DO HOUSEHOLDS WITHDRAW HOME EQUITY FOR CONSUMPTION?

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ABSTRACT

Home equity refinancing played a key role in laying the groundwork for the 2007-2008 financial crisis (Mian and Sufi (2011)). How homeowners spend the money that they withdraw influences how vulnerable they are to financial distress; if the funds go toward consumption instead of reinvestment, household debt increases while assets remain stable. This in turn may have broader financial consequences as the likelihood of mortgage default goes up. However, it is difficult to empirically identify a causal relationship between home equity withdrawal and personal consumption. To address this, I apply an identification strategy using municipal solid waste (MSW) data in a new context. I use two different samples: one of metropolitan statistical areas (MSAs) across the U.S. and another of Florida counties. My results are statistically significant and indicate a positive relationship between house prices and household consumption expenditures, suggesting that if house prices increase by 1%, consumption contemporaneously increases by 0.37% to 0.42%. However, I am unable to confirm a causal relationship. This leaves me to conclude that the increases in consumption and house prices in my sample may be simultaneously driven by some latent factor.

Keywords: *household finance, home equity withdrawal, consumer spending*

1. INTRODUCTION

Home mortgage refinancing has become increasingly common over the past forty years. Survey data collected by the Federal Reserve show that in 1977, only 8% of U.S. homeowners had refinanced their mortgage; this number grew to 20% by 1989 and 47% by 1999 (Brady, Canner, and Maki (2000)). Mian and Sufi (2011) estimate that $1.25 trillion of the rise in U.S. household debt from 2002 to 2006 can be attributed to mortgage refinancing. The relationship between mortgage equity withdrawal (and the corresponding debt increase) and the 2007-2008 financial crisis highlighted the financial risks of mortgage refinancing. Since then, mortgage cash-out refinancing has come under increased scrutiny by researchers.

Mortgage equity withdrawal has important implications in the context of financial crises, depending on how the extracted equity is spent. A first possibility is that homeowners use cash-out refinancing to pay down other loans, invest, or renovate. In this case, mortgage equity withdrawal has no significant net wealth effect on the economy and is no cause for concern. A second possibility is that additional mortgage loans are consumed. This provides a temporary economic stimulus, but simultaneously leaves homeowners with larger mortgage loans and an unchanged ability to pay them down. This makes homeowners more likely to default on their mortgages, should their homes drop in value. As more homeowners default, more houses go on the market, potentially driving down house prices from oversupply and precipitating even more defaults. This means that banks may need to take additional precautions on home mortgage refinancing to prevent this type of spiral effect (such as that leading up to the 2007-2008 financial crisis) and the large losses with which banks are otherwise hit.

In order to identify how homeowners spend withdrawn equity, I tackle the problem by using a novel dataset. Instead of using traditional consumption measures, I follow an approach pioneered by Savov (2011) and use municipal solid waste (MSW), or simply "garbage", to proxy for consumption. He finds that MSW is more volatile and tracks stocks more closely than the National Income and Product Accounts consumption expenditure. As such, MSW is likely to provide a more sensitive measure of consumption than traditional data. I investigate consumption behavior in two samples: one, a collection of the largest U.S. cities with surrounding areas (termed metropolitan statistical areas or MSAs) and another, the counties of Florida. Data on consumption are individually collected online from relevant states' reporting authorities (links are provided at the end of this paper).

I use two different empirical methods. The first is an ordinary least squares (OLS) regression that regresses change in consumption on change in house price (which is meant to capture unobservable mortgage equity withdrawal), controlling for the expected change in income. I use MSW as a proxy for consumption. With this measure, I find statistically significant results showing a positive relationship between house prices and household consumption expenditures, suggesting that a 1% increase in house price corresponds to a consumption increase of 0.37% to 0.42%. In an alternative specification, I use a more traditional measure for consumption, taxable sales, to check if MSW yields similar results. However, taxable sales fail to produce estimates that significantly differ from zero after controlling for income expectations. This seemingly indicates that MSW is a more sensitive measure of consumption than more traditional measures.

The second empirical method that I employ is an instrumental variables (IV) approach. Since some latent factor could simultaneously influence consumption and house prices, the previous result may be spurious. To establish causality, I instrument for the change in house prices using a housing supply elasticity measure developed by Saiz (2010). This measure uses satellite imagery to identify the amount of developable land and, by extension, how quickly housing supply can react to an uptick in demand. Specifically, I replace the previous change in housing prices with that predicted from the housing supply elasticity measure. However, the IV approach generates coefficient estimates which are not significantly different from zero. Thus, the evidence fails to reject that these results are not causal in nature. While house price and consumption (as measured by garbage generated) covary in my sample, the relationship may not be causal and both may instead be driven by some third unknown factor.

The paper is laid out as follows: In *Section 2*, I summarize findings from previous literature on this topic. In *Sections 3* and *4*, I explain and justify the method chosen for analysis and provide details on the data used and their sources. In *Section 5*, results are presented and interpreted in two analyses: *Part A* looks at several MSAs across the U.S. and *Part B* uses data at the county level in Florida. The paper concludes with closing remarks in *Section 6*. *Appendices 1* and *2* provide supplementary information on the data used. Finally, *References* are listed.

2. THEORY AND LITERATURE

Home mortgage refinancing has significant costs to the borrower. These include mortgage fees, application fees, and appraisal fees (Brady, Canner, and Maki (2000)). Bennett, Peach, and Peristiani (1998) estimate these fees at 2% of the mortgage value on average. Given the substantial costs, why would a homeowner choose to renegotiate his house mortgage? Hurst and Stafford (2004) identify two reasons and label these the “financial motivation” and the “consumption-smoothing motivation”.

The financial motivation comes into play when interest rates drop below the original mortgage’s rate. In this case, the discounted savings from lower interest payments outweigh the upfront costs of refinancing. Should the homeowner choose to increase his mortgage amount, he can also borrow money at a lower rate than with personal or credit card loans (Brady, Canner, and Maki (2000)). Mortgage interest payments also distinguish themselves from other loans in that they are tax deductible, providing additional financial incentive to expand the home equity loan.

The consumption-smoothing motivation is not dependent on interest rate declines. Instead, it requires accumulated house value appreciation. In this case, the homeowner cashes out his accumulated home equity and increases his personal consumption. This becomes attractive when he is credit constrained. For example, he may have received news of an income raise, or he could be experiencing unexpected costs (such as being laid off) (Hurst and Stafford (2004)). A lack of self-control, investigated by Laibson (1997), could also motivate homeowners to consume now at future cost. Lustig & Van Nieuwerburgh (2010) document the effect of constrained credit on households, finding that the consumption growth of households with limited collateral is twice as sensitive to income growth as that of unconstrained households. Hurst and Stafford (2004) also find that credit constrained households facing unexpected unemployment are 25% more likely to refinance their mortgage than unconstrained ones.

The real economic effect of home equity withdrawal depends on how the funds are used. If the money goes toward paying down other outstanding loans or making new investments, the net wealth effect will be zero. Mian and Sufi (2011) find no evidence that the proceeds of home equity withdrawal are being used for either. If the funds instead are used for personal consumption, they provide a short-term boost to the economy through increased spending. However, this stimulus is of a temporary nature, only lasting until the funds have been spent.

Moreover, cash-out refinancing makes homeowners increasingly leveraged. That is, home equity extraction increases the mortgage loan size while leaving liquid funds unchanged (as the extracted equity is consumed). This, in turn, leaves them more likely to default in case of unexpected setbacks (Iacoviello (2005)). Almaas et al. (2015) report empirical evidence of financial difficulties among Norwegian homeowners with high mortgage “cash-out-to-income” ratios. Since U.S. mortgages are non-recourse loans, a default makes homeowners more likely to walk away from their mortgage should their house drop in value, in turn weakening the robustness of the real estate market. This may have a broad economic effect due to a subsequent drop in consumption. Bostic, Gabriel, and Painter (2009) predict that a 10% decline in U.S. housing values from 2005 levels would have caused a 1.2% drop in personal consumption expenditures and 1 percentage point decline in real GDP growth.

