Are Unfunded Public Pension Liabilities Capitalized in Local Real Estate Markets?

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Abstract

Unfunded public pension liabilities are a particular form of public debt, ultimately backstopped by the taxpayer. State and local governments are subject to balanced-budget requirements, and therefore increases in unfunded pension liabilities imply, in expectation, the need to generate additional revenue or to reduce services at some future point. I test whether the increased expected costs represented by a shock to unfunded pension liabilities is capitalized into home prices. Using novel, hand-collected data on assets, liabilities, and fund flows for 200 of the largest county and municipal pension funds in the United States, I estimate whether changes in per-capita unfunded liabilities predict house price growth. My measure of changes in unfunded liabilities comes from large investment losses during the Great Recession. To address concerns that investment returns may be correlated with regional economic variables, I construct an instrument for fund investment returns from unexpected returns by asset class. The identifying assumption is that the unexpected component of any broad asset class return during the Great Recession is orthogonal to regional economic drivers. Using microdata on individual home transactions, I find a clear negative link between pension liabilities and home price growth, along with strong evidence that these effects are larger for more valuable properties. This suggests wealth-heterogeneity in how local residents weigh the benefits of public expenditures against the costs of public debt, and also shows that municipal financial structure is directly relevant to household financial well-being.

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1 Introduction

State and local governments make large, inter-generational financial commitments to public employees in the form of defined benefit pension plans. Public pension funds, which administer these benefits, manage a pool of assets which are dedicated to covering future liabilities. When the current value of invested assets is equal to the discounted present value of earned retirement benefits, a pension fund is "fully funded". It has been widely documented that many public pension funds in the U.S. are significantly underfunded (Novy-Marx and Rauh 2009, 2011, Rauh 2016). Retirement benefits are contractually specified, and generally receive strong legal protections. As a result, unfunded public pension liabilities will require the government sponsor of the fund to make direct contributions to the pension system. Because the duration of the liabilities is measured in decades, governments facing an excessive shortfall typically plan to close the gap over a period of many years, rather than with a single lump sum payment – but nonetheless, governments sponsoring a fund with assets that cannot plausibly cover future liabilities from investment income must allocate revenue to their pension systems *at some point*. Any payment to a pension system entails a trade-off for the associated government: that payment can come from existing revenue streams or new ones. In the former case, the government's current operating budget will be reduced. Because state and local governments face balanced budget requirements, this implies a reduction in public goods or services. In the latter case, a new source of revenue means additional taxation, user fees, or public borrowing. Therefore unfunded public pension liabilities represent a future need to tax or to curtail services.

This paper uses local housing markets as a laboratory to test whether local residents seem to internalize the future need to tax – or to reduce services – represented by unfunded public pension liabilities. Specifically, I test whether a plausibly exogenous shock to unfunded public pension liabilities has predictive power for house prices. Two factors motivate the link between pension debts and housing markets. First, a long literature in urban economics posits a spatial equilibrium across regions, where regional amenities (dis-amenities) are balanced against higher (lower) costs in such a way that everyone receives the same utility (Tiebout 1956, Rosen 1974, Roback 1982, Gyourko and Tracy 1991). A shock to pension assets today implies some non-negative probability of reduced services or higher taxes in the future. Second, the central financial pillar for cities, counties, and other local governments is the property tax. When local governments need to raise revenue, this is one of the largest levers available to pull. Therefore, in a spatial equilibrium with fully rational homebuyers, an increase in future dis-amenities (either higher taxes or lower services) would translate to a lower willingness to bid for homes today.

My main empirical exercise tests whether changes in unfunded pension liabilities affect subsequent house price growth. I estimate cross-sectional forecast regressions of home price growth on changes in unfunded pension liabilities during the Great Recession (2007-2010). The measure of home-price growth comes from microdata of property-level transactions, and uses repeat sales. This data extends to 2016 and so I am able to trace out the dynamics of capitalization up to six years after the shock to unfunded liabilities.

