Non-durable Consumption and Housing Net Worth in the Great Recession: Evidence from Easily Accessible Data*

Greg Kaplan Kurt Mitman Giovanni L. Violante

April 30, 2016

Abstract

In an influential paper, Mian, Rao, and Sufi (2013) exploit geographic variation in housing supply elasticities to measure the effect of changes in the housing share of net worth on total household expenditures during the Great Recession. Their widely-cited estimates are based on proprietary house price data, and use new vehicle registrations as the main proxy for total spending. We revisit their study using different, publicly available data on house prices, and an easily-accessible proxy for expenditures in *non-durable* goods. We re-affirm their findings in our data, and refine their analysis in several dimensions: (i) we separate the roles of falling house prices and initial leverage; (ii) we distinguish the effects on real consumption versus nominal expenditures; and (iii) we infer the implied elasticity of total non-durable expenditures in goods and services to housing net worth.

JEL Codes: E21, E32, R21.

Keywords: Non-durable Expenditures, House Prices, Consumption, Great Recession.

*Kaplan: Princeton University and NBER, e-mail `gkaplan@princeton.edu`; Mitman: IIES and CEPR, e-mail `kurt.mitman@iies.su.se`; Violante: New York University, CEPR and NBER, e-mail `glv2@nyu.edu`.

1 Introduction

One of the most distinctive features of the Great Recession was that the drop in household consumption expenditures was sharper, broader and more persistent than in other recent downturns. Unlike in past recessions, virtually all components of consumption expenditures, not just durables, dropped substantially (Petev, Pistaferri, and Eksten, 2012). The leading explanation for these atypical aggregate consumption dynamics is the simultaneous extraordinary destruction of housing net worth: most aggregate house price indexes show a decline of around 30 percent over this period, and only a partial recovery towards trend since.

To what extent is the plunge in housing wealth responsible for the decline in the consumption expenditures of US households during the Great Recession? A reliable answer to this question is helpful in shaping the way that economists think about key issues such as consumption insurance, the sources of aggregate fluctuations, and the role of policy in mitigating the costs of business cycles.

In a widely influential paper, Mian et al. (2013) — hereafter referred to as MRS — exploit geographic variation in house price declines over the period 2006-2009 and household balance sheets in 2006, to estimate the elasticity of consumption expenditures to changes in the housing share of household net worth. They obtain estimates of this elasticity in the range of 0.6 to 0.8 for total spending (including both durables and non-durables). These estimates come from both OLS regressions, and IV regressions that use the local housing supply elasticity index constructed by Saiz (2010) as a source of exogenous variation in the exposure of different geographical areas to a common aggregate housing shock.[1]

Given the enormous influence that the MRS estimates have had on academia and policy, our first goal in this paper is to address two important limitations of their analysis. First, essentially all of their data come from proprietary sources. This has restricted the possibility for other researchers to replicate their findings and verify the robustness of their estimates.[2]

[1]There is disagreement in the literature about the validity of the Saiz (2010) housing supply elasticities as an instrument for regional differences in house price changes in the context of these regressions (Davidoff, 2013). We are agnostic about this debate since in this note our objective is limited to a replication and robustness analysis of an influential piece of academic research. Readers who are skeptical of the validity of the instrument can safely focus on the OLS estimates —none of our measurements necessarily require a causal interpretation in order to be of economic interest.

[2]There is a growing consensus among economists that transparency of empirical research should be an important goal for the profession, particularly when it concerns high profile, influential and surprising findings. See, for example Cochrane (2015) and Cochrane (2016), as well as Card, Chetty,

Second, the empirical analysis in MRS uses a proxy for total expenditures based on two sources: (i) R.L. Polk new vehicle registrations; and (ii) MasterCard data on credit-card spending from a 5% random sample of the population. It is well known that automobiles purchases are significantly more volatile than purchases of other goods and services, and are fairly unique in their cyclicality. Moreover, since most macroeconomic models are specified in terms of non-durable consumption, the most useful house-price elasticity for parameterizing these models or comparing their implications with data is the elasticity with respect to non-durable consumption alone.

Hence, our first contribution is to verify the robustness of the MRS findings using different data on both expenditures and housing net worth. For non-durable expenditures, we use store-level sales from the Kilts-Nielsen Retail Scanner Dataset (KNRS), a panel dataset of total sales (quantities and prices) at the UPC (barcode) level for around 40,000 geographically dispersed stores in the US. KNRS data are now available in all major universities and research centers. To construct our measure of local housing net worth, we use house price data from Zillow, which is freely available online, whereas MRS use proprietary data from Core Logic.

In spite of these differences, our findings are very reassuring. When we replicate MRS using our own data sources, we obtain an OLS estimate of 0.24 and an IV estimate of 0.36 for the elasticity of non-durable expenditures to housing net worth shocks. Based on Mastercard data on non-durables alone, MRS report OLS estimates of 0.34-0.38. Using the KNRS expenditure data together with a measure of the change in the housing share of net worth provided by MRS, we obtain an OLS estimate of 0.34 and an IV estimate of 0.37 – essentially the same elasticities that MRS find. Our lower baseline estimate can therefore be attributed to our use of Zillow house price data, which show a somewhat different cross-regional pattern of house price growth than the Core Logic house price data. Overall, we find it encouraging that two very different measures of household spending yield such similar elasticity estimates.

