable “Refinance - Renters” shows the differential response against renters. All policy shocks are normalized to be one standard deviation expansionary shock.

Homeowners who refinance their mortgage increase consumption by approximately 3% over a quarter in response to a LSAP shock in the previous quarter. An average household in my sample has a quarterly expenditure of \$10,000. A 3% difference in consumption implies that households who refinance their mortgages on average spend \$300 more on consumption over a quarter or \$1200 more over a year relative to homeowners who do not adjust their loan, and renters. The positive effect of the LSAP shock on consumption of homeowners who adjust their loan lasts for roughly four quarters. However, the difference in consumption across categories weakens for longer lags.

The results highlight the role of refinancing channel affecting the transmission of unconventional monetary policy to real consumption. Refinancing allows homeowners with mortgages to enjoy lower mortgage payments and thus, higher disposable income. The income effect is even higher for homeowners who opt for ‘cash-out refinancing’. Cash-out refinancing allows mortgage owners to extract their home equity to the extent that their monthly payments remain unchanged. The consumption growth of homeowners with cash-out refinancing would be even larger in response to the large increase in transitory income. The CEX data does not allow us to differentiate between types of refinancing activities by household to exploit their relative effect on consumption. However, data from Freddie Mac suggests that, on average, cash out refinancing comprise 50% of all refinances. Another source of heterogeneity in consumption is the liquidity effect from higher disposable income and lower borrowing constraints. Evidence from the literature on heterogeneity in marginal propensity to consume suggests that household with mortgages also have a higher marginal propensity to consume. Cloyne et al. (2019) show that households who own mortgages are borrowing constrained and as a result, they are also more responsive to transitory income shocks.

House prices play a significant role in how refinancing channel affects consumption of indebted households. Homeowners with mortgages can refinance their homes to take advantage of lower mortgage rates. However, this channel is conditional on the value of their home

against their outstanding debt. Lower house prices would lead to lower home equity. As households need collateral to obtain a mortgage, households with low home equity are unable to refinance and cannot extract similar benefits of low interest rates as households with higher home equity. Mortgage owners facing low house prices are additionally constrained by their existing mortgages because it acts as a lower bound on their homes rendering them unable to lower the price of their home. This tightens their borrowing constraint and dampens the liquidity channel as consumption of constrained households fall.

Table 5: Differential effect of LSAP shock on consumption growth

Dep. Var: $\Delta \log C_{h,t}$		(1)	(2)	(3)
LSAP <sub>t-1</sub>	Refinance their Loan	3.23*** (0.995)	3.06*** (1.046)	3.04*** (1.038)
	Refinance - Do not Refinance	2.81*** (1.032)	2.6** (1.071)	2.57** (1.061)
	Refinance - Renters	2.8*** (1.006)	2.68** (1.058)	2.65** (1.05)
LSAP <sub>t-2</sub>	Refinance their Loan	0.83 (1.138)	0.55 (1.115)	0.55 (1.111)
	Refinance - Do not Refinance	-0.08 (1.063)	-0.375 (1.042)	-0.38 (1.038)
	Refinance - Renters	-0.07 (1.175)	-0.3 (1.168)	-0.3 (1.165)
LSAP <sub>t-3</sub>	Refinance their Loan	3.17** (1.444)	2.82* (1.455)	2.81* (1.45)
	Refinance - Do not Refinance	2.09 (1.34)	1.91 (1.321)	1.9 (1.313)
	Refinance - Renters	1.19 (1.407)	1.04 (1.411)	1.03 (1.404)
LSAP <sub>t-4</sub>	Refinance their Loan	3.69** (1.489)	3.36** (1.517)	3.38** (1.509)
	Refinance - Do not Refinance	2.77* (1.491)	2.62* (1.506)	2.64* (1.498)
	Refinance - Renters	2.89** (1.461)	2.79* (1.489)	2.81* (1.485)
Controls		✓	✓	
State FE	✓		✓	
Month and year FE	✓	✓	✓	
Recession dummy	✓	✓	✓	
Obs		147,737	145,680	145,680

*Note:* The table shows the consumption response of households who refinance their loan and the differential response against households who do not refinance, and renters, to a lagged one standard deviation expansionary LSAP shock. The sample period is restricted to 2007Q1 to 2018Q2. Loan adjustment is a categorical variable which divides households into households who own a home and adjust loan, households who own a home and do not adjust, and households who rent a home. The base category for loan adjustment variable is households who own a home and adjust loan. All regressions include twelve lags of the monetary policy shocks. Results for control variables are presented in Appendix C. All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-values are calculated using delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.