My measure of changes in unfunded liabilities comes from a novel panel dataset of financial flows for large pension funds which I obtain from hand-collected public accounting documents. To compute a total amount of unfunded pension liabilities associated with any given property, I aggregate unfunded liabilities to the level of a *government network*: a region that holds fixed the set of geographically overlapping pension funds and associated sponsor governments. It is the taxing authority of these sponsor governments which ultimately backstops pension debts. By definition, every home within a government network faces the same set of public pension funds and sponsoring governments, and therefore is subject to the same financial burden from pension systems. I normalize the measure of unfunded liabilities by the 2010 level of general revenue for the entire government network.

I choose the Great Recession setting because pension funds experienced large losses in their investment portfolio during these years, and as a result I can observe large shifts in unfunded pension liabilities. Across government networks in my sample, the median shock to unfunded liabilities during this period was .42: this represents a bit less than half a year's worth of revenue in additional pension debts. Investment returns during this period are at least quasi-exogenous with respect to regional home price movements, as asset returns during 2008-2009 were primarily driven by macroeconomic shocks. However, there is still an endogeneity concern. Regions forecasting low economic growth might plausibly take on additional investment risk in an attempt to raise asset returns and thereby avoid having to send operating dollars to the retirement system in future years. In this case, asset losses during the Great Recession would be highest (and increases in unfunded liabilities largest) for those regions already predicting low future economic growth. In other words, changes in unfunded liabilities may well be endogenous with respect to persistent factors that affect regional home price growth.

To avoid introducing bias from this endogeneity, I construct an instrument for unfunded pension liabilities. I first obtain detail on fund asset class allocation. Then, using an asset pricing model, I compute the unexpected realized return to each asset class during 2008-2009. This unexpected return is the forecast error between the realized asset class return and the expected return based on asset class factor loadings in the Fama French 3-factor model (Fama and French 1993). I argue that from the standpoint of regional economic conditions, unexpected return to broad asset classes should be considered as good as randomly assigned, making this a valid instrument.

My overall results show that unfunded pension liabilities are capitalized into home prices, with a delay of several years. I first show that there is no evidence of contemporaneous capitalization: shocks to pension debts during the Great Recession are not reflected in home price growth during this same period. I then use the longest forecast period feasible in this data and test for capitalization by 2016. The IV estimate reflects 3.1 percentage points lower home price growth in response to an increase in unfunded liability equivalent to a year's worth of revenue. For the median house (200k) and the median shock (42% of annual revenue), this is a reduction of $2,600. To trace out the dynamics of capitalization, I repeat the forecast specification for each year between 2011 and 2016. Because this specification uses repeat sales, each coefficient is estimated based on a different set of homes. I find weak evidence of capitalization by 2014; point estimates are negative by 2012, but most coefficients are not statistically significant. I then show strong evidence of heterogeneity by home value. Within each government network I split the sample by median home value (using the 2010 price). For lower priced homes there is no evidence of negative capitalization. For higher priced homes, there is strong and significant evidence of negative capitalization by 2012. By 2016, for the median high-priced home (330k) subject to a median shock, my estimates suggest $10,250 less price appreciation over the six year period.

This research adds to the literature exploring the extent and effects of public pension under funding. Novy-Marx and Rauh (2009, 2011) and Brown and Wilcox (2009) document that unfunded public pension liabilities are large and under-reported relative to the (minimal) economic risk of future commitments. Rauh (2016) documents that annual financial flows to retirement systems are inadequate to close, or even hold static, funding gaps for the vast majority of states and large city governments. Myers (2019) models the relationship between risky pension debts, public services, and municipal insolvency. Using data from California, he estimates that stock market shocks to pension assets significantly increase the likelihood that municipal governments declare a fiscal emergency.[1] Boyer (2020) shows that higher unfunded liabilities within state pension plans subsequently increase state borrowing costs. The contribution of this paper is to show real economic effects of public pension underfunding. I show that unfunded pension liabilities directly affect the path of home prices. Homes are the most valuable asset for most households,[2] and therefore the pass-through from pension debts to real estate prices means that the financial structure of retirement systems is not

[1] In California, such a declaration is often a necessary step in establishing eligibility to raise local tax rates under state legislation intended to limit such increases.

[2] 2016 Survey of Income and Program Participation, 2014 Panel, Wave 4

simply an accounting nuance related to off-balance sheet debt of the municipal corporation, but rather a meaningful choice than can measurably impact household financial well-being.