Estimates for what portion of home equity withdrawal goes toward consumption vary. Brady, Canner, and Maki (2000) collect survey data indicating that in 1998 and early 1999, 39% of U.S. withdrawers used some portion of their loan for personal consumption expenditures. However, the dollar amount of these expenditures only amounted to 18% of the total amount withdrawn. Hurst and Stafford (2004) find that credit constrained households consume 2/3 of their withdrawals, while unconstrained households consume an insignificant portion of these loans. Hatzius (2006) estimates that 50% to 62% of withdrawn mortgage equity is spent on short-term consumption. Greenspan and Kennedy (2008) put this figure at one quarter.

Some studies show that the overall effect of mortgage equity withdrawals on consumption is negligible. Greenspan and Kennedy (2008), for example, find that only 1% of all personal consumption expenditures from 1991 to 2006 can be attributed to cash-out refinancing. However, when viewing the financial effects of home mortgage refinancing, the risk perspective is more salient than a macroeconomic one. My objective is to identify a relationship between house price appreciation and increased household leverage. To this end, I am only interested in cash-out consumption as an indicator of higher household indebtedness. As the buildup to the financial crisis of 2007-2008 showed, such behavior can have far-reaching financial consequences, making this question a pivotal one.

My paper contributes to the existing literature by applying a novel dataset to measure consumption in the context of mortgage equity withdrawal. I follow Savov (2011), who finds that municipal solid waste (MSW) is more volatile and correlates more closely with stocks than traditional consumption measures (in this case, National Income and Product Accounts (NIPA) consumption expenditure). Since MSW is more sensitive to changes in consumption, it should allow me to measure consumption shifts with higher accuracy. Using this improved consumption measure, I hope to be able to: (i) confirm whether a significant proportion of withdrawn home equity is consumed, and (ii) produce my own numerical estimate of this amount.

3. EMPIRICAL STRATEGIES

To examine the relationship between house price increases and consumption, I define the base equation, which regresses change in consumption on the change in house price (which is a proxy for mortgage equity withdrawal) and expected income:

$$\Delta \text{Consumption} = \alpha + \beta * \Delta \text{HPI} + \gamma * \Delta \text{Wage}_{\text{expected}} + \varepsilon \qquad \textit{(Eq. 1)}$$

where *ΔConsumption* is the annual change in per capita consumption, *ΔHPI* is the annual change in house price index, and $\Delta Wage_{expected}$ is the expected annual change in real per capita income. β is my coefficient of interest. I will estimate this equation with a regular OLS regression. As discussed below, I will also apply the IV approach to establish causality between house price increases and consumption. However, *Eq. (1)* has issues that need to be addressed first.

It is hypothetically possible, but practically impossible, to measure *ΔConsumption* directly – doing so would require privately-held local data from a huge number of retail stores, restaurants, etc. Instead, I measure consumption using garbage, as advocated by Savov (2011). Municipal solid waste (MSW) reflects increased household consumption both in disposed packaging (new goods, when purchased, come in various containers) as well as disposed old items (once new goods are bought, the old ones are often thrown away). It consists of "product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries." (US EPA, 2016) To compare the results obtained using MSW with those of more traditional consumption measures, I repeat the analysis using per capita real taxable sales.

$\Delta Wage_{expected}$ is inherently immeasurable, making a proxy necessary. To approximate the expected change in wages, I apply several alternative measures calculated based on per capita real income growth trends. These are used to control for how changing expectations of future income may influence current consumption. I provide more information in *Section 4* and technical definitions in *Appendix 1*.

Since I am unable to observe mortgage equity withdrawals directly, I approximate them using house price growth, following Mian and Sufi (2011). *ΔHPI* is potentially endogenous, however, and may thus yield biased β estimates. Controlling for wage expectations should go some way toward mitigating this bias, but may not eliminate it. Additionally, causality remains an important concern. Several factors may influence consumption and simultaneously affect house prices. For instance, an increase in expected future wages could prompt consumers to spend more on goods and services while also driving up house prices via increased demand. A rosy stock market outlook could have the same effect. If I believe that borrowers are credit constrained, they may not be able to capitalize such future revenue streams, leaving their current consumption unchanged. This would mean that observed consumption increases could be traced to mortgage equity cash-out. However, I do not have enough evidence to make this assumption. As such, to truly isolate the causality of house price change on consumption, I need to find a suitable instrument for growth in home value. The instrument in this case should be correlated with consumption, but only through housing prices and in no other way.

The instrument that I apply is Saiz's (2010) housing supply elasticity proxy, which is also used by Mian and Sufi (2011). The metric uses satellite imagery to approximate an area's geographic potential for housing development (as limited by existing development, bodies of water, inclines, swamps, etc.), which then shows how easy it would be to expand the stock of housing. For areas with a high supply elasticity, shifts in house price should be relatively muted compared to areas with low supply elasticity. With low elasticity, I expect changes in demand to have a more dramatic effect on prices. Instrumenting allows me to establish a causal relationship; since changes in consumption do not influence the area of developable land in the short term, any observed relationship between housing supply elasticity and change in consumption is driven by the elasticity (through house prices) and not the other way around.

With this instrumental variable in mind, I can set up the 2-stage least squares (2SLS) equation as follows:

$$\Delta \text{HPI} = \alpha + \delta^1 * \text{Elasticity} + \delta^2 * \Delta \text{Wage}_{\text{expected}} + \varepsilon \qquad \textit{(Eq. 2)}$$

$$\Delta \text{Consumption} = \alpha + \beta * \widehat{\Delta HPI} + \gamma * \Delta \text{Wage}_{\text{expected}} + \varepsilon \qquad \textit{(Eq. 3)}$$

Where *Elasticity* is the housing supply elasticity measure and $\widehat{\Delta HPI}$ is the predicted year-to-year change in house price index estimated from *Eq. (2)*, and all other variables are defined as before. *Eq. (2)* is the first-stage equation and *Eq. (3)* is the second-stage equation. The 2SLS process is applied to the datasets of U.S. MSAs and Florida counties separately. As previously mentioned, I also run a regular OLS analysis that uses the base equation *Eq. (1)*. This regression is useful for quantifying the relationship between house price changes and consumption changes, but insufficient to establish causality.

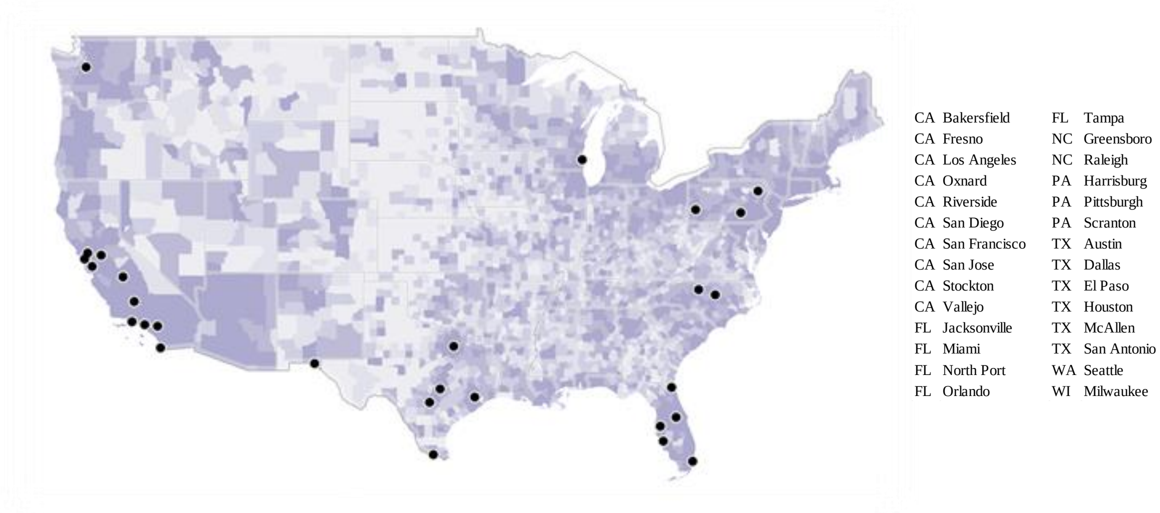
4. DATA: SOURCES AND SUMMARY

I conduct two parallel experiments with different samples: first, data from 66 of the largest U.S. Metropolitan Statistical Areas (MSAs), and second, data from 64 of Florida's 67 counties. The experimental setup will be the same for both groups. The five most important data types in my analysis are municipal solid waste (MSW), taxable sales, house price, house price elasticity, and income. Since I conduct two experiments on different samples, these data come from multiple sources.