### IV.A.1 Heterogeneous response by severity of housing crisis

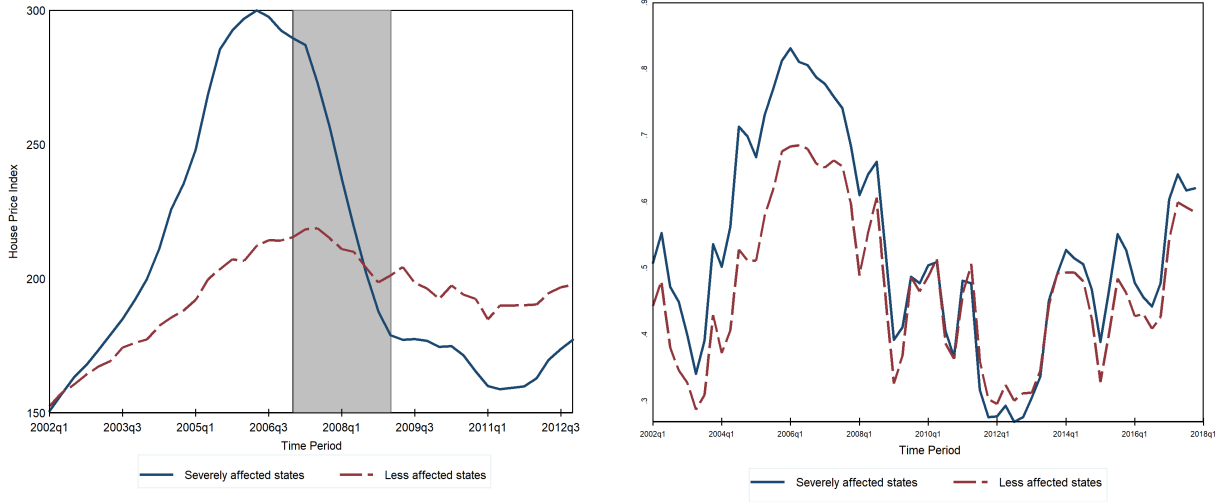
Since the great recession was driven by the housing market crash, it had significant effects on homeowner's equity. The effect, however, was not homogeneous across the U.S. and some regions experienced much higher drop in house prices than other regions. In this section, I discuss the distribution of house prices and refinancing activity across states within the U.S. I then split the regressions by states that were severely affected by the housing crisis and those that were less severely affected, and show how households in these states change consumption in response to LSAP policy shocks. I find that households in the severely affected states were not able to extract the same level of equity by refinancing their houses, and hence, did not significantly respond to LSAP policy shocks.

Panel A of Figure 1 shows the median house price index for the states for which the absolute change in house price index between 2007Q1 - 2008Q4 is higher than the median house price growth during the period 2004Q1 - 2006Q4. The shaded region denotes the period of housing market crash considered for the classification of severely affected states. The solid line is the median house price index for four most severely affected states, while the dashed line is for next five severely affected states. Panel B shows the cash refinances as a proportion of total refinances in the above nine states.<sup>12</sup> The vertical lines mark the four major LSAP announcements. Cash refinances accounted for approximately 85% of all refinances in the severely affected states at the peak of housing market boom. This suggests that households prefer to extract home equity when the equity is significantly high. These states also dominated other states in equity extraction. However, the housing market crash of 2008 reduced the proportion of cash refinances in these states below the level of relatively less affected states. The variation in proportion of cash refinances shed light on the role of home equity in homeowners' level of disposable income from refinancing mortgages.