The paper proceeds as follows. Section 2 presents background details on public pensions plans in the U.S. and describes the empirical strategy. Section 3 details the data used. Section 4 presents the results. Section 5 concludes.

2 Setting and Empirical Strategy

2.1 Unfunded Public Pension Liabilities Represent A Cost to Local Taxpayers

Employer sponsored pension plans broadly fall into one of two categories: defined benefit (DB) or defined contribution (DC). In the former, payments made during retirement are set in advance according to a formula which generally depends heavily on years of service and salary level while working. In DC plans, retired employees are entitled to the individual contributions which have been made in their name plus investment proceeds. The distinction is where the risk lies: in DB plans, payments are fixed and therefore risk lies with the plan sponsor. For DC plans, the level of payments depends on investment returns achieved by each individual retiree account, and therefore the risk lies with the employee.

In the mid-20th century, the majority of workers in both the public and private sector were covered by defined benefit pension plans (Munnell et al. 2007). The last several decades have seen a large shift towards DC plans in the private sector, however DB plans have remained prevalent in the public sector. In 2019, 86% of state and local government employees had access to a defined benefit pension plan.[3] Every state in the US provides DB pension benefits to retirees, along with many large counties, cities and independent local governments (such as school districts).[4] In addition, larger local governments commonly sponsor their own DB pension plans. In 2017, the U.S. Census Annual Survey of Public Pensions reflects 433 county-level plans, 4,320 plans provided by cities and townships, 439 plans provided by autonomous quasi-governmental entities (predominantly municipal utility districts, transportation authorities, or fire districts) and 20 plans sponsored by independent school districts. Smaller counties and towns also provide DB pension benefits, but often delegate management to a state-level "multi-employer" plan rather than establishing a distinct

[3] Bureau of Labor Statistics, National Compensation Survey- Benefits, data series NBU31900000000000028290.

[4] Two states, Alaska and Michigan, no longer provide any DB option for new employees (Munnell et al. 2007), however both states manage legacy DB systems with ongoing commitments to current retirees.

pension fund. In 2017, there were 291 state-level DB pension plans across the U.S.[5]

A public employee earns DB retirement benefits during her years of service. The exact methodology for determining benefit levels is typically moderately complex and is often an outcome of collective bargaining between public sector unions and the employing government. An illustrative example would specify that any employee serving a minimum of 20 years would be entitled to receive annual benefits upon retirement equal to 80% of the average salary of her top three earning years. In addition, these benefits might be indexed to inflation in some way, and could include some provision for proportional reduction if the total years of service failed to exceed 20. While there are several differing accounting methodologies for exact measurement of future payments (Novy-Marx and Rauh 2011), the broader principle is simple: employees earn today benefits which will be paid in the future.

Pension fund liabilities are, therefore, financial commitments made by state and local governments. To cover these liabilities, pension funds manage a pool of invested assets. The source of these assets is contributions from employees (if these are required under the employment contract) and contributions from the plan sponsor. Public accounting standards require pension funds to make annual disclosures concerning the fiscal stability of the pension system.[6] As discussed below, there are accounting nuances in the measurement of both sides of a pension fund's balance sheet. This paper relies on the reported market value of assets (MVA), along with the standard measure of liabilities reported in pension fund accounting documents. This measure, "Actuarial Accrued Liability" (AAL), is intended to capture the present discounted value of future benefit payments that have already been earned by employees.[7] The top line measure of DB pension fund fiscal stability is a funded ratio: if the fund's MVA is equal to it's AAL, a plan is 100% funded.

It is a stylized fact that most public pension funds in the U.S. are less than 100% funded. Of the 193 funds in my final sample, 187 had a funded ratio less than 1 as of 2010. The median funded ratio is 69%. Rauh (2016) detail similar under-funding in 2017 for 649 of the largest state, county, and city pension plans in the U.S. A gap between the current value of a fund's assets and its liabilities is referred to as unfunded liability - or, more precisely, "Unfunded Actuarial Accrued Liability" (UAAL).[8] Future cash flows to employees generally receive strong legal protections: in most U.S. states this takes the form either of explicit constitutional protections for pension benefits, or judicial recognition of retirement benefits

[5] Author's calculations using Annual Survey of Public Pensions 2017 data files.