After reaffirming the MRS findings with different, easily accessible data on both the main dependent and independent variables, we offer three additional contributions to the academic and policy debate. First, we distinguish the overall elasticity of non-durable expenditures with respect to changes in house prices, from the elasticity with respect to the housing net worth shock that arose from those price changes. This alternative regression specification is useful because (a) it can be more easily compared with previous attempts to estimate the relationship between house prices and con-

Feldstein, and Saez (2010).

sumption; (b) it allows us to test, rather than to impose, that the household balance sheet channel was the most important transmission mechanism during this episode; and (c) it is valuable as a summary statistic that can be used to discipline quantitative structural investigations of the joint dynamics of consumption and housing during the Great Recession.[3] Our main finding is that the interaction between the fall in local house prices and the size of initial leverage has no statistically significant effect on non-durable expenditures, once the direct effect of the fall in local house prices has been controlled for.

Second, we separate the price and quantity components of the fall in nominal consumption expenditures. In the KNRS data, it is possible to observe the quantities of goods sold at the UPC level, together with the corresponding average price for every UPC for every store in every week. This unique feature of these data allows us to distinguish the effect of changes in house prices on the relative price of non-durable goods, from the effect on the quantities of goods purchased and consumed. The first component, as noted by Stroebel and Vavra (2014), can be interpreted as the outcome of demand shocks on local mark-ups. The second component measures the impact of changes in household wealth on the real demand for non-durable goods, including the substitution and income effects that result from the equilibrium change in prices. When we control for these changes in prices, we find an elasticity that is 20% smaller than our baseline estimates for nominal expenditures.

Third, since the KNRS bundle covers only a subset of nondurables and services, a plausible concern is that it is not representative of the reaction of total non-durables to house prices. We use the Diary Survey of the Consumer Expenditure Survey (CE) to estimate the elasticity of total nondurable goods and services to the CE counterpart of expenditures in the KNRS bundle.[4] We obtain an elasticity between 0.7 and 0.9, suggesting that the elasticities we estimated for KNRS expenditures should be reduced by roughly 20% when applied to total non-durable goods and services.

---

[3] A number of recent papers study this topic: see, for example, Berger, Guerrieri, Lorenzoni, and Vavra (2015), Corbae and Quintin (2015) Favilukis, Ludvigson, and Van Nieuwerburgh (2015), Gorea and Midrigan (2015), Hedlund (2014), Huo and Rıos-Rull (2015), Jeske, Krueger, and Mitman (2013), Landvoigt (2015), Kaplan, Mitman, and Violante (2015).

[4] Attanasio, Battistin, and Ichimura (2005) argue that the Diary Survey is the component of the CE where household non-durable expenditures are best measured

Department	All Stores (2006)	Continuing Stores (2006-09)	Baseline OLS Sample
Dry grocery	37%	37%	37%
Frozen foods	8%	8%	8%
Dairy	8%	8%	8%
Deli	2%	2%	2%
Packaged meat	3%	3%	3%
Fresh produce	3%	3%	2%
Non-food grocery	13%	13%	13%
Alcohol	5%	5%	5%
Health and beauty aids	14%	14%	14%
General merchandise	8%	8%	9%
Number of stores	31,093	29,681	14,756

Table 1: Distribution of types of goods sold at stores in the KNRS sample

Notes: The baseline OLS sample restricts attention to continuing stores located in CBSAs for which we have house price data available.

2 Data sources

2.1 Expenditure data

We use data on store-level sales from the Kilts-Nielsen Retail Scanner Dataset (KNRS) as our measure of non-durable expenditures. The KNRS is a weekly panel dataset of total sales at the UPC (barcode) level for around 40,000 geographically dispersed stores in the United States. The survey records both quantities and prices. From this weekly-UPC level data we construct an annual store-level panel of total sales. We also aggregate sales across all stores in each Core-Based Statistical Area (CBSA) to obtain a measure of CBSA-level expenditures.[5]

Table 1 shows the breakdown of goods sold at stores in the KNRS sample by department code in 2006.[6] The KNRS bundle is mostly composed of non-durables and is overweighted in food, but also contains non-food grocery (e.g., detergents and laundry supplies), health and beauty aids (e.g., cosmetics and drugs), and a residual category called general merchandise that includes some small household durables (e.g., cookware, electronics, office supplies).[7]

The types of goods covered by the data is unchanged when we restrict attention to stores present in both 2006 and 2009, and to stores located in CBSAs for which

[5] See `https://en.wikipedia.org/wiki/Core-based_statistical_area` for a definition of a CBSA and its relationship to Metropolitan Statistical Areas (MSA) and Combined Statistical Areas (CSA).

[6] Department code is the first level in the product hierarchy, with UPC being the most detailed level of disaggregation.

[7] Nielsen also collects information on goods that do not have UPCs (known as Magnet data). These goods are excluded from our analysis.

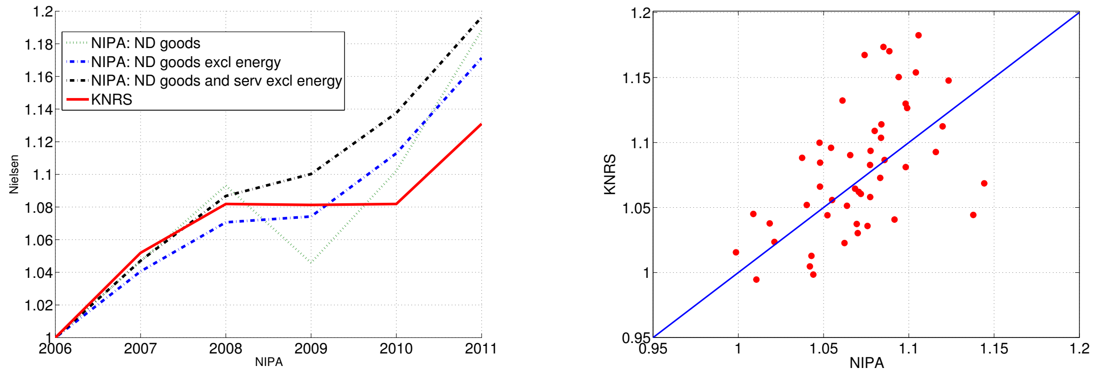

Figure 1: Left panel: Total annual sales for continuing stores in KNRS data vs various definitions of non-durable expenditures in NIPA, all normalized to 1 in 2006. Right panel: 2006-09 state-level sales growth for continuing stores in KNRS vs non-durable expenditures in NIPA