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<sup>12</sup>The data from Freddie Mac only includes fixed rate mortgages for which the benefit from lower rates crucially depends on the household's ability to refinance. The data only includes mortgages on owner occupied houses.

Figure 1



(a) Median house price index

(b) Proportion of cash refinances

*Note:* Panel A shows the house price index measured by FHFA for states with house price crash between the period 2007Q1 - 2008Q4 greater than median house price growth during the period 2004Q1 - 2005Q4. The solid line denotes the median price in four most severely affected states: Arizona, California, Florida and Nevada. The dashed line denotes the median price for the remaining, less affected, states. The shaded area denotes the period of house price collapse, 2007q1-2009q1. Panel B shows the ratio of total cash refinances to total refinances from Freddie Mac's single family loan level dataset for severely and less affected states.

As shown by Figure 1, the gain in transitory income from refinancing after the housing market crash is much lower for all mortgage owners but is particularly low for homeowners in the four most severely affected states. Data from Freddie Mac's annual report on cash-out refinance supports this argument.<sup>13</sup> As recorded, the annual home equity cashed out in the U.S., at the peak of housing price boom in 2006 was \$320.5 billion (30% of all refinancing volume) while that in 2008 was only \$95.7 billion, a decrease of over \$200 billion. Although the report does not provide state level data, Figure 1 suggests that the decrease in volume is likely driven by states most severely hit by the housing market crash.

In this section, I study the average consumption response of homeowners in states severely hit by the housing market crash and those less severely affected to the LSAP shocks. Table 6 shows the response of homeowners who refinance their mortgages and their differential response versus homeowners who do not refinance, and renters, following a LSAP policy shock. The sample period for the analysis is restricted to 2007Q1 - 2018Q2 to capture the effect of housing market crash on consumption effects of refinancing. Columns (1), (2), and

<sup>13</sup>Current and past reports can be downloaded at: <http://www.freddiemac.com/research/datasets/refinance-stats/archive.page>

(3) show the response of states classified as severely affected states and columns (4), (5), and (6) show the response of less severely affected states. All regressions include month and year fixed effects and the dummy variable for NBER recession dates. The policy shocks are standardized to capture the effect of one standard deviation expansionary shock.

The results in Table 6 highlight the regional heterogeneity in consumption response to unconventional policy shocks. Column (1) shows that the average consumption response of households in severely affected states is small. Although the difference in consumption of households who refinanced relative those who did not refinance or households which are renters, is positive, the coefficients are statistically insignificant. On the other hand, consumption of homeowners who refinanced their loan in less severely affected states responded significantly to LSAP shocks. The difference in average consumption for homeowners who refinanced is also much higher than households falling in other two categories. On average, homeowners who refinanced their mortgages increased their consumption by 3% more than homeowners who did not refinance, and renters. With average household consumption expenditure of \$10,000 in the CEX data, the result suggests that homeowners who refinanced increased their consumption by \$300 following a LSAP shock in the previous quarter. Although, the difference in consumption across household types becomes insignificant for longer lags of LSAP shocks, the positive effect on consumption for those who refinance remains positive and significant at 10% significance level. The effects are robust to inclusion of control variables and state fixed effects.

Overall, the result suggests that LSAP shocks are highly effective in stimulating consumption in states that were not severely hit by the housing market crash. The result is not driven by the variation in cost of refinancing faced by homeowners as the mortgage rates do not vary with local economic activity across different states in the U.S. (Beraja et al. (2019), Hurst et al. (2016)). Table 6 suggests that the unconventional monetary policy was unable to stimulate refinancing activity in worst hit regions resulting in lower growth in household consumption. A large proportion of homeowners in these states faced low or negative home equity and could not take advantage of the falling mortgage rates, reducing their capacity to gain from the policy shocks. The LSAP shocks thus, aggravated the regional inequality in consumption which resulted from the housing market crash.