[6] This paper relies on disclosures mandated by Governmental Accounting Standards Board (GASB) Statements 67 and 68.

[7] In keeping with GASB Statement 67, the term "Actuarial Accrued Liability" denotes the same concept as "Total Pension Liability" - another commonly used term.

[8] A negative UAAL value would represent an excess of assets relative to liabilities.

as contractually protected obligations of the state or local government (Brown and Wilcox 2009).

UAALs, therefore, are a form of public debt. From the standpoint of local residents, an increase of $1 UAAL represents an additional financial claim on the local government, for which tax payers are ultimately responsible. Although pension obligations are paid out over decades, meaning that necessary increases in taxation could be very far into the future, the principle of Ricardian equivalence holds that taxpayers will internalize today a reduction in wealth implied by any need to impose taxes in the future (Ricardo 1824, Barro 1974). The fact that pension liabilities are measured in present value makes the valuation of these future debts particularly simple. If all taxpayers have the same individual discount rate as that chosen by the local pension system, then local residents would value an additional dollar of UAAL as a (collective) cost of $1. Even without the restrictive assumption of homogeneous individual discount rates, the broader point holds: a positive shock to UAALs represents a strictly negative wealth shock to local residents in aggregate.

One technical note is important. There are large, meaningful nuances in the measurement of pension liabilities – most saliently the rate at which future benefit payments are discounted to the present. Funds are currently constrained to use their long-term expected rate of return on investments, or a high-quality municipal bond rate for highly underfunded plans.[9]. Many economists have argued that a lower discount rate is appropriate in order to match the essentially risk-free nature of the benefit payments (Lucas and Zeldes 2006, Brown and Wilcox 2009, Novy-Marx and Rauh 2009, 2011). For purposes of this paper, I measure fund liabilities as stated in the fund's public accounting documents, without making any adjustment to harmonize discount rates. The empirical analysis rests on changes in unfunded liabilities driven by changes in asset values. In this first-difference specification, any measurement error on the liability side will be differenced out as long as that error is constant over a period of 1-2 years. As the level pension fund liabilities is an extremely slow-moving variable, especially relative to asset values during times of market volatility, I argue this simplification will not alter my results in any meaningful way.

2.2 Is Pension Debt Reflected In House Prices?

I use local housing markets as a laboratory for testing whether local residents are, in fact, sensitive to the costs embodied by pension UAALs. Property taxes are the largest source of revenues for local governments. For the average local government, property taxes comprise

[9] GASB Statement 68.

56% of the total revenue streams which local authorities can directly affect.[10] This makes it quite plausible that future revenue shortfalls will be closed by increasing property taxes. However, local governments certainly have a range of levers to pull in order to close fiscal shortfalls. This might include increasing user fees for any range of services provided by local governments (such as permits, inspections or licensing) or simply reducing spending in other categories. Of course all of these actions will also most directly affect local residents.

A central tenet of urban economics is the notion of spatial equilibrium, which holds that individuals are mobile and prices adjust until a constant level of utility is achieved across regions (Tiebout 1956, Rosen 1974, Roback 1982, Gyourko and Tracy 1991). In this framework, an exogenous increase in some future need to tax faced by one region would imply either a reduction of some cost or an increase of some non-pecuniary amenity. Amenities (typically viewed as things like weather or natural resources) are presumably fixed in short run. Given the central role of the property tax in local finances, this paper tests for a reduction in local housing market costs.

My central empirical exercise is a series of cross-sectional forecast regressions of change in house prices on a shock to unfunded pension liabilities. Using the forecast horizon from 2010 to 2016 as an example, the estimating equation would be:

$$\Delta log(p_{i,g,2010-16}) = \alpha_{state} + \beta \Delta UAAL_{g,2007-10} + \Theta \Delta X_{g,2010} + \epsilon_{i,g} \tag{1}$$

In this regression i denotes a home and g denotes a government network. The variable of interest, $\Delta UAAL$, denotes total changes in unfunded pension liabilities between 2007 and 2010 for all funds sponsored by governments that contain home i (the government network). The methodology used to define government networks is described in greater detail in Section 3. This variable is scaled by 2010 total general own-revenue for the government network. A one unit shift in $\Delta UAAL$, therefore, would represent additional pension debt equal to a year's worth of revenue for all the sponsoring governments.[11] The dependent variable is the log difference in home price between 2010 and 2016. By design, therefore, the sample is limited to homes which sell in 2010 and sell again in 2016. X is a vector of government-level controls for economic factors (measured as of 2010) that would be presumed to affect both public budgets and home prices.