County- and MSA-level MSW data are state-specific and are reported by some, but not all, state Environmental Protection Agencies (EPA) or equivalent. All states except for Florida report landfilled amounts, either in tons (mass) or cubic yards (volume). Since landfill data only indicate the ultimate destination of waste, I cannot be certain about its point of origin. However, landfills are common enough around the large MSAs used here so this is unlikely to be problematic. I use per capita figures for MSW and, to make different units comparable, I analyze proportional year-to-year changes. Florida has unique data that specify the MSW county of origin. I find MSW data for 28 MSAs in 7 states (shown in *Figure 1*), as well as 64 Florida counties.

To compare my findings with those generated by a more traditional approach, I also collect sales data individually from each U.S. state's Department of Revenue or equivalent (directly from webpages or via email). While Savov (2011) compares MSW to National Income and Product Accounts (NIPA) personal consumption expenditure data, these are unavailable at a per county-basis and I thus use taxable sales instead. Some states report taxable sales directly, while others allow me to back out a sales figure by dividing the collected sales tax by the sales tax rate. Taxable sales are on a per capita-basis and adjusted for inflation in the same way as wages. Change in taxable sales is calculated from annual percent change to account for level differences between observational units. I use sales tax data from 48 MSAs across 18 states (shown in *Figure 2*). Some MSAs are missing because not all states provide data on county- or MSA-level taxable sales, and many states are missing because they do not contain any of the 95 largest MSAs used by Saiz (2010).

FIGURE 1: NATIONWIDE MSA COLLECTED MSW SAMPLE
MSAs for which collected MSW data are used

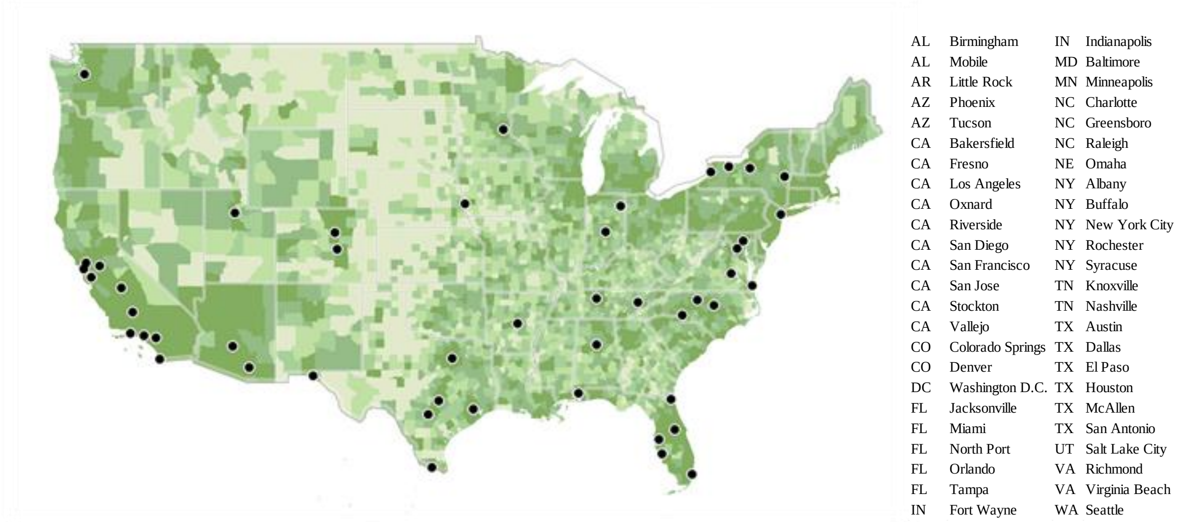


Focal cities are designated by black dots. The shading indicates county population (with darker segments designating highly populated areas) and is included to give context to the distribution of sampled MSAs.

I use two house price indexes (HPIs) for U.S. MSAs and one for Florida counties. The first is the purchase-only index for the 100 largest U.S. MSAs, provided by the Federal Housing Finance Agency (FHFA). This index is estimated based on sales price data and uses 1991 as its base year. There are two versions of the FHFA index: seasonally-adjusted ("SA") and unadjusted ("NSA"). However, since I annualize the data by finding the yearly mean value of the index, seasonality is not an issue. I keep both price indexes for testing, as they produce slightly diverging results. The second MSA-level HPI is the Zillow Home Value Index for all homes, which lists monthly indexed house prices for U.S. MSAs. For Florida counties, I use the median sales price for single-family homes and condominiums from the Florida Housing Data Clearinghouse. Unlike Zillow, the FHDC price index includes all Florida counties.

FIGURE 2: NATIONWIDE MSA TAXABLE SALES SAMPLE

MSAs for which taxable sales data are used



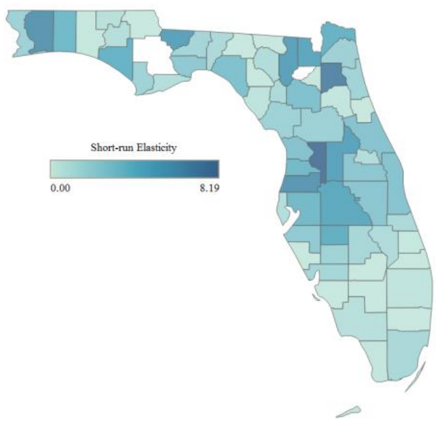
This figure is the same as *Figure 1* but shows MSAs for which taxable sales data have been collected.

To instrument for house price change, I use the housing supply elasticity proxy developed by Saiz (2010), who uses satellite imagery to find the amount of developable land for 95 U.S. MSAs with populations over 500,000. For Florida counties, I use short-run supply elasticity estimates produced by Ihlandfeldt & Mayock (2014), who apply a similar technique to the state's 67 counties (although estimates are only found for 64 of these). Their elasticity estimates are shown with a map overlay in *Figure 3*.

Does housing supply elasticity fulfill the two criteria of a strong instrument? The first is the relevance criterion, which requires that the instrument and instrumented variable covary. As a preliminary test, I map the correlation between housing supply elasticity and the relative change in house price in *Table 1* and *Table 2* for the MSA- and county-level experiments, respectively. The former shows a quite high correlation, especially for the FHFA HPI. Recall that I expect it to be negative: higher supply elasticity should correlate with smaller house price increases. For the MSA-level experiment, this relationship seems to hold. However, the correlation using Ihlandfeldt & Mayock's (2014) elasticity estimates appears to be weak – in most cases it is even positive! Excluding low-population counties only seems to exacerbate the issue, and restricting the sample period has only a minor effect. As such, it is reasonable to expect the standard errors of estimates in the Florida analysis to be high, making it unlikely to find a statistically significant relationship between consumption and changing house prices in the 2SLS regressions for Florida counties. I later confirm this in *Tables 5*, *6*, and *10*.