Table 6: Differential effect of LSAP shock on consumption growth by severity of housing market crash

Dep. Var: $\Delta \log C_{h,t}$		Severely Affected States			Less Severely Affected States		
		(1)	(2)	(3)	(4)	(5)	(6)
LSAP <sub>t-1</sub>	Refinance their Loan	2.23 (1.99)	2.31 (2)	2.23 (1.977)	3.49*** (1.176)	3.27*** (1.226)	3.24*** (1.219)
	Refinance - Do not Refinance	1.5 (2)	1.34 (2.004)	1.24 (1.97)	3.16*** (1.209)	2.89** (1.249)	2.87** (1.237)
	Refinance - Renters	1.63 (1.84)	1.49 (1.794)	1.41 (1.758)	3.12*** (1.189)	2.98** (1.245)	2.96** (1.236)
LSAP <sub>t-2</sub>	Refinance their Loan	1.12 (2.733)	1.33 (2.602)	1.25 (2.562)	0.77 (1.318)	0.43 (1.286)	0.44 (1.288)
	Refinance - Do not Refinance	-0.31 (2.56)	-0.29 (2.435)	-0.39 (2.406)	0.04 (1.224)	-0.33 (1.2)	-0.32 (1.198)
	Refinance - Renters	0.07 (3.128)	0.14 (3.002)	0.06 (2.967)	-0.08 (1.303)	-0.36 (1.298)	-0.36 (1.297)
LSAP <sub>t-3</sub>	Refinance their Loan	3.42 (3.058)	3.33 (2.801)	3.37 (2.822)	3.08* (1.734)	2.72 (1.743)	2.71 (1.74)
	Refinance - Do not Refinance	1 (2.881)	0.88 (2.77)	0.89 (2.783)	2.4 (1.57)	2.19 (1.534)	2.18 (1.525)
	Refinance - Renters	0.97 (2.798)	0.94 (2.788)	0.96 (2.792)	1.25 (1.721)	1.06 (1.71)	1.04 (1.701)
Controls		✓	✓		✓	✓	
State FE	✓		✓	✓		✓	
Month and year FE	✓	✓	✓	✓	✓	✓	
Recession dummy	✓	✓	✓	✓	✓	✓	
Obs		32,825	32,550	32,550	114,854	113,130	113,130

*Note:* The table shows the consumption response of households who refinance their loan and the differential response against households who do not refinance, and renters, to a lagged one standard deviation expansionary LSAP shock. The sample period is restricted to 2007Q1 to 2018Q2. There are 4 states identified as severely affected states- California, Arizona, Florida and Nevada. Loan adjustment is a categorical variable which divides households into households who own a home and adjust loan, households who own a home and do not adjust, and households who rent a home. The base category for loan adjustment variable is households who own a home and adjust loan. All regressions include twelve lags of the monetary policy shocks. All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-values are calculated using delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.

## IV.B Forward Guidance policy shocks

The effect of Forward Guidance shock on household consumption and its channel of transmission is relatively ambiguous. Table 4 shows that over the period of 1996Q1 - 2018Q2, Forward Guidance shock has negative and weakly significant effect on consumption for shorter lags and a positive but insignificant effect for longer lags. In this section, I run the baseline specification for Forward Guidance shock for the period of 1996Q1 - 2007Q4. This shorter sample measures the effect of forward guidance before the financial crisis. The results are presented in Table 7.

Across all specifications, Forward Guidance shocks do not significantly affect consumption at the shorter horizon. Consumption responds significantly to shocks on the medium horizon and the response dies down for longer horizons. More specifically, the cumulative impact of four quarters of one standard deviation Forward Guidance shock one year ago on consumption growth of households today is 2-4% on average. There is no significant difference in growth in consumption response across household categories.