The null hypothesis of $\beta = 0$ is that changes in unfunded pension liabilities have no ability to forecast changes in house prices. Any null result in equation 1 would not rule

[10] Author's calculation using Census of Governments data.

[11] "Own revenue" excludes revenue from intergovernmental transfers, and is the component of revenue which a given government can directly affect.

out that unfunded liabilities are very quickly capitalized into house prices. I show that evidence from a contemporaneous cross-sectional regression does not support this notion. One limitation of any null finding in this analysis is that I cannot rule out capitalization at any remove of more than 6 years.

Large investment shocks to funds assets during this period represent plausibly exogenous shifts in UAALs. The financial crisis in 2008-2009 resulted in large losses across many asset classes. Pension funds, which often seek passive exposure to a broad market portfolio, saw large losses during this period. Across the 109 government networks analyzed in this paper, every one realized net losses during 2008 and 2009. During fund fiscal year 2008, 96% of individual funds lost money; for 2009, 57% of individual funds lost money.[12]

Although negative returns on invested assets during 2008 and 2009 are more likely driven by the macroeconomic shock of the Great Recession than local economic conditions (which one would expect to correlate with local home prices), fund returns may still be endogenous with respect to house prices. Regions facing economic challenges may have underfunded pension plans as a result of financial constraints. If these regions seek to make up the shortfall by taking additional risk exposure with invested pension assets, then negative returns during a broad market downtown would positively covary with local economic stress. The latter would presumably be reflected in house prices through a range of channels.

To address this endogeneity, I construct an instrument for changes in UAALs. I obtain data on funds' asset allocation from the US Census of Governments. I then use an asset pricing model to predict expected returns for each asset class. For each asset class, I take the unexpected return to each asset class – the forecast error – and aggregate to the fund level using the reported asset class weights. I use this total unexpected return as an instrumental variable in a two-stage least squares regression:

$$\Delta log(p_{i,g,2010-16}) = \alpha_{state} + \beta \Delta \widehat{UAAL}_{g,2007-10} + \Theta \Delta X_{g,2010} + \epsilon_{i,g} \quad (2)$$

$$\Delta \widehat{UAAL}_{g,2010-2007} = \psi + \Theta unexpected\_return_{g,2009} + \delta unexpected\_return_{g,2008} + \nu_g. \quad (3)$$

Like $\Delta UAAL$, unexpected returns are scaled by the 2010 general revenue for the government network. Unexpected return is computed for each fund and then aggregated to the government network level as (before scaling):

[12] Author's calculation using data assembled from fund financial disclosures.

$$unexpected\_return_{ft} = MVA_{f,t-1} \sum_j w_{fjt}(r_{jt} - E[r_{jt}]) \tag{4}$$

where f indexes a fund and j indexes asset classes. Note that the realized returns are not indexed by either fund or government network; these are realized returns for the asset class benchmark. Expected return for each asset class is calculated using the Fama-French 3-factor asset pricing model, augmented with LIBOR (Fama and French 1993):

$$E[r_{jt}] = \hat{\beta}^j_L LIBOR_t + \hat{\beta}^j_M (r_m - r_f) + \hat{\beta}^j_{SMB} SMB_t + \hat{\beta}^j_{HML} HML_t + e_{jt}. \tag{5}$$

Asset class betas are estimated from historical returns of asset class benchmarks.