we have data on housing net worth (i.e. the sample used for our baseline estimates). According to the KNRS data manual (Kilts Center for Marketing, 2014), in 2011 the expenditures reflected in the raw data cover 53% of total sales in food, 55% of drugs, 32% of mass merchandise and 1% of liquor.

Retail sales in KNRS are a good proxy for non-durable spending in terms of aggregate time-series variation and geographic cross-sectional variation.[8] The left panel of Figure 1 shows a time-series plot of annual expenditures in the KNRS sample for the subset of stores that are always present in the data, together with various categories of consumption expenditures from the National Income and Product Accounts (NIPA, Table 2.3.5). Between 2006 and 2009, nominal growth in KNRS sales lies between growth in Personal Consumption Expenditures (PCE) in non-durables goods and growth in PCE in non-durables goods and services (excluding gasoline and other energy goods, whose price plummeted in the recession). Growth during 2010-11 is also aligned well with these measures. The only significant discrepancy occurs in 2009-10, when KNRS expenditures are flat whereas NIPA expenditures rise.

The right panel of Figure 1 shows a scatter plot of the state-level 2006-09 change in expenditures in the KNRS data versus the NIPA data (state-level is the finest level of geographic aggregation for expenditure data that is published by NIPA). The correlation of these growth rates is 0.54.

Since we conduct our analysis using store-level changes in sales, we effectively con-

[8]In Section 5, we also show that the KNRS bundle accounts for roughly 40 percent of expenditures in non-durable goods and services.

trol for changes in the composition of stores in a given region across years. None of our findings are affected by restricting attention to stores that are present for all intermediate years. There is still the concern that variation in entry and exit of stores —especially exit, over this recessionary period — differentially affects sales growth of continuing stores across areas and generates an attenuation bias in our estimates. For example, areas with the largest drop in house prices may be those with the sharpest rise in store exit which, in turn, weakens the drop in sales in continuing stores as households shift their shopping towards surviving stores. To verify whether this is a serious concern, we have also repeated our analysis by aggregating store sales at the broader CBSA-level. None of our main results are affected.

2.2 Housing and financial net worth data

The second important variable in our analysis is household net worth, which we construct for the years 2006-2010. We define household net worth in region i at date t as

$$NW_t^i = H_t^i + F_t^i - M_t^i - D_t^i$$

where H_t^i is housing wealth, F_t^i is financial assets, M_t^i is mortgage debt, and D_t^i is non-mortgage household debt.

We now describe the construction of these variables one by one. Each region i is a county, which we later aggregate into CBSAs.

Financial assets: We follow the corresponding calculation in MRS step by step. From the quarterly IRS Statistics of Income (SOI) data, we obtain the fraction of non-wage income (Adjusted Gross Income - wages and salaries) coming from interest and dividends for each county. Next we allocate total financial assets from the Flow of Funds (FoF) Balance Sheet of Households to each county/quarter based on the fraction of interest and dividends in each county/quarter. The implicit assumption is that the representative household in each county/quarter holds the market index for stocks and bonds.

Housing wealth: We compute the total number of houses by county from the American Community Survey (ACS) and generate housing wealth by multiplying them by the Zillow Home Value Index for All Homes. We verify that total housing wealth lines up well with its FoF counterpart for this period.

The Zillow data are publicly available from `http://www.zillow.com/research/data`. In constructing housing wealth, MRS use the Core Logic house price price index, which

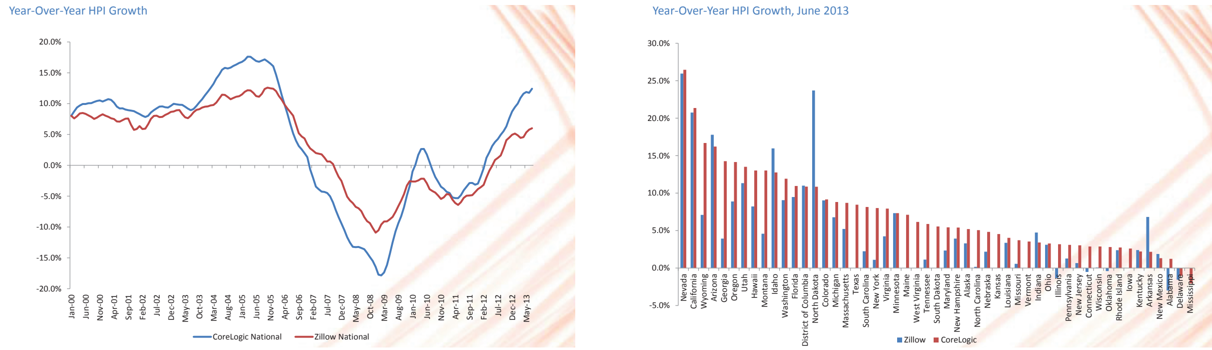

Figure 2: Left panel: Core Logic vs Zillow house price growth, aggregate time series. Right panel: Core Logic vs Zillow house price growth across states, June 2013. Source: Fleming and Humphries (2013)

is based on proprietary data. This is the most important discrepancy between our data sources and those in MRS for the construction of household net worth. The main difference between Core Logic and Zillow is that the former is a repeat-sale index, whereas the latter is a hedonic price index that also includes sales of new homes. There are pros and cons to both approaches, as discussed in Fleming and Humphries (2013). The left panel of Figure 2 shows a strong time-series correlation between the two aggregate house price indexes, although the Core Logic data show both a larger boom and larger bust than the Zillow data. The right panel of Figure 2 shows annual house price growth for selected US states according to the two price series for the year ending 2013. For some areas, there are sizable differences in price growth between the two series.