The effect of Forward Guidance shock on household consumption growth during the period of Great Recession is largely insignificant (Table 7). One potential explanation for the result is the relative effectiveness of LSAP shocks in influencing bank lending during the financial crisis. Rodnyansky and Darmouni (2017) show that the LSAP measures targeting mortgage backed securities resulted in an aggressive increase in bank lending. The large effect of the Fed's LSAP program on long term rates potentially overshadowed the impact of Forward Guidance, thus weakening the refinancing channel of transmission of Forward Guidance shocks.<sup>14</sup>

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<sup>14</sup>See Gagnon et al. (2011).

Table 7: Differential effect of Forward Guidance shock on consumption growth

Dep. Var: $\Delta \log C_{h,t}$		(1)	(2)	(3)
1st year impact	Refinance their Loan	-1.38 (2.07)	-0.79 (2.093)	-0.8 (2.091)
	Refinance - Do not Refinance	-0.01 (1.774)	-0.14 (1.797)	-0.12 (1.792)
	Refinance - Renters	0.84 (1.843)	0.68 (1.868)	0.69 (1.862)
2nd year impact	Refinance their Loan	3.03* (1.662)	3.24* (1.7)	3.23* (1.7)
	Refinance - Do not Refinance	0.73 (1.236)	0.64 (1.301)	0.63 (1.305)
	Refinance - Renters	0.7 (1.242)	0.59 (1.326)	0.59 (1.332)
3rd year impact	Refinance their Loan	0.4 (1.51)	0.45 (1.644)	0.46 (1.645)
	Refinance - Do not Refinance	-0.81 (1.525)	-1 (1.596)	-1 (1.594)
	Refinance - Renters	-0.34 (1.637)	-0.62 (1.737)	-0.62 (1.735)
Controls		✓	✓	
State FE	✓		✓	
Month and year FE	✓	✓	✓	
Recession dummy	✓	✓	✓	
Obs	177,447	172,504	172,504	

*Note:* The table shows the consumption response of households who refinance their loan and the differential response against households who do not refinance, and renters, to a lagged one standard deviation expansionary LSAP shock. The sample period is restricted to 1996Q1 - 2008Q4. Loan adjustment is a categorical variable which divides households into households who own a home and adjust loan, households who own a home and do not adjust, and households who rent a home. The base category for loan adjustment variable is households who own a home and adjust loan. All regressions include twelve lags of the monetary policy shocks. All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-values are calculated using delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.

## V. Conclusion

In this paper, I find that the Fed's influence on the housing loan market through the LSAP policies, in particular, increases aggregate consumption. The effect is more pronounced for households who directly benefit from the low rates by refinancing their home mortgages. An expansionary monetary policy lowers mortgage rates and allows homeowners to extract home equity via refinancing, resulting in higher disposable income. Higher disposable income converts into higher consumption for debt constrained households relative to homeowners who do not refinance, and households who do not own a house.

This differential response of household consumption is dependent on the local housing conditions. Homeowners in states with severe crash in housing prices during the 2008 recession were constrained by their low or negative home equity. Thus, their capacity to refinance and extract home equity was limited by the floored prices in their region. This is reflected in the positive but insignificant response of average consumption to monetary policy in distressed states. However, households in less distressed states could successfully refinance their mortgages following a monetary policy shock, and thus, increased their consumption on average. The result for LSAP policy shocks is robust to alternative data adjustments and consumption measures. Lastly, the Fed's policy of Forward Guidance is effective at stimulating consumption with approximately a one year lag. The policy's influence on household consumption growth during the period of financial crisis is, however, ambiguous.

The result shows that heterogeneities across households and regions significantly affect the transmission of monetary policy to real economy. An emphasis solely on aggregate measures of monetary policy can overlook these effects and result in exacerbating inequality. The evidence in the paper highlights the importance of incorporating heterogeneous agents in theoretical models studying monetary policy.

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# Appendix

## A. Consumer Expenditure Survey (BLS)

I use the Consumer Expenditure Survey (CEX) dataset published by Bureau of Labor Statistics (BLS). The survey is conducted quarterly, with data on a rich set of variables on household level expenditure, income and individual level demographics. I use the interview dataset from 1996 Q1 to 2018 Q2, downloaded from the BLS website.<sup>15</sup> A household in the data is surveyed for at most 4 quarters and only once per quarter. The information on household level income and expenditure is recorded in FMLI datafile along with demographic characteristics such as age of head of household and spouse, number of household members, housing tenure, etc. Each household can be identified using a unique ID recorded under the variable NEWID after removing the last digit.