The logic of the instrument is this: in any given year, assets classes as a whole may under- or over-perform relative to the asset-pricing model forecast. As long as these unexpected returns are orthogonal to regional drivers of home prices, the exclusion restriction will be satisfied. Given this, there are two ways of motivating instrument validity. The first is the standard asset pricing result that forecast errors in an asset pricing model are unpredictable (Froot and Frankel 1989). If any regional factor could predict the forecast error in asset class performance, then in an efficient market, this would be incorporated into asset prices ex-ante. Another motivation recognizes this instrument is effectively constructed as a shift-share instrument: the local vector of asset class weights is aggregated using national shocks. These weights are analogous to base-shares in a classic Bartik instrument, and the unexpected asset class return would be correspond to industry sector shocks (Bartik 1991). Because the weights do not derive from a pre-period, they cannot be considered exogenous. However as Borusyak et al. (2018) show, base shares do not need to be exogenous as long as the shocks are numerous and sufficiently orthogonal to factors affecting the dependent variable (the condition is slightly weaker than full exogeneity). Viewed through this lens, the identification assumption in this setting becomes that asset class performance relative to the factor model prediction is exogenous with respect to regional economic factors. Given that these broad asset classes represent national or international investments, this seems a relatively mild assumption.

3 Data

3.1 Novel Pension Dataset

The core data of this paper is a novel panel dataset of unfunded liabilities and investment returns for just over 200 of the largest local DB pension plans in the country during 2006-

2016. I extract this information by hand-collecting public accounting documents for each fund. There is a relative lack of any compiled dataset on local pension funds. The standard sources of data on public pensions are the Census Bureau's Annual Survey of Public Pensions and Government Finance Statistics. Neither of these surveys, however, asked funds to disclose liabilities until the 2017 vintage. As a result, it is not possible to ascertain a measure of unfunded liabilities from this data. To the best of my knowledge, the data used in this paper represents the broadest snapshot of local pension fund finances that has been compiled. There are other data which have partial overlap with my dataset. The Center for Retirement Research (CRR) at Boston College maintains a database spanning 190 large pension plans and extending back as far as 2001. At the time I collected data for this paper, the CRR resource focused primarily on states. In recent years, that database has expanded to include some large counties and cities. Joshua Rauh has also compiled more recent data beginning in 2016 on pension liabilities, which is made available through a Hoover Institution at Stanford University publication entitled *Hidden Debts, Hidden Deficits* (Rauh 2016).

Local funds are those sponsored by sub-state governments: counties, cities, towns, and other regional public sponsors like independent school districts. I focus on local funds because it is these governments that derive a significant portion of their revenue through property taxes. Property taxes are not typically important for states, comprising less than 2% of total revenue in recent years.[13] By restricting attention to local funds, I am focusing on pension debt that is most likely to impact home prices.[14]

The data itself comes from disclosures mandated by the Government Accounting Standard Board Statement 67 and 68. These statements, issued in 2014, altered existing guidelines to expand the reporting detail required, most saliently around fund discount rates and the components of changes in Net Pension Liability (equivalent to UAAL). Pension funds disclose this information annually in a Comprehensive Annual Financial Report (CAFR).[15,16] GASB 67 mandated disclosure of ten years of historical information, which greatly enabled the compilation of the panel.

I first use the Census Bureau's Annual Survey of Public Pensions to identify the largest

[13] Author's calculation using Census of Governments Government Finance Statistics, 2013-2016

[14] As mentioned, state pension funds also often have large unfunded liabilities. For this reason, I use state fixed effects in all specifications. My estimates are, therefore, identified off of spatial variation in unfunded liabilities within a given state.

[15] A CAFR is the public sector equivalent of a 10-K filing, and GASB is the public sector counterpart to the Financial Accounting Standards Board. GASB is an independent non-profit organization and does not have regulatory enforcement authority. Nonetheless, public entities follow these standards very closely.

[16] While most pension funds produce a separate CAFR, sometimes the information is disclosed in the CAFR of the sponsor government instead.

pension funds in the U.S. by assets.[17] Then, I hand-collect CAFRs for each fund and use these to build a panel of the following variables over the 2006-2016 period: market value of assets, actuarial value of assets, actuarial accrued liabilities, investment return, net investment income, required employer contribution, actual employer contribution, member contribution, and fund discount rate. My measure of UAAL is actuarial accrued liabilities (AAL) minus market value of assets (MVA). I use MVA rather than actuarial value of assets because the major feature of the latter is smoothing of investment returns.