FIGURE 3: FLORIDA COUNTY ELASTICITY ESTIMATES

Ihlandfeldt & Mayock (2014) housing supply elasticity estimates



Alachua	3.16	Franklin	0.83	Lake	5.14	Pasco	6.06
Baker	4.94	Gadsden	5.33	Lee	0.00	Pinellas	0.84
Bay	4.10	Gilchrist	1.14	Leon	1.50	Polk	4.79
Bradford	0.00	Glades	0.00	Levy	1.76	Putnam	0.29
Brevard	2.84	Gulf	1.73	Madison	0.00	Saint Johns	1.67
Broward	0.01	Hamilton	0.10	Manatee	2.41	Saint Lucie	0.18
Charlotte	1.46	Hardee	4.39	Marion	1.85	Santa Rosa	6.07
Citrus	2.89	Hendry	0.00	Martin	0.00	Sarasota	0.00
Clay	7.12	Hernando	3.66	Miami-Dade	1.27	Seminole	0.87
Collier	0.68	Highlands	1.35	Monroe	0.25	Sumter	8.19
Columbia	5.32	Hillsborough	3.66	Nassau	4.14	Suwannee	0.94
DeSoto	1.73	Holmes	0.64	Okaloosa	3.73	Taylor	3.11
Dixie	0.45	Indian River	1.17	Okeechobee	0.97	Volusia	2.82
Duval	1.86	Jackson	0.00	Orange	2.56	Wakulla	2.47
Escambia	1.78	Jefferson	1.19	Osceola	2.70	Walton	0.15
Flagler	0.00	Lafayette	0.00	Palm Beach	0.35	Washington	0.79

Above, the short-term housing supply elasticity estimates for 64 of Florida's 67 counties are presented. These were provided by Ihlandfeldt & Mayock (2014).

The second instrumentation criterion is the exclusion restriction, which requires that the instrument is unrelated to all other explanatory variables (besides the variable being instrumented for) that may influence the dependent variable (change in consumption). It seems reasonable that housing elasticity supply passes this criterion; I cannot think of a plausible explanation to how housing supply elasticity could influence the change in consumption through any channel other than house price changes. While the house supply elasticity measure could be correlated with the *level* of consumption through channels other than house price (for example, areas with low development potential may be more densely populated and residents of such environments may consume more than those in areas with plenty of room for expansion), this analysis is only concerned with the *change* in consumption.

TABLE 1: NATIONWIDE MSA IV CORRELATION

Correlation of housing supply elasticity and change in house price index

Analysis Sample	ΔHPI (Price)	ΔHPI (Index SA)	ΔHPI (Index NSA)
Taxable Sales	-31.37%	-43.01%	-45.09%
Collected MSW	-28.28%	-45.29%	-48.44%

Above, the correlations of the instrument and instrumented variables are shown. The first column specifies in which sample the correlation is measured, while the second through fourth columns indicate for which variable I instrument: growth in Zillow HPI, growth in FHFA seasonally-adjusted HPI, or growth in FHFI unadjusted HPI. The instrumenting variable is Saiz's MSA housing supply elasticity measure. The sample period is 1999-2006.

TABLE 2: FLORIDA COUNTY IV CORRELATION

Correlation of housing supply elasticity and change in house price index

Filtering Criteria	Counties	Correlation (1997-2006)	Correlation (2002-2006)
None	64	1.23%	-6.10%
Nonzero only	58	2.40%	-4.73%
Nonzero, over 100,000	32	5.75%	0.29%
Nonzero, over 200,000	23	11.43%	5.86%
Nonzero, over 300,000	18	14.38%	10.18%
Nonzero, over 400,000	13	15.96%	11.79%
Nonzero, over 500,000	10	13.28%	7.81%

Shown above is the correlation of the instrumental and instrumented variables for different sample configurations. The sample is filtered along two dimensions: 2012 county population minima and sample time period. Ihlandfeldt & Mayock's (2014) short-term housing supply elasticity measure instruments for the change in FHDC median sales price. "Nonzero" indicates that counties with elasticity estimates of 0.00 are dropped.

To control for expectations of real wage increases, I create four different measures based on per capita personal income as reported by the Bureau of Economic Analysis. These are adjusted for inflation. They differ only in how accurate they consider real wage predictions to be; some are based on future data (implying a high degree of accuracy) while others are based only on historical data (implying that homeowners do not have any more information about future developments than historical trends). The measures are:

(i) Current expectations: the real annual growth rate of the current year t

(ii) Near expectations: the average of real annual growth rates of year t and t+1

(iii) Broad expectations: the average of real annual growth rates of the four years from t-1 to t+2

(iv) Past expectations: the average of real annual growth rates of year t-1 and t

Measures (i) and (iv) assume that homeowners predict their future income growth based on historical and current trends. Measures (ii) and (iii) make a stronger assumption and state that homeowners' wage development expectations turn out to be partially accurate by being based directly on the outcome.

The sample period used depends on the experiment and corresponds to the MSW data. For the national MSA-level experiment, I use the sample period 1999-2006, while the Florida county-level experiment uses 1997-2006. The data are annual. The choice of sample periods has two primary rationales. The first is data availability; sales tax and MSW data are generally not available before the late 1990's. The second, and more important, is to have a sample period with largely monotonic house price increases, as I am interested in how homeowners spend additional funds acquired via mortgage refinancing; home mortgage renegotiations have little relevance for this question in housing market busts.

Summary statistics are shown in *Table 3*. The number of observations depends on the experiment: for nationwide MSAs, 366 observations are available for taxable sales as consumption and 192 for MSW, while for Florida counties this number is 471. The maximum for the change in per capita MSW is quite extreme, likely due to some reporting error; however, the mean value is reasonable. The mean annual change in per capita taxable sales is 6% for the MSA-level analysis and 3% for the county-level analysis. The equivalent figures for mean change in per capita MSW are 3% and 8%. The mean change in house price ranges from 7% to 10% depending on the specific measure and experiment. Finally, expectations of wage growth are around 2%. For more details on the data I use, please refer to *Appendix 1*. Links to all sources are provided in *Appendix 2*.

TABLE 3: SUMMARY STATISTICS

Summary statistics for MSA- and county-level analyses

Nationwide MSAs (per capita sales)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Elasticity	366	1.79	0.98	0.60	5.36
ΔSales	351	0.06	0.37	-0.32	3.33
ΔHPI (Price)	257	0.07	0.07	-0.10	0.25
ΔHPI (Index SA)	335	0.09	0.06	-0.02	0.27
ΔHPI (Index NSA)	365	0.09	0.06	-0.02	0.26
ΔWage (Current)	366	0.02	0.02	-0.06	0.08
ΔWage (Near)	366	0.01	0.01	-0.03	0.05
ΔWage (Far)	366	0.02	0.02	-0.05	0.06
ΔWage (Past)	366	0.02	0.02	-0.05	0.06

Nationwide MSAs (per capita MSW)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Elasticity	192	1.60	0.92	0.60	3.68
ΔMSW	224	0.03	0.15	-0.35	0.65
ΔHPI (Price)	136	0.09	0.07	-0.03	0.25
ΔHPI (Index SA)	192	0.10	0.07	-0.02	0.27
ΔHPI (Index NSA)	224	0.10	0.07	-0.02	0.26
ΔWage (Current)	192	0.02	0.03	-0.06	0.08
ΔWage (Near)	192	0.02	0.01	-0.03	0.05
ΔWage (Far)	192	0.02	0.02	-0.05	0.06
ΔWage (Past)	192	0.02	0.02	-0.05	0.06

Florida counties

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Elasticity	531	2.44	1.96	0.01	8.19
ΔSales	471	0.03	0.14	-0.40	1.60
ΔMSW (SFH)	471	0.08	0.52	-0.87	6.79
ΔHPI	468	0.09	0.12	-0.92	0.87
ΔWage (Current)	568	0.02	0.03	-0.07	0.12
ΔWage (Near)	568	0.02	0.02	-0.03	0.07
ΔWage (Far)	568	0.02	0.02	-0.06	0.10
ΔWage (Past)	568	0.02	0.02	-0.06	0.10

This table provides summary statistics of my three datasets. The first two are different configurations of the MSA-level data, depending on if taxable sales or MSW are used to proxy for consumption (since both data types are not available for all MSAs). The third dataset is from the Florida county-level analysis.

5. RESULTS

A. NATIONWIDE MSA ANALYSIS

For the MSA-level analysis, I regress change in consumption on changes in house price and expected income. I start with the OLS approach of *Eq. (1)* to investigate if there is any relationship between changing house price and changing consumption (whether causal or not). Consumption is approximated using MSW and taxable sales separately. For simplicity, only the “current” wage expectations proxy is used to control for expected income effects. While not repeated here, the inferences are roughly the same for regressions using the other wage expectation measures. The estimates are shown in *Table 4*.