**A.1 Data Adjustments:** I make the following adjustments to the CEX data largely consistent with Coibion et al. (2017) and Wong (2021):

1. The CEX data records data with 1 quarter lag and needs to be adjusted. For example, data recorded for April of year 2015 till March of 2016 is adjusted to be data for the financial year 2015 following Krueger and Perri (2006).
2. Keep only households where the age of head of the household is between 25 and 75 years (inclusive).
3. Drop households with tenure status recorded as student housing or occupied without payment of cash rent.
4. Drop households with zero food expenditure in all quarters.
5. Drop all observations with missing state IDs.

Other than the above adjustments, I also adjust the data on food, tobacco and utility expenditure of households which were first interviewed in February and March and thus report expenditures for less than 3 months in the first calendar quarter. For these households, I impute the data for the first quarter but proportionally increase the reported expenditure. For example, a household first interviewed in February of 2010 has data for November and December of 2009 but not October. I impute the food expenditure for October as half of the total food expenditure for November and December of the household. The imputation is crucial to avoid under-estimating the consumption expenditure for households first interviewed in second and third month of a quarter. The imputation affects 20% of the total observations. In Appendix B.3, I show the results after dropping these observations. In the main analysis,

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<sup>15</sup>Link: [https://www.bls.gov/cex/pumd\\_data.htm](https://www.bls.gov/cex/pumd_data.htm)



I retain all households interviewed for at least two quarters. However in appendix B.4, I show that the results are robust to excluding all households interviewed for less than four quarters.

I define expenditure categories with their CPI deflators, as follows:<sup>16</sup>

Table A1: Table recording expenditure categories and CPI series used to deflate it.

Category	Variable	CPI Category
<b>Non-durable Expenditure</b>		
Food Alcoholic Beverages Tobacco Gas and Motor Oil Apparel	food alcbbev tobacc gasmot appar	Food Alcoholic Beverages Tobacco and Smoking Products Motor Fuels Apparel
<b>Durable Expenditure</b>		
Household Furnishings and Equipments Purchase of vehicles Miscellaneous Household and Expenditures TV, Radio and Sound Equipment	houseq evehpur miscq tvradio	Household Furnishings and Operations New Motor Vehicles Household Furnishings and Operations Recreation
<b>Service Expenditure</b>		
Household Utilities Household Operations Recreational Services Public Transportation Personal Care Services Health Care Education Entertainment Reading	util housop misc1 pubtra persca health educa entert read	Fuels and utilities Household Furnishings and Operations Miscellaneous Personal Services Public Transportation Personal Care Medical Care Tuition Expenditures Recreation Recreational Reading Material

<sup>16</sup>All CPI data is monthly, city average for all urban consumers with base year 1982-84, not seasonally adjusted.

**A.2 Mortgage Adjustments:** To identify households who refinanced their loans in the data, I use the detailed expenditure file on Owned Living Quarters and Other Owned Real Estate - Mortgages. CEX records existing mortgages which were changed due to refinancing under the variable “qnewdate” as a new loan date, while the variable “qrfindat” records changes for all other reasons. To capture the heterogeneity in policy transmission effectively, I keep values for only owner occupied houses (recorded by the house type code 100). I also drop bottom 1% of households by mortgage amount similar to Wong (2021). I create a binary variable to identify homeowners who adjusted loan. The variable equals one if the date of loan change is same as the current date and zero otherwise. The variable “qnewdate” can have an entry for reasons other than refinancing, like cash out refinancing, CEX does not have sufficient details to separate these and so I do not distinguish between all types of refinancing in the analysis.