Liabilities: Our main source of data on household debt by county is the quarterly FRB-NY Consumer Credit Panel (CCP). The underlying source of these latter data is Equifax, which is the data source used by MRS, so this portion of the data construction is also very comparable. The CCP has information on levels of mortgage debt and non-mortgage debt (auto loans and revolving consumer credit) in each county. Since the CCP does not have data on student loans, we do an imputation for each county based on the aggregate fraction of total household debt represented by student loans from the FoF. We then define other debt (D_t^i) as the sum of auto and student loans and revolving consumer credit. Finally, we rescale debt in each county proportionately, so that the total in the CCP in each quarter equals the FoF total household liabilities.

3 Expenditure elasticities to housing net worth shocks

We follow closely the regression specification in MRS. In particular, we define the housing share of net worth as the ratio between housing wealth and household net worth, H_t^i/NW_t^i, and the log-change in this variable between date t and $t+\tau$ induced by changes in house prices – referred to as the 'housing net worth shock' – as $\Delta HNW_{t,t+\tau}^i = \Delta \log p_{t,t+\tau}^i \times (H_t^i/NW_t^i)$.

In our baseline model, we regress the three-year changes in store-level annual sales from 2006 to 2009 on the CBSA-level housing net worth shock over the same time-period. We focus on 2006-09 since this corresponds roughly to the period of the sharpest house price declines (Figure 2), and is the three-year period studied in MRS. However, since Figure 2 also shows that house prices were still rising in early 2006 and still falling in 2010, we also present results for other periods that exclude 2006 and include 2011.

Our OLS regression specification is

$$\Delta \log C_{06-09}^{s,i} = \beta_0 + \beta_1 \Delta \log p_{06-09}^i \left(\frac{H_{06}^i}{NW_{06}^i} \right) + \epsilon_{06-09}^{s,i}. \tag{1}$$

where the dependent variable is sales of KNRS goods in store s in CBSA i. The independent variable is the CBSA-level change in the housing share of net worth induced by changes in local house prices.[9] We weight observations by store-level sales in 2006 (alternative weighting possibilities have little impact on the results), and we cluster by CBSA when computing standard errors.

In the left panel of Figure 3 we show a scatter plot of the change in CBSA-level sales, i.e. $\Delta \log C_{06-09}^i$ where $C^i = \sum_{s \in i} C^{s,i}$, against the CBSA-level change in the housing share of net worth, together with linear and non-linear fitted lines. The size of the circles reflects the weight of each CBSA in the regression. There is a clear positive slope that is strongest in areas which experienced the smallest declines in the housing share of net worth. Among areas with large declines (below -10 pct), there is essentially no relationship between spending and the log-change in the housing share of net worth.

Our IV regressions follow closely the specification in MRS. We use the estimates of housing supply elasticities from Saiz (2010) to instrument for the housing net worth shock. This instrument is provided at the CBSA level, and is not available for all of the CBSA's in which we observe store-level changes in expenditure because not all CBSAs

[9] In Section 4 we consider reasonable alternative ways of constructing the independent variable in this regression.

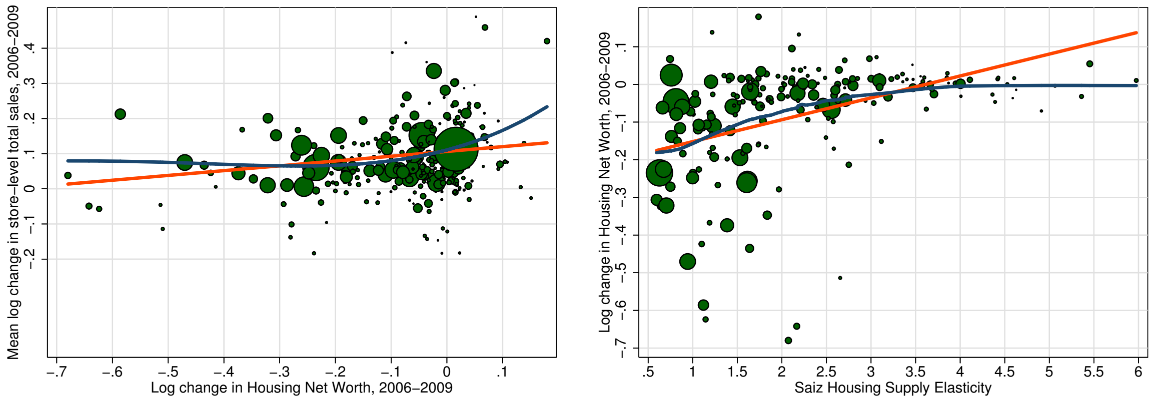

Figure 3: Left panel: Mean log change in store level sales from 2006-2009 versus log change in housing net worth. Right panel: Log change in housing net worth from 2006-2009 versus housing supply elasticity. Linear and non-linear fit lines. Size reflects CBSA-level sales in 2006.