The first six columns of *Table 4* (MSR1-MSR6) show regression estimates when MSW is used to proxy for consumption. $\hat{\beta}$ estimates are positive and statistically significant at the 1% level. A 1% increase in house price corresponds to a per capita waste production uptick of between 0.39% and 0.52%. However, as shown in the table’s second trio of columns (MSR4-6), controlling for the change in expected income lowers the magnitude of the coefficient estimate to 0.37% to 0.39%. This implies that some of the effect previously attributed to the house price change was, in fact, connected to earnings expectations. When taxable sales are used to proxy for consumption (in MSR7-MSR12), I find no significant relationship between *ΔHPI* and *ΔConsumption*. My results suggest that Savov’s (2011) findings hold in this empirical setting as well; MSW captures variation in consumption where traditional measures fail to do so.

Next, I attempt to establish if the relationship between MSW and house price growth shown above is causal. For this, I employ the 2SLS approach and, as discussed above, use Saiz’s (2010) MSA housing supply elasticity to instrument for change in house price. I first present the first-stage results in *Tables 5* and *6* to see if the instrument meets the relevance criterion. Since the samples used for MSW and taxable sales diverge, the first stage varies slightly depending on which consumption proxy is used. However, the conclusions are still the same, showing a strongly negative relationship between change in house price and housing supply elasticity. This result is statistically significant at the 1% level.

TABLE 4: NATIONWIDE MSA OLS RESULTS

OLS regression results, two-tailed hypothesis testing

	(MSA1)	(MSA2)	(MSA3)	(MSA4)	(MSA5)	(MSA6)	(MSA7)	(MSA8)	(MSA9)	(MSA10)	(MSA11)	(MSA12)
VARIABLES	ΔMSW						ΔSales					
ΔHPI (Price) (β)	0.390***			0.371***			28.91			14.50		
	(0.065)			(0.074)			(29.61)			(17.48)		
ΔHPI (Index SA) (β)		0.410***			0.376***			32.35			23.08	
		(0.075)			(0.081)			(32.57)			(24.70)	
ΔHPI (Index NSA) (β)			0.518***			0.392***			30.29			21.52
			(0.114)			(0.078)			(30.35)			(22.90)
ΔWage (Current) (γ)				0.163	0.200	0.195				127.0	80.29	76.97
				(0.202)	(0.171)	(0.181)				(110.3)	(69.07)	(66.20)
Constant	-0.004	-0.009	0.006	-0.005	-0.011	-0.008	1.310	0.0554	0.0637	0.394	-0.388	-0.370
	(0.007)	(0.006)	(0.009)	(0.007)	(0.007)	(0.007)	(0.944)	(0.465)	(0.400)	(0.368)	(0.783)	(0.711)
Observations	292	554	659	292	423	466	546	759	842	546	759	842
R-squared	0.112	0.056	0.021	0.114	0.056	0.058	0.004	0.007	0.006	0.012	0.011	0.010

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This table presents the results from directly regressing the consumption proxy (either change in MSW or change in taxable sales) on change in house price index and expected change in wages. For simplicity, only the "current" income growth expectations are used. Using other expectation mesasures instead yields similar results. The sample tested varies depending on which consumption proxy is used, but always uses MSA-level data.

TABLE 5: NATIONWIDE MSA 2SLS FIRST-STAGE RESULTS (COLLECTED MSW)

First-stage 2SLS regression results with collected MSW as consumption proxy, two-tailed hypothesis testing

	(MSA13)	(MSA14)	(MSA15)	(MSA16)	(MSA17)	(MSA18)	(MSA19)	(MSA20)	(MSA21)	(MSA22)	(MSA23)	(MSA24)
VARIABLES	ΔHPI (Price)				ΔHPI (Index SA)				ΔHPI (Index NSA)			
Elasticity (δ^1)	-0.0273***	-0.0266***	-0.0216***	-0.0267***	-0.0365***	-0.0363***	-0.0339***	-0.0354***	-0.0359***	-0.0360***	-0.0347***	-0.0350***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)	(0.0035)	(0.0035)	(0.0035)	(0.0034)
ΔWage (Current) (δ^2)	0.425**				0.446***				0.449***			
	(0.208)				(0.153)				(0.149)			
ΔWage (Near) (δ^2)		0.555**				0.497***				0.476**		
		(0.248)				(0.187)				(0.185)		
ΔWage (Broad) (δ^2)			1.475***				1.302***				1.247***	
			(0.378)				(0.285)				(0.273)	
ΔWage (Past) (δ^2)				0.526**				0.716***				0.729***
				(0.240)				(0.167)				(0.163)
Constant	0.117***	0.115***	0.0950***	0.114***	0.153***	0.153***	0.138***	0.146***	0.154***	0.154***	0.140***	0.147***
	(0.011)	(0.011)	(0.013)	(0.012)	(0.009)	(0.009)	(0.01)	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)
Observations	136	136	136	136	176	176	176	176	192	192	192	192
R-squared	0.115	0.113	0.154	0.114	0.239	0.231	0.266	0.257	0.272	0.263	0.296	0.291

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Above are the first-stage results from the 2SLS regressions based on *Eq. (2)* . In this sample, I use change in collected garbage as a proxy for change in per capita consumption (this is relevant as the MSW and taxable sales samples encompass have some diverging MSAs). The three different house price indexes are each regressed on the elasticity instrument and wage controls.

TABLE 6: NATIONWIDE MSA 2SLS FIRST-STAGE RESULTS (TAXABLE SALES)

First-stage 2SLS regression results with taxable sales as consumption proxy, two-tailed hypothesis testing

	(MSA25)	(MSA26)	(MSA27)	(MSA28)	(MSA29)	(MSA30)	(MSA31)	(MSA32)	(MSA33)	(MSA34)	(MSA35)	(MSA36)
VARIABLES	ΔHPI (Price)				ΔHPI (Index SA)				ΔHPI (Index NSA)			
Elasticity (δ^1)	-0.0294***	-0.0281***	-0.0247***	-0.0294***	-0.0317***	-0.0312***	-0.0289***	-0.0311***	-0.0283***	-0.0281***	-0.0262***	-0.0275***
	(0.0042)	(0.0042)	(0.0043)	(0.0043)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0024)	(0.0024)	(0.0025)	(0.0024)
ΔWage (Current) (δ^2)	0.483***				0.529***				0.518***			
	(0.156)				(0.126)				(0.121)			
ΔWage (Near) (δ^2)		0.755***				0.668***				0.623***		
		(0.192)				(0.157)				(0.152)		
ΔWage (Broad) (δ^2)			1.575***				1.457***				1.335***	
			(0.298)				(0.238)				(0.225)	
ΔWage (Past) (δ^2)				0.517***				0.749***				0.747***
				(0.182)				(0.138)				(0.134)
Constant	0.109***	0.103***	0.0867***	0.108***	0.136***	0.133***	0.119***	0.130***	0.131***	0.129***	0.117***	0.125***
	(0.008)	(0.008)	(0.0093)	(0.009)	(0.007)	(0.007)	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)
Observations	257	257	257	257	335	335	335	335	365	365	365	365
R-squared	0.135	0.143	0.175	0.128	0.232	0.228	0.260	0.244	0.251	0.245	0.272	0.264

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This table is the same as *Table 5* , but encompasses a slightly different sample as it uses change in taxable sales per capita (instead of change in MSW per capita) as a proxy for change in per capita consumption.

Next, I show the second-stage results in *Tables 7* and *8*. In the former, MSW proxies for consumption, while the latter employs taxable sales as a proxy. I run twelve regressions in each for all combinations of the three house price indexes (HPIs) and the four expected income growth estimates. The first three rows of *Tables 7* and *8* show estimates of $\hat{\beta}$ (the coefficient for the change in house price). The null hypothesis states that this coefficient is equal to zero, i.e. that consumption is unaffected by a change in home value.