## B. Robustness

**B.1 Re-categorizing severely affected states:** In this section, I check the robustness of my results by the prime effect category in table 5. I change my measure of states who were severely affected by the crisis by redefining the cut off for categorization. I take house price change in all states during the period 2004Q1-2005Q4 and take the median change in house prices as the new cut-off. I then find change in house prices in all states between 2007Q1 - 2008Q4 and classify all states above the cut-off as states that were severely affected by the housing crisis. There are 9 states that now fall into the severely affected category- Arizona, California, Florida, Maryland, Michigan, Minnesota, Nevada, Oregon and Virginia.

Table B1 shows the result from equation 1 with the revised definition for severely affected states. Columns (1), (2), and (3) correspond to the differential effect of a one standard deviation expansionary LSAP shock to households in severely affected states. I find that homeowners in these states do not respond with higher consumption to the unconventional policy shocks. Columns (4), (5), and (6) show results for all other states. Homeowners in these states, who do not adjust loan, consume approximately 1.5% less than homeowners who adjust loan, in response to a one standard deviation LSAP shock in the previous quarter. These households also consume 2.8% less than households who adjust loan in response to a LSAP shock two quarters ago. The average consumption response of all households in states which were not severely affected is also higher and significant than the response of household consumption in states which were severely affected. On average, an household in the less affected states increased their consumption 1.46% in response to a one standard deviation expansionary LSAP shock last quarter and 2% higher in response to the LSAP shock two quarters ago (in column (5)).

The results in Table B1 shows that the differential effect on households across the two categories of states is robust to changes in the definition of the categorization.

Table B1:  
Heterogeneous response of household consumption in severely affected states vs all other states

Dep. Var: $\Delta \log C_{h,t}$		Severely Affected States			Less Affected States		
		(4)	(5)	(6)	(1)	(2)	(3)
LSAP <sub>t-1</sub>	Refinance	2.78*	2.39	2.36	3.29***	3.23**	3.2**
		(1.638)	(1.655)	(1.641)	(1.28)	(1.359)	(1.352)
	Refinance - Do not Refinance	2.38	2.07	2.03	3**	2.8**	2.79**
		(1.736)	(1.747)	(1.735)	(1.314)	(1.366)	(1.354)
	Refinance - Renters	2.4	2.04	2.02	2.97**	3**	2.94**
		(1.614)	(1.587)	(1.576)	(1.311)	(1.384)	(1.374)
Controls		✓	✓		✓	✓	
State FE	✓		✓	✓		✓	
Month and Year FE	✓	✓	✓	✓	✓	✓	
Recession dummy variable	✓	✓	✓	✓	✓	✓	
Obs		50,400	49,754	49,754	97,279	95,926	95,926

*Note:* The table shows differential response of households who adjust loan and who do not adjust loan to a lagged one standard deviation expansionary monetary policy shock for the period 2007Q1 to 2018Q2. There are 9 states identified as severely affected states- California, Arizona, Florida, Nevada, Maryland, Michigan, Minnesota, Oregon and Virginia. Loan adjustment is a categorical variable which divides households into households who own a home and adjusts loan, households who own a home and do not adjust, and households who rent a home. The base category for loan adjustment variable is households who own a home and adjust loan. I include twelve lags of the monetary policy shocks. Results from longer lags decreases in significance. All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-values are calculated using the delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.

**B.2 Without data imputation:** Table B2 shows the result for Table 6 without the data imputations for food, tobacco and utilities as described in Appendix A.1. Homeowners who refinance in severely affected states do not respond significantly to LSAP shocks. On the other hand, homeowners who refinance following a LSAP shock in less affected states increase their consumption by approximately 3.5% following a LSAP shock.