are covered by the Saiz (2010) data. As a result, the OLS and IV samples differ.[10] The right panel of Figure 3 shows a scatter plot of the first stage of this regression, i.e. the change in the CBSA-level housing share of net worth against the Saiz (2010) instrument, together with linear and non-linear fitted lines. The figure is suggestive of a strong first stage, but also reveals a marked degree of non-linearity in the strength of the relationship. In particular, the relationship between changes in the housing share of net worth and the instrument is much stronger among low elasticity areas than among high elasticity areas. Given the poor fit of the linear specification, particularly for high elasticity areas where the reduced form relationship is strongest (Figure 3, right panel), we use a quartic polynomial in the Saiz housing supply elasticity as our instrument. The use of a non-linear first stage represents another difference with MRS, who use a linear first stage, and sharpens the estimates without having a large impact on the value of the coefficients.[11]

Table 2 reports our main results. For the three-year period 2006 to 2009, we obtain a baseline elasticity estimate of 0.24 (0.03) using OLS, and of 0.36 (0.08) using IV (Table 2, first two columns). Both estimates are significant at the 1% level. The corresponding IV estimate with a linear first stage is 0.41 (0.09) (Table 2, third column).

In their Table III, MRS report an estimated elasticity of 0.63 (0.12) using OLS,

[10] This difference in samples has a negligible impact on the estimates.

[11] For all specifications, instrumenting with a quartic polynomial of the elasticity results in uniformly marginally lower IV estimates and smaller standard errors than the corresponding estimates that restrict to a linear first stage.

	2006-09			2006-09		2006-09	
	CBSA			County		CBSA - MRS HNW	
	OLS	IV	IV (linear)	OLS	IV	OLS	IV
ΔHNW^i	0.239**	0.361**	0.405**	0.207**	0.192*	0.341**	0.286**
	(0.029)	(0.077)	(0.089)	(0.025)	(0.080)	(0.047)	(0.116)
N	14,756	12,701	12,701	21,226	16,748	22,945	19,513
Clusters	281	181	181	584	382	330	233
R^2	0.024	0.017	0.012	0.017	0.017	0.019	0.018

Table 2: Elasticity of non-durable expenditures to housing net worth

and of 0.77 (0.24) using IV for their measure of durable spending (vehicle registration). These are larger numbers compared to ours, which is intuitive as durables are much more cyclical. In Table 2 of their Online Appendix not for publication, the authors report elasticity estimates using data on non-durable and services expenditure from MasterCard, a proprietary dataset of purchases using either debit or credit cards that are part of the MasterCard network. This proxy for expenditures is closer to ours and to a representative bundle of non-durable goods.

Their OLS estimates for non-durables vary from 0.34 (0.11) to 0.38 (0.10), depending on the exact definition, and are therefore remarkably similar to ours.[12] One possible concern may be that MRS use county-level data rather than CBSA-level data in these regressions. When we re-estimate (1) using the county-level equivalent of our measure of the housing net worth shock, we obtain an OLS estimate of 0.21 (0.03) and an IV estimate of 0.19 (0.08) (Table 2, fourth and fifth columns). Hence the difference in the level of geographic aggregation has only a minor effect on the OLS estimates. The impact on IV estimates is somewhat larger, but the discrepancy between county- and CBSA-level estimates is not statistically significant.

Although MRS are not able to make their county-level measures of the housing share of net worth available for other researchers due to the proprietary nature of their sources, they do make an analogous CBSA-level measure available that replaces Equifax data for debt with the FRB-NY CCP data (the same source that we use), and replaces Core Logic data on house prices with the house price index produced by the FHFA. When we use this one as our independent variable, we obtain an OLS elasticity estimate of 0.34 (0.05) and IV of 0.29 (0.12) (Table 2, sixth column). It is very reassuring that two completely different sources of data on non-durable expenditures generate essentially identical estimates for the elasticity with respect to changes in the

[12] MRS do not report the IV counterpart of these estimates for non-durable expenditures.

	2006-10		2006-11		2007-09		2007-10		2007-11	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
ΔHNW^i	0.263**	0.455**	0.274**	0.462**	0.208**	0.328**	0.244**	0.458**	0.260**	0.509**
	(0.024)	(0.099)	(0.023)	(0.090)	(0.027)	(0.088)	(0.031)	(0.131)	(0.027)	(0.133)
N	14,536	12,518	14,220	12,231	16,266	13,735	16,032	13,544	15,682	13,226
Clusters	281	181	281	181	338	183	338	183	338	183
R^2	0.028	0.015	0.032	0.021	0.015	0.009	0.02	0.006	0.021	0.005

Table 3: Elasticity of non-durable expenditures to housing net worth in alternative time periods

housing share of net worth, provided that the latter variable is consistently measured.

Our estimates of the elasticity of non-durable spending to changes in the housing share of net worth are relatively insensitive to the particular choice of time period. In Table 3 we report corresponding estimates for alternative time periods around the Great Recession. Since the decline in expenditures typically lagged the fall in house prices, including 2010 and/or 2011 leads to larger estimates (since house prices had mostly leveled off by 2010 but consumption was still declining), and excluding 2006 leads to smaller estimates (since house prices were falling through most of 2006 but the largest declines in consumption were still to come).

4 Expenditure elasticities to house prices

As in MRS, the independent variable in our baseline regression specification (1) is the change in the housing share of net worth induced by the change in house prices, $\Delta \log p^i_{06-09}\left(\frac{H^i_{06}}{NW^i_{06}}\right)$. MRS focus on this specification because they are interested in investigating the strength of a particular transmission mechanism for the effects of changes in house prices on expenditures, the so-called household balance sheet channel. According to this narrative, one would expect two regions experiencing the same size decline in house prices to differ in their expenditure responses depending on how big of an impact the change in house prices has on their net worth.