As shown in both tables, $\hat{\beta}$ is insignificant from zero in all 24 regressions (MSA37-MSA60). Thus, there is no evidence that house price changes influence consumption growth and I fail to reject the null hypothesis. The choice of consumption proxy does not affect this result.

The OLS regression estimates displayed in *Table 4* show a relationship between house price changes and MSW fluctuations, but not between changing house prices and taxable sales variation. As such, it is unsurprising that the 2SLS in *Table 8* show no sign of a causal dynamic relationship between house prices and taxable sales. However, I observe a relationship between change in house price and change in garbage from regular OLS. If this relationship is causal, the second stage of the 2SLS should produce statistically significant $\hat{\beta}$ estimates. It does not; while consumption (as proxied by MSW) and house price covary, I find no evidence that this relationship is causal. Instead, it seems that increases in consumption and house prices may be simultaneously driven by some latent factor in my data.

What about the other coefficient estimates? In *Table 8*, estimates of $\hat{\gamma}$ (the coefficient for expected wage growth) are statistically different from zero at the 10%-, 5%-, or 1% significance level depending on the regression specification. The positive sign of $\hat{\gamma}$ indicates that expected change in income and change in consumption are positively correlated; a 1% increase in the expected per capita real income corresponds with a one-year average change in spending by about 3%-5%. This suggests that consumers partly “cash out” in advance, spending a greater portion of their income today on the expectation that future income will compensate for the difference.

TABLE 7: NATIONWIDE MSA 2SLS RESULTS (COLLECTED MSW)

Second-stage 2SLS regression results with collected MSW as consumption proxy, two-tailed hypothesis testing

	(MSA37)	(MSA38)	(MSA39)	(MSA40)	(MSA41)	(MSA42)	(MSA43)	(MSA44)	(MSA45)	(MSA46)	(MSA47)	(MSA48)
VARIABLES							ΔMSW					
ΔHPI^ (Price) (β)	0.383	0.367	0.173	0.366								
	(0.647)	(0.663)	(0.799)	(0.637)								
ΔHPI^ (Index SA) (β)					-0.00992	-0.0581	-0.120	-0.0328				
					(0.382)	(0.390)	(0.411)	(0.383)				
ΔHPI^ (Index NSA) (β)									-0.172	-0.189	-0.245	-0.214
									(0.416)	(0.418)	(0.426)	(0.419)
ΔWage (Current) (γ)	-0.120				0.281				0.349			
	(0.569)				(0.408)				(0.475)			
ΔWage (Near) (γ)		-0.0473				0.724				0.616		
		(0.748)				(0.527)				(0.581)		
ΔWage (Broad) (γ)			0.970				1.563*				1.830*	
			(1.580)				(0.891)				(1.020)	
ΔWage (Past) (γ)				-0.0388				0.493				0.852
				(0.665)				(0.510)				(0.634)
Constant	0.00314	0.00333	0.00543	0.00340	0.0244	0.0227	0.0175	0.0226	0.0451	0.0428	0.0309	0.0398
	(0.0545)	(0.0544)	(0.0556)	(0.0537)	(0.0419)	(0.0415)	(0.0397)	(0.0416)	(0.0440)	(0.0434)	(0.0396)	(0.0428)
Observations	136	136	136	136	176	176	176	176	192	192	192	192
R-squared	0.020	0.020	0.023	0.020	0.001	0.002	0.002	0.001				

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Above are the second-stage results from 2SLS regressions shown in *Eq. (3)* . The regressions use change in per capita MSW as a proxy for change in per capita consumption. The regressions instrument for three different house price indexes seperately. "ΔHPI^" is the coefficient estimate of ΔHPI from the first stage of the regression (shown in *Table 5*).

TABLE 8: NATIONWIDE MSA 2SLS RESULTS (TAXABLE SALES)

Second-stage 2SLS regression results with taxable sales as consumption proxy, two-tailed hypothesis testing

	(MSA49)	(MSA50)	(MSA51)	(MSA52)	(MSA53)	(MSA54)	(MSA55)	(MSA56)	(MSA57)	(MSA58)	(MSA59)	(MSA60)
VARIABLES	ΔSales											
ΔHPI^ (Price) (β)	-1.240	-1.227	-1.773	-1.378								
	(1.579)	(1.711)	(2.055)	(1.703)								
ΔHPI^ (Index SA) (β)					-0.439	-0.394	-0.591	-0.521				
					(0.688)	(0.737)	(0.826)	(0.769)				
ΔHPI^ (Index NSA) (β)									-0.263	-0.192	-0.341	-0.381
									(0.518)	(0.545)	(0.602)	(0.595)
ΔWage (Current) (γ)	4.934**				3.767***				3.528***			
	(2.027)				(1.355)				(1.218)			
ΔWage (Near) (γ)		4.872**				3.456***				3.176***		
		(2.346)				(1.246)				(1.006)		
ΔWage (Broad) (γ)			9.053*				5.974**				5.206**	
			(5.211)				(2.638)				(2.054)	
ΔWage (Past) (γ)				5.588**				4.314**				4.086***
				(2.505)				(1.754)				(1.563)
Constant	0.0802	0.0850	0.0706	0.0750	0.0387	0.0427	0.0286	0.0341	0.0237	0.0255	0.0133	0.0229
	(0.107)	(0.106)	(0.0965)	(0.103)	(0.0603)	(0.0597)	(0.0540)	(0.0564)	(0.0448)	(0.0429)	(0.0391)	(0.0417)
Observations	248	248	248	248	323	323	323	323	351	351	351	351
R-squared	0.038	0.006		0.018	0.040	0.013	0.012	0.029	0.042	0.017	0.016	0.032

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This table is the same as *Table 7* , but uses taxable sales (instead of MSW) as a consumption proxy. Here, "ΔHPI^" estimates come from the first stage of the regression shown in *Table 6* .

While the 2SLS regressions in *Table 8* use taxable sales to proxy for consumption, those of *Table 7* use MSW instead. Here I observe that wage growth coefficient estimates ($\hat{\gamma}$) are now largely insignificant. This implies that expected future income fluctuations do not have as clear a relationship to the change in waste production as to the change in taxable purchases.

B. FLORIDA COUNTY ANALYSIS

Table 9 presents the set of the OLS regressions estimating *Eq. (1)* with the Florida county-level analysis. For brevity, I repeat the results for only one house price index for all regressions. As shown in the table, the estimate of $\hat{\beta}$ is statistically significant in three of the models: FLC1, FLC2, and FLC3. FLC3 uses taxable sales as a proxy for consumption, yielding a positive coefficient for $\hat{\beta}$ that is weakly significant at the 10% level. Once I control for wage expectations in FLC4, however, the significance disappears. In FLC1 and FLC2, single family household waste is used as a proxy for consumption instead. With this empirical measure, I find a positive association between house price growth and consumption that is statistically significant at the 5% level, whether controlling for income expectations or not.

TABLE 9: FLORIDA COUNTIES OLS RESULTS

OLS regression results, two-tailed hypothesis testing

	(FLC1)	(FLC2)	(FLC3)	(FLC4)
VARIABLES	ΔMSW (SFH)		ΔSales	
ΔHPI (β)	0.370**	0.422**	0.169*	0.152
	(0.176)	(0.175)	(0.0927)	(0.0927)
ΔWage (Current) (γ)		-1.974*		0.622***
		(1.091)		(0.195)
Constant	0.0521**	0.0896**	0.0190*	0.0072
	(0.0260)	(0.0404)	(0.0108)	(0.0115)
Observations	468	468	468	468
R-squared	0.007	0.023	0.019	0.039

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In this table I regress each consumption growth proxy on the change in house price index (with expected wage controls) using OLS. Only "current" income growth is used to model expectations. Using other expectation measures provides similar end results. "SFH" indicates single family households.

The output suggests that a 1% increase in real home value corresponds to a rise in household garbage by 0.37% (without accounting for wage expectations) to 0.42% (with wage expectations accounted for). Notably, this effect is of a similar magnitude to that found in the MSA-level OLS regressions MSA4-MSA6 as shown in *Table 4*, of 0.37% to 0.39% with wage controls. This supports my idea that the MSA-level and county-level analyses provide parallel experiments despite encompassing different samples. As previously mentioned, possible house price endogeneity entails that the OLS estimates should be interpreted as association, but not a causal relationship.