Table B2:

Heterogeneous response of household consumption in severely affected states vs all other states

Dep. Var: $\Delta \log C_{h,t}$		SeverelyAffected States			Less Affected States		
		(4)	(5)	(6)	(1)	(2)	(3)
LSAP <sub>t-1</sub>	Refinance	2.85 (2.931)	2.94 (3.108)	2.89 (3.083)	3.9*** (1.317)	3.56*** (1.377)	3.54*** (1.373)
	Refinance - Do not Refinance	2.15 (2.746)	2.06 (2.902)	1.98 (2.874)	3.67*** (1.375)	3.29** (1.402)	3.27** (1.394)
	Refinance - Renters	2.1 (2.7)	2.11 (2.813)	2.05 (2.784)	3.37** (1.325)	3.22** (1.392)	3.2** (1.385)
Controls		✓	✓		✓	✓	
State FE		✓		✓	✓	✓	
Month and Year FE		✓	✓	✓	✓	✓	
Recession dummy variable		✓	✓	✓	✓	✓	
Obs		32,825	32,550	32,550	114,854	113,130	113,130

*Note:* The table shows the consumption response of households who refinance their loan and the differential response against households who do not refinance and renters to a lagged one standard deviation expansionary LSAP shock. The sample period is restricted to 2007Q1 to 2018Q2. There are 4 states identified as severely affected states- California, Arizona, Florida and Nevada. Loan adjustment is a categorical variable which divides households into households who own a home and adjust loan, households who own a home and do not adjust, and households who rent a home. The base category for loan adjustment variable is households who own a home and adjust loan. The regression includes twelve lags of the monetary policy shocks. Result for longer lags decreases in significance. All observations are weighted by the sample weights calculated by BLS. Standard errors are clustered at the state level. P-value is calculated using delta method. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level respectively.

## C. Result for control variables

The table below shows the results for control variables for the regression in Table 5, 6 and 7 with all the fixed effects. The direction and significance of coefficients are similar across regressions. Household consumption growth is 11% higher on average for households with bigger family size, and 1.8% higher for households with at least one vehicle. Consumption growth also responds negatively and significantly to local change in unemployment rate, and the response is even larger for households in severely affected states. If unemployment rate increase by 1%, household consumption growth decreases by 1.3% on average in less affected states, and 3% in severely affected states. The response to growth in regional house prices is largely insignificant.

Table C1

Dep. Var: $\Delta \log C_{h,t}$	Table 5	Table 6		Table 7
	(1)	Severely Affected States (2)	Less Affected States (3)	(4)
Age	-0.32*** (0.069)	-0.29 (0.216)	-0.33*** (0.069)	-0.18** (0.072)
Age <sup>2</sup>	0.004*** (0.001)	0.004 (0.003)	0.003*** (0.001)	0.002*** (0.001)
$\Delta$ Family Size	10.5*** (1.143)	11* (4.094)	10.34*** (1.108)	7.52*** (0.702)
$\Delta$ Unemp <sub>state</sub>	-1.32** (0.559)	-3.19** (0.781)	-1.26* (0.72)	0.59 (0.53)
$\Delta$ HP <sub>state</sub>	-0.86 (0.531)	0.012 (0.806)	-1.21** (0.451)	-0.611 (0.472)
No. of vehicles	1.75*** (0.177)	1.42* (0.524)	1.84*** (0.171)	1.85*** (0.158)
State FE	✓	✓	✓	✓
Month and Year FE	✓	✓	✓	✓
Recession dummy variable	✓	✓	✓	✓

*Note:* The table shows the result for non-dummy variables for Table 5, 6 and 7. The sample period for Columns (1), (2), and (3) is 2007Q1 - 2018Q4. The sample period for Column(4) is 1996Q1 - 2008Q4. There are 4 states identified as severely affected states- California, Arizona, Florida, Nevada. The less severely affected states include all other states. Using the OECD scale, the family size of a household is calculated as: (head of household) + 0.7\*(number of 18 years old or older - 1) + 0.5\*(number of children).  $\Delta$  Unemp<sub>state</sub> is the quarterly change in state's unemployment level.  $\Delta$  HP<sub>state</sub> is the quarterly change in house price index at the state level. All observations are weighted by the sample weights calculated by BLS. P-values are calculated using delta method. Standard errors are clustered at the state level. \*, \*\*, and \*\*\* indicate significance at 10%, 5% and 1% significance level.