An alternative interpretation of this same variable is that of an interaction between local house price changes $\Delta \log p^i_{06-09}$ and the initial share of housing in net worth $\frac{H^i_{06}}{NW^i_{06}}$, which is a measure of leverage. We can therefore test for the presence of the

	2006-09					
	OLS	IV	OLS	OLS	OLS	OLS
$\Delta \log p^i$	0.169**	0.260**	0.136*	0.176**	0.119**	0.116**
	(0.020)	(0.057)	(0.057)	(0.067)	(0.031)	(0.029)
$\Delta \log p^i \left(\frac{H^i}{NW^i}\right)$			0.050	-0.014		
			(0.097)	(0.116)		
$\frac{H^i}{NW^i}$				-0.034		
				(0.027)		
$\Delta \log p^i \left(\frac{H^i}{H^i - M^i}\right)$					0.036	0.037*
					(0.019)	(0.017)
$\frac{H^i}{H^i - M^i}$						-0.003
						(0.003)
N	14,756	12,701	14,756	14,756	14,756	14,756
Clusters	281	181	281	281	281	281
R^2	0.026	0.019	0.026	0.026	0.026	0.026

Table 4: Elasticity of non-durable expenditures to house prices: alternative specifications to assess the household balance-sheet channel

housing wealth channel with the following more general specification of the regression:

$$\Delta \log C^{s,i}_{06-09} = \beta_0 + \beta_1 \Delta \log p^i_{06-09} \left(\frac{H^i_{06}}{NW^i_{06}}\right) + \beta_2 \Delta \log p^i_{06-09} + \beta_3 \left(\frac{H^i_{06}}{NW^i_{06}}\right) + \epsilon^{s,i}_{06-09}. \tag{2}$$

The coefficient on the interaction term β_1 measures the extent to which the elasticity with respect to prices depends on the initial housing share of net worth, and so is a test for the presence of a strong household balance sheet channel, over and above the effect of the fall in house prices. The restriction implicit in the MRS specification, i.e. that $\beta_2 = \beta_3 = 0$ (meaning that changes in house prices only impact expenditures through their effect on the housing share of net worth), can then be explicitly evaluated.

In Table 4 we report estimates of alternative specifications based on equation (2). The estimate of the elasticity of non-durable expenditures with respect to house prices, $\hat{\beta}_2$, is 0.17 (0.02) using OLS, and 0.26 (0.06) using IV. Since the housing share of net worth at the CBSA-level is typically far below unity, the elasticities with respect to house prices in the first two columns of Table 4 are necessarily smaller than the elasticities with respect to the house price induced changes in the housing share of net worth in the first two columns of Table 2. When we include the interaction term as

	2006-09			
	OLS	IV	OLS	IV
$\Delta \log H^i$	0.124**	0.183**		
	(0.019)	(0.038)		
$\Delta \log \left(H^i - M^i\right)$			0.072**	0.121**
			(0.011)	(0.025)
N	14,756	12,701	13,724	11,745
Clusters	281	181	229	171
R^2	0.021	0.017	0.021	0.012

Table 5: Elasticity of non-durable expenditures to gross and net housing wealth

an additional regressor, either with or without the initial level of the housing share of net worth, the OLS estimate of β_2 is barely affected while the OLS estimate of β_1 is small and negative, and is statistically indistinguishable from zero (columns 3 and 4). When we instead use a measure of housing leverage ($\frac{H^i}{H^i - M^i}$), the interaction term has the correct sign and is barely statistically significant (columns 5 and 6).[13] In sum, we interpret the results in Table 4 as suggestive of the notion that at least some of the observed co-movement between house prices and non-durable expenditures is due to mechanisms other than the household balance sheet channel.

For completeness, we also report elasticities with respect to gross and net housing wealth directly, rather than to house prices or the housing share of net worth. Future quantitative studies of consumption and housing in the Great Recession may be interested in these elasticities. Which independent variable is most relevant will differ depending on the specifics of the mechanism being investigated.

We report these alternative elasticity measures in Table 5. The estimated elasticities with respect to gross housing wealth H^i are 0.12 (OLS) and 0.18 (IV) (first and second columns). These estimates are lower than the corresponding elasticities with respect to house prices because, during this period, the regions with the largest decline in house prices also had the largest fall in the quantity of housing (through lower investment).

5 Consumption versus expenditures

Our results have so far focused on nominal consumption expenditure. This measure is of first order importance for understanding the transmission of house price shocks to

[13]We report only OLS estimates for the specifications that include both changes in house prices and the interaction between changes in house prices and initial net worth, since estimation by IV would require additional instruments.

	2006-09				2007-11			
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
ΔHNW^i	0.196**	0.290**			0.218**	0.444**		
	(0.026)	(0.085)			(0.027)	(0.135)		
$\Delta \log p^i$			0.140**	0.213**			0.128**	0.261**
			(0.018)	(0.061)			(0.015)	(0.077)
N	14,756	12,701	14,756	12,701	15,682	13,226	15,682	13,226
Clusters	281	181	281	181	338	183	338	183
R^2	0.016	0.012	0.018	0.013	0.013	0.001	0.013	0.002

Table 6: Elasticity of real non-durable consumption to housing net worth shocks

fluctuations in aggregate economic activity. However, it provides an imperfect measure of the change in the real consumption of goods by households (e.g., Aguiar and Hurst (2005) document that changes in food expenditures are not equivalent to changes in food consumption). Since it is real consumption that matters for household welfare, understanding the effect of changes in housing wealth on the quantity of nondurable goods consumed is also of interest.