TABLE 10: FLORIDA COUNTIES 2SLS FIRST-STAGE RESULTS

First-stage 2SLS regression results, two-tailed hypothesis testing

	(FLC5)	(FLC6)	(FLC7)	(FLC8)
VARIABLES	ΔHPI (Price)			
Elasticity (δ^1)	0.0016	0.0017	0.0018	0.0015
	(0.0037)	(0.0037)	(0.0038)	(0.0037)
ΔWage (Current) (δ^2)	0.342*			
	(0.174)			
ΔWage (Near) (δ^2)		0.684***		
		(0.263)		
ΔWage (Broad) (δ^2)			1.141***	
			(0.352)	
ΔWage (Past) (δ^2)				0.504**
				(0.254)
Constant	0.0742***	0.0675***	0.0603***	0.0714***
	(0.0115)	(0.0121)	(0.0115)	(0.0107)
Observations	468	468	468	468
R-squared	0.010	0.020	0.027	0.011

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This table shows the first-stage results from the 2SLS regression (*Eq. (2)*). The first stage regresses change in house price index on housing supply elasticity and expected income growth.

In *Table 10,* results from the first stage of the 2SLS specification are shown. As with the MSA-level analysis, the Florida level analysis uses house price elasticity as an instrument for change in house price. The δ^1 estimates are statistically insignificant for all four regressions and I fail to reject the null hypothesis. Thus, there appears to be no relationship between the house supply elasticity and change in house price for the Florida counties using Ihlandfeldt & Mayock's (2014) elasticity estimates. This leaves the relevance criterion for 2SLS unfulfilled and makes the instrument ineffectual.

TABLE 11: FLORIDA COUNTIES 2SLS RESULTS

Second-stage 2SLS regression results, two-tailed hypothesis testing

	(FLC9)	(FLC10)	(FLC11)	(FLC12)	(FLC13)	(FLC14)	(FLC15)	(FLC16)
VARIABLES	ΔMSW(single family households)				ΔSales			
ΔHPI^ (β)	-4.952	-4.500	-3.682	-4.578	1.794	1.650	1.608	1.850
	(13.98)	(11.76)	(9.662)	(13.30)	(5.104)	(4.398)	(4.109)	(5.249)
ΔWage (Current) (γ)	-0.145				0.0635			
	(4.781)				(1.712)			
ΔWage (Near) (γ)		1.452				-0.446		
		(7.912)				(2.934)		
ΔWage (Broad) (γ)			5.446				-0.753	
			(11.30)				(4.688)	
ΔWage (Past) (γ)				2.622				0.550
				(7.211)				(2.741)
Constant	0.509	0.439	0.300	0.421	-0.121	-0.0985	-0.0902	-0.135
	(1.103)	(0.857)	(0.630)	(1.000)	(0.400)	(0.317)	(0.267)	(0.393)
Observations	468	468	468	468	468	468	468	468

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Above are the second-stage coefficient estimates of 2SLS regressions using Florida county-level data. The regressions use two different proxies for change in per capita consumption: growth of per capita gross sales and growth of MSW tons per person in single family homes. Four different controls for expected income growth are used. "ΔHPI^" is, as before, based on the coefficient estimates of ΔHPI from the first stage (shown as δ^1) in *Table 10* .

Table 11 presents the second-stage results of the 2SLS. Indeed, none of the regression models yield coefficient estimates for $\hat{\beta}$ that are statistically different from zero. That is, there is no evidence of a relationship between consumption and house price growth. The coefficient estimates for $\hat{\gamma}$ are also all insignificant from zero. The MSA-level 2SLS regressions in *Table 7* and *8* find similar results, and in that case I fail to reject that there is no causality between change in house price and consumption in my sample. For the county-level analysis, however, I cannot draw the same conclusion, as the insignificant results more likely originate from a weak instrument. This does not in any way invalidate the insights of the MSA-level analysis; instead, it simply fails to support them. It is possible that a larger and more robust sample may show a causal relationship between house price changes and consumption.

6. CONCLUDING REMARKS

In this paper, I examine if changes in house prices lead to an increase in consumption. I use municipal solid waste (MSW) as a proxy for consumption. First, I run a regular OLS and show that there is a statistically and economically significant relationship between prices and consumption (measured by per capita MSW). The OLS regressions indicate that a 1% increase in house price corresponds to consumption growth of between 0.37% and 0.42% after controlling for income expectations (significant at the 1%- and 5% level, respectively).

These OLS estimates are higher than those found by Brady, Canner, and Maki (2000) (0.18%); Canner, Dynan, and Passmore (2002) (0.16%); and Greenspan and Kennedy (2008) (0.25%). They are also lower than that of Hatzius (2006) (0.50% to 0.62%). The consumption that I observe is economically significant – a little under half of the increase in home value covaries with greater expenditures. One possible explanation for why my estimates are higher than most is that garbage is a more sensitive proxy for consumption and more accurately captures its fluctuations. As such, I expect MSW to increase more pronouncedly than taxable sales in conjunction with house price growth.

Second, I apply a 2SLS estimator in the hope of establishing whether the observed relationship is causal or not. The regressions fail to produce clear results on the relationship between rising home prices and homeowner consumption expenditures. For the Florida county-level analysis, this can be attributed to weak instrumentation. For the MSA-level analysis though, the instrument is strong, leaving me to conclude that changing house prices and increased consumption may not be causally related in my data, and may instead be jointly driven by some latent factor.

What could explain the lack of causality? One possibility is that the homeowners in my sample are not credit constrained and are not lacking in self-control (as proposed by Laibson (1997)). If so, they should not have a strong incentive to cash-out home equity to increase consumption. For example, a homeowner may receive an income raise and wish to increase his current consumption or be more willing to move into a more expensive house. If he is not borrowing constrained, he can choose to take out a loan that is less costly to obtain than mortgage refinancing – something that he would be unable to do if credit constrained. Thus, the data would show increases in income growth expectations, consumption, and house price (via increased demand). However, house price and consumption would not be causally related. The previously mentioned findings of Hurst and Stafford (2004) support such a possibility; they find that households without credit constraints do not consume a significant portion of the funds acquired from mortgage equity withdrawal.

It is feasible that other, more detailed, data (e.g. individual household-level data) may show a causal relationship between house prices and consumption, but my data do not explicitly do so. In fact, one possible shortcoming of this paper is that it only uses aggregate data; it fails to separate the individual's mortgage equity withdrawal from those of all homeowners. Individual homeowners can have a large amount of high cash-out consumption and still be hidden in the aggregate data if other homeowners withdraw smaller amounts. While a sizable portion of homeowners need to be vulnerable to falling house prices systemic financial troubles to hit banks, a successive series of defaults can be triggered from a small group of homeowners with high cash-out consumption (such as subprime borrowers in 2006).

Survey evidence illustrates how aggregated data can fail to pick up on this phenomenon. Brady, Canner, and Maki (2000) find that in 1998 and early 1999, 39% of mortgage equity withdrawers consumed some portion of the new funds, amounting to 18% of all mortgage cash-outs. In a follow-up survey by Canner, Dynan, and Passmore (2002), the number of consuming withdrawers had decreased to 25%, but the dollar amount of the consumption was static at 16%. This means that fewer refinancers were consuming their cash-out equity, but each individual consumer was spending a larger proportion of their withdrawn funds. In this scenario, the group of borrowers at risk of mortgage default is shrinking but their likelihood of default is growing. Aggregated data would only show a consumption decrease from 18% to 16%, but this number would conceal the fact that consumption increased for many households. As such, the estimated consumption for mortgage refinancing households may be underestimated in my data.

APPENDIX 1: DATA DETAILS

A more detailed summary of my data than that of *Section 4* is provided below. Entries are sorted alphabetically.

Fiscal year: States frequently use different fiscal years. As such, calendar year values are calculated by taking a weighted average of adjacent years. For example, Texas has a fiscal year (FY) of September-August; to find values for the calendar year (CY) 2004 taxable sales, I sum 8/12*FY2004 and 4/12*FY2005.

Growth: Changes or growth rates for all variables (e.g. HPI, Consumption) are calculated as percent change on an annual basis. Absolute changes are not used for analysis. These data are also Winsorized at the 1^{st} and 99^{th} percentiles to account for possible extreme outliers.

Housing supply elasticity: Since Saiz (2010) and I use slightly different MSA definitions, 7 pairs of Saiz's MSAs are combined in this paper (for example, Saiz defines "Miami, FL" and "West Palm Beach-Boca Raton, FL" as separate MSAs but this paper counts "Miami-Fort Lauderdale-West Palm Beach, FL" as one single MSA), leaving us with 88 U.S. MSA supply elasticity estimates. Where MSAs are combined, the elasticity estimate of the larger constituent is used.

Inflation: Inflation is calculated as the change in consumer price index (CPI) from January of year t-1 to January of year t. CPI figures are provided by the Bureau of Labor Statistics. All monetary figures are adjusted for inflation and expressed in real terms.

Metropolitan statistical areas (MSAs): Definitions of which counties make up an MSA are those used by the U.S. Office of Management and Budget. The MSAs used have anywhere between 1 and 25 constituent counties (since county areal definitions vary widely from state to state).

Population: MSA yearly population estimates are provided by the Bureau of Economic Analysis. The Florida county-level analysis uses different sources depending on which consumption proxy is being used:
(i) Taxable sales: Yearly county population numbers are from the Florida Office of Economics & Demographic Research.
(ii) Collected MSW: To match the single-family MSW recorded for Florida counties, I use annual data on persons living in single-family homes per county. These data are reported by Florida Department of Environmental Protection.

Taxable sales: For the county-level analysis, gross sales are used instead of taxable sales and provided by the Florida Department of Revenue. The Florida MSA-level data are from the Florida Office of Economic & Demographic Analysis (and are used because they are measured at the MSA level directly).

APPENDIX 2: LINKS TO DATA SOURCES

House price index

FHDC
http://flhousingdata.shimberg.ufl.edu/a/profiles?action=geo

FHFA
https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#atvol

Zillow
https://www.zillow.com/research/data/

Municipal solid waste (MSW)

California
http://www.calrecycle.ca.gov/SWFacilities/Landfills/Tonnages/

Florida
http://www.dep.state.fl.us/waste/categories/recycling/SWreportdata/15_data.htm

North Carolina
http://deq.nc.gov/about/divisions/waste-management/waste-management-rules-data/solid-waste-management-annual-reports

Pennsylvania
http://www.dep.pa.gov/Business/Land/Waste/SolidWaste/MunicipalWaste/Pages/MW-Disposal-Info.aspx
(Older data obtained via email)

Texas
http://www.tceq.state.tx.us/permitting/waste_permits/waste_planning/wp_swasteplan.html
(Older data obtained via email)

Washington
http://www.ecy.wa.gov/programs/swfa/solidwastedata/

Wisconsin
http://dnr.wi.gov/topic/Landfills/fees.html

Taxable sales

Alabama
http://revenue.alabama.gov/anlrpt.cfm

Arkansas
http://www.dfa.arkansas.gov/offices/exciseTax/salesanduse/Pages/CollectionDataLocal.aspx
http://www.dfa.arkansas.gov/offices/exciseTax/salesanduse/Documents/taxRateFile.txt

Arizona
https://www.azdor.gov/ReportsResearch/AnnualReports.aspx

California
http://www.boe.ca.gov/news/tsalescont.htm

Colorado
https://www.colorado.gov/pacific/revenue/retail-sales-report
(Older data obtained via email)

D.C.
https://cfo.dc.gov/node/215942

Florida
http://floridarevenue.com/taxes/Pages/colls_from_7_2003.aspx
http://edr.state.fl.us/content/revenues/reports/taxable-sales-and-index-of-regional-economic-activity/index.cfm

Indiana
http://www.stats.indiana.edu/topic/taxes.asp

Maryland
http://finances.marylandtaxes.com/Where_the_Money_Comes_From/General_Revenue_Reports/Consolidated_Revenue_Reports.shtml

Minnesota
http://www.revenue.state.mn.us/research_stats/Pages/Sales-and-Use-Tax-Statistics-and-Annual-Reports.aspx

North Carolina
http://www.dor.state.nc.us/publications/fiscalyearsales.html

Nebraska
http://revenue.nebraska.gov/research/salestax_data.html

New York
https://www.tax.ny.gov/research/stats/statistics/stat_fy_collections.htm

Tennessee
https://www.tn.gov/revenue/article/revenue-retail-sales-by-calendar-year-month

Texas
https://mycpa.cpa.state.tx.us/allocation/HistSales
(Older data obtained via email)

Utah
http://tax.utah.gov/commission-office/reports

Virginia
https://ceps.coopercenter.org/content/taxable-sales

Washington
http://dor.wa.gov/Content/AboutUs/StatisticsAndReports/stats_localretailsales.aspx

REFERENCES

Almaas, Synne and Bystrøm, Line and Carlsen, Fredrik and Su, Xunhua, Home Equity-Based Refinancing and Household Financial Difficulties: The Case of Norway (June 20, 2015). Available at SSRN: https://ssrn.com/abstract=2523025 or http://dx.doi.org/10.2139/ssrn.2523025

Bennett, Paul, Richard Peach, and Stavros Peristiani. "Implied Mortgage Refinancing Thresholds." *Real Estate Economics* 28.3 (2000): 405-34. Web.

Bostic, Raphael, Stuart Gabriel, and Gary Painter. "Housing Wealth, Financial Wealth, And Consumption: New Evidence From Micro Data". *Regional Science and Urban Economics* 39.1 (2009): 79-89. Web.

Brady, Peter, Glenn Canner, and Dean Maki. 2000. “The Effects of Recent Mortgage Refinancing.” *Federal Reserve Bulletin*, 79(1): 14-31

Canner, Glenn, Karen Dynan, and Wayne Passmore. 2002. “Mortgage Refinancing in 2001 and Early 2002.” *Federal Reserve Bulletin*, 88(12): 469-81

Greenspan, A., and J. Kennedy. "Sources And Uses Of Equity Extracted From Homes". *Oxford Review of Economic Policy* 24.1 (2008): 120-144. Web.

Hatzius, J. (2006), “Housing Holds the Key to Fed Policy”, Goldman Sachs Economics Paper No. 137, February.

Hurst, Erik, and Frank P. Stafford. "Home Is Where The Equity Is: Mortgage Refinancing And Household Consumption". *Journal of Money, Credit, and Banking* 36.6 (2004): 985-1014. Web.

Iacoviello, Matteo. "House Prices, Borrowing Constraints, And Monetary Policy In The Business Cycle". *American Economic Review* 95.3 (2005): 739-764. Web.

Ihlanfeldt, K., and T. Mayock. "Housing Bubbles and Busts: The Role of Supply Elasticity." *Land Economics* 90.1 (2013): 79-99. Web.

Laibson, D. "Golden Eggs And Hyperbolic Discounting". *The Quarterly Journal of Economics* 112.2 (1997): 443-478. Web.

Lustig, Hanno, and Stijn Van Nieuwerburgh. "How Much Does Household Collateral Constrain Regional Risk Sharing?". *Review of Economic Dynamics* 13.2 (2010): 265-294. Web.

Mian, Atif, and Amir Sufi. "House Prices, Home Equity-Based Borrowing, and the US Household Leverage Crisis." *American Economic Review* 101.5 (2011): 2132-156. Web.

"Municipal Solid Waste | Wastes | US EPA". Archive.epa.gov. N.p., 2016. Web. 4 Apr. 2017.

Saiz, Albert. "The Geographic Determinants of Housing Supply*." *Quarterly Journal of Economics* 125.3 (2010): 1253-296. Web.

Savov, Alexi. "Asset Pricing with Garbage." *The Journal of Finance* 66.1 (2011): 177-201. Web.