We construct a series for store-level real sales by aggregating product-level sales (at the bar-code level) using product-level prices common across stores at a fixed date. Our baseline measure uses the 2012 economy-wide average price for each product (or the last year for which we have price data for discontinued products) – and is thus close to a Paasche index – but we have tried various alternative choices and our results are barely affected.[14]

When using consumption as the dependent variable, the elasticity estimates are uniformly around 20% lower than the corresponding estimates in which expenditure is the dependent variable (Table 6). For the 2006-09 period the OLS estimate of the elasticity with respect to the housing net worth shock falls from 0.24 to 0.20, and the IV estimate falls from 0.36 to 0.29. For the elasticity with respect to house prices, the OLS estimate falls from 0.17 to 0.14, and the IV estimate falls from 0.26 to 0.21. For the 2007-11 period the estimates of the elasticity of consumption with respect to the housing net worth shock are 0.22 (OLS) and 0.44 (IV), and with respect to house prices are 0.13 (OLS) and 0.26 (IV).

These findings suggest that a significant portion of the drop in consumption expenditures is due to equilibrium prices falling in response to the negative demand shock.

[14] Our results are not affected by using a weighted (across stores) average price for each product, or by restricting attention to products that are present in every year of the Nielsen data.

This conclusion is in line with the results in Stroebel and Vavra (2014) who argue that a decline in mark-ups is responsible for these price dynamics.

6 From Kilts-Nielsen to total non-durables

A possible concern throughout our empirical analysis is that our measure of household consumption expenditure obtained from the KNRS data may be rather narrow. One may worry that these categories could display different dynamics form total nondurable expenditures. In this section, we use the Consumption Expenditure survey (CE) to estimate the elasticity of total nondurables to a subset of expenditures that is as close as possible to the KNRS bundle. This number can be then used to rescale the various expenditure elasticities to changes in housing net worth estimated in the previous sections. Our aim is to estimate

$$\log c_{it}^{ND} = \mathbf{D}_t + \beta_0' \mathbf{X}_{it} + \beta_1 \log c_{it}^{KN} + \varepsilon_{it}, \tag{3}$$

where $\mathbf{D}_t$ are time dummies, $\mathbf{X}_{it}$ are a set of controls, and c_{it}^{ND} and c_{it}^{KN} are expenditures on non-durables and the KNRS bundle, respectively. The elasticity of interest is β_1.

Our starting point is the sample constructed from the Diary Survey (DS) of the CE by Attanasio et al. (2005).[15] The DS is a cross-section of consumer units asked to self-report their daily purchases for two consecutive one-week periods by means of product-oriented diaries. Each diary is organized by day of purchase and by broad classifications of goods and services. Compared to the more commonly used Interview Survey (IS), where households are retrospectively asked for their usual expenditure in the last quarter, the key advantage of the DS component of the CE is that expenditures on the goods we are interested in –specifically, the KNRS bundle which is the independent variable of regression – are much more accurately measured.[16] This is an important consideration for us, since the attenuation bias from measurement error tends to artificially reduce the estimate of the elasticity of total nondurables to KNRS expenditures, the coefficient β_1 in (3).

The sample in Attanasio et al. (2005) covers a large set of items belonging to nondurable goods and services for survey years 1987-2001, i.e. the period preceding

[15] We refer the reader to their paper for a description of the data. For an ever more detailed presentation, see Battistin (2003). We thank Erich Battistin for sharing the data.

[16] The insight of the Attanasio et al. (2005) paper is precisely that of using the DS measures for frequently purchased goods and the IS measures for more durable goods and services in order to more accurately measure changes in consumption inequality over time.

Dependent variable:	$\log c_{it}^{NDgoods}$	$\log c_{it}^{NDgoods\&serv}$
$\log c_{it}^{KN}$	0.905	0.679
	(0.003)	(0.004)
Other controls	Y	Y
N	37,893	37,893
R^2	0.81	0.54

Table 7: Elasticity of total non-durable expenditures to expenditures in the the KNRS bundle. Source CEX.

the boom-bust. Based on their detailed classification, we define KNRS consumption as the sum of food and non alcoholic beverages at home, alcohol, personal care, and housekeeping products. This definition is close to the aggregate of the items included in the KNRS data described in Section 2. For total non-durables we use two definitions. *ND goods* include, in addition to the KNRS goods, clothing and footware, tobacco, books, newspapers and magazines. This set of goods is close to the NIPA definition of nondurable goods, excluding energy (NIPA Table 2.4.5). The second variable we construct, *ND goods and services,* also includes food away from home, clothing services, entertainment, communication services, and transportation.[17]

In our DS sample, median monthly KNRS expenditures are \$840 and median spending in ND goods (ND goods and services) are \$1,160 (\$2,150). Thus, the fraction of our strict (broad) definition of nondurables accounted for by the KNRS bundle is 72 (39) percent. For comparison, the same calculation from the NIPA Table 2.4.5 for 2000 yields 70 (39) percent.

In the regression (3) we control for year dummies (which capture changes in the relative price of the KN bundle to total nondurables) as well as an equivalence scale, a polynomial in age, and indicator variables for family type, race, education and region. The results of these regressions are displayed in Table 7.

The estimates in Table 7 suggest that the elasticity of nondurable expenditures to the KNRS bundle varies between 0.68 and 0.90, depending on how broad the definition of non-durable expenditures is. Thus the estimates in the preceding sections should be reduced by around 10 to 30 percent when interpreting them in terms of the effects on total non-durable expenditures of consumption.

[17]With respect to the NIPA definition of total services, we therefore exclude expenditures on housing, health care, education, financial and insurance services. As pointed out by Attanasio et al. (2005) and Blundell, Pistaferri, and Preston (2008), these services have a more durable nature that closely assimilates them to investment and saving activities.

7 Conclusions

Transparency in empirical work, and the ability to replicate and verify the robustness of widely influential results should be a pillar of applied economic research.

In this note we have shown that, by combining public and easily accessible data, it is possible, for the first time, to reassess the findings of Mian et al. (2013) — findings that have been instrumental in guiding the academic and policy debate on the role of the collapse of housing in the Great Recession.

Our analysis largely confirms their results, therefore ruling out the possibility that the large co-movement of consumption and house prices in the Great Recession is due to peculiarities of their data sources.

We offer three additional contributions to this debate: (i) after controlling for the drop in house prices, we do not find a significant independent effect of initial leverage on non-durable expenditures, a result that casts some doubts on the balance-sheet channel interpretation of the Great Recession; (ii) real consumption drops approximately 20 percent less than nominal expenditures on the KNRS bundle, implying a sizable demand-induced fall in producer prices; (iii) when applied to total spending in nondurable and services, the estimated elasticity of expenditures on the KNRS bundle to changes in housing net worth should be reduced by roughly 20 percent.

Our preferred specifications (OLS estimates of the elasticity with respect to house prices) suggest that the observed 30 percent decline in house prices during the Great Recession can account for a 4.1% fall in nominal expenditures on nondurable goods and services, and a 2.8% fall in consumption of nondurable goods and services over the period 2006-09, and a 6.2% fall in nominal expenditures on nondurable goods and services, and a 3.1% fall in consumption of nondurable goods and services over the period 2007-11.

References

Aguiar, M. and E. Hurst (2005): "Consumption versus Expenditure," *Journal of Political Economy*, 113, 919–948.

Attanasio, O., E. Battistin, and H. Ichimura (2005): "What Really Happened to Consumption Inequality in the US?" *Hard to Measure Goods and Services: Essays in Honor of Zvi Griliches. Eds: Ernst R. Berndt and Charles R. Hulten. Chicago: University of Chicago Press.*

Battistin, E. (2003): "Errors in Survey Reports of Consumption Expenditures," Working Paper, Institute for Fiscal Studies.

Berger, D., V. Guerrieri, G. Lorenzoni, and J. Vavra (2015): "House Prices and Consumer Spending," Working Paper, National Bureau of Economic Research.

Blundell, R., L. Pistaferri, and I. Preston (2008): "Consumption Inequality and Partial Insurance," *The American Economic Review*, 98, 1887–1921.

Card, D., R. Chetty, M. S. Feldstein, and E. Saez (2010): "Expanding Access to Aministrative Data for Research in the United States," *American Economic Association, Ten Years and Beyond: Economists Answer NSF's Call for Long-Term Research Agendas. Eds: Charles L. Schultze and Daniel H. Newlon. American Economic Association.*

Cochrane, J. (2015): "Secret Data," [Online; posted 28-December-2015].

——— (2016): "Secret Data Encore," [Online; posted 5-January-2016].

Corbae, D. and E. Quintin (2015): ""Leverage and the Foreclosure Crisis." *Journal of Political Economy*, 123, 1–65.

Davidoff, T. (2013): "Supply Elasticity and the Housing Cycle of the 2000s," *Real Estate Economics*, 41, 793–813.

Favilukis, J., S. C. Ludvigson, and S. Van Nieuwerburgh (2015): "The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk-Sharing in General Equilibrium," Working Paper, National Bureau of Economic Research.

Fleming, M. and S. Humphries (2013): "Home Price Indices: Appreciating the Differences," Working Paper, The Urban Institute.

Gorea, D. and V. Midrigan (2015): "Liquidity Constraints in the US Housing Market," Working Paper, NYU.

Hedlund, A. (2014): "The Cyclical Dynamics of Illiquid Housing, Debt, and Foreclosures," Working Paper, University of Missouri.

Huo, Z. and J.-V. Rios-Rull (2015): "Balance Sheet Recessions," Working Paper, Federal Reserve Bank of Minneapolis.

Jeske, K., D. Krueger, and K. Mitman (2013): "Housing, mortgage bailout guarantees and the macro economy," *Journal of Monetary Economics*, 60, 917–935.

Kaplan, G., K. Mitman, and G. L. Violante (2015): "Consumption and House Prices in the Great Recession: Model Meets Evidence," Working Paper, NYU.

Kilts Center for Marketing (2014): "Retail Scanner Dataset Manual," Working Paper, The Kilts Center Archive of The Nielsen Company.

Landvoigt, T. (2015): "Housing Demand during the Boom: The Role of Expectations and Credit Constraints," Working Paper, University of Texas Austin.

Mian, A., K. Rao, and A. Sufi (2013): "Household Balance Sheets, Consumption, and the Economic Slump," *The Quarterly Journal of Economics*, 128, 1687–1726.

Petev, I., L. Pistaferri, and I. S. Eksten (2012): "Consumption and the Great Recession: An Analysis of Trends, Perceptions, and Distributional Effects," *The Great Recession. Ed: David Weimer. NY: Russell Sage.*

Saiz, A. (2010): "The Geographic Determinants of Housing Supply," *The Quarterly Journal of Economics*, 125, 1253–1296.

Stroebel, J. and J. Vavra (2014): "House Prices, Local Demand, and Retail Prices," Working Paper, National Bureau of Economic Research.