It is common to have overlap in the geographic footprint for multiple pension funds. The canonical example is a large county which contains a large city: both of these government entities commonly sponsor funds. Residents of the city, therefore, would be associated with financial obligations for both the city and the county. Residents of the county located outside of the city will be associated only with the financial obligations of the county. Every home, therefore is associated with one government network: the unique combination of governments that contain that home. To form these networks, I use the precise latitude and longitude of the home (obtained from ATTOM) along with a shapefile delineating the boundary of each pension fund's sponsor government (obtained from Atlas Muni Data). I use standard GIS techniques to geo-associate the point location of each parcel with all governments containing it. By definition, every home that faces the same set of funds and sponsor governments belongs to the same government network. I aggregate UAALs across all funds within a given government network, and then normalize by 2010 total revenue for that government network. Returning to the canonical example, the regressor of interest would be:

$$\Delta UAAL_{g,2007-10} = \frac{(UAAL_{county,2010} + UAAL_{city,2010}) - (UAAL_{county,2007} + UAAL_{city,2007})}{revenue_{county,2010} + revenue_{city,2010}}. \tag{6}$$

It is relatively common for a city or county to sponsor several pensions funds (for instance, separate funds for teachers, police and fire, and general public administrators). Since my baseline analysis is conducted at the government network level, whenever I come across multiple funds sponsored by the same government, I collect information for those fund as well, even if they do not appear on the list of largest funds by assets.

[17] The optimal list would include the largest funds by unfunded liabilities, however it is exactly this lack of data that the overall exercise seeks to address.

3.2 Other Data Used

In order to construct the instrument, I obtain information on fund asset allocation from the US Census of Governments, along with detail on total expenditures and revenues for sponsor governments. Fund holdings are classified into: cash, savings, US Treasuries, agency debt, state and local debt, corporate stocks, corporate bonds, mortgages, foreign stocks, real property, savings, and miscellaneous. For each asset class, I select a passive benchmark for which I can observe monthly returns. From The Center for Research in Security Prices (CRSP), I obtain the historical time-series for each benchmark extending back to 2005, and use these to compute monthly betas for each asset class between 2007 and 2009. (I compute rolling betas updated monthly using the return series from 2005 to the current month). Exhibit 1 shows the list of asset classes along with the passive vehicle selected to represent that asset class.

For a measure of home prices, I obtain real estate transactions records from ATTOM. This is a comprehensive dataset of 53 million transactions between 1999 and 2016. Transaction data is sourced from county recorder offices. Each property is characterized by a unique identifying ID, which allows me to focus on repeated transactions. The recorder portion of the ATTOM dataset has several indicator flags for arm's-length transactions and partial interest sales, which collectively can be used to exclude transactions that may not provide an accurate signal of market value. I include only homes which sell in an arm's-length, full consideration transaction. Each property-year observation also includes a large vector of property characteristics, including size, number of rooms, age, and several binary indicators for various property features.

From the Census of Governments Government Finance Statistics, I obtain several fiscal aggregates for local governments: total revenues, general revenues (which excludes intergovernmental transfers), property tax receipts, total expenditures, and direct expenditures (which excludes capital spending). I construct regional economic controls using the Bureau of Economic Analysis Regional Economic Accounts for a range of county-level indicators, and information from Atlas Muni Data for demographic controls by government network.

4 Results

I present results in two sections. I first consider all homes in a government network together, and show: (i) a clear lack of immediate capitalization, (ii) negative capitalization at the longest forecast horizon, and (iii) weak evidence of negative capitalization during intervening years. Second, I repeat the analysis while allowing for heterogeneity by home value. There is no evidence supporting negative capitalization for below-median price homes, and strong evidence of negative capitalization for above-median price homes.

4.1 Results for All Homes

All regressions follow the form of equation 1 (OLS) or 2 (IV). The change in horizon induces only a change in the left-hand side variable. All forecast regressions use change in home prices between 2010 and 20XX, with 20XX $\in$ [2011,2016]. Contemporaneous regressions use the change in home prices between 2007 and 2010 – the same period over which the change in unfunded liabilities is measured. Signs are consistent: that is, a positive point estimate in the contemporaneous regression reflects positive growth from 2007 to 2010, and a positive point estimate in a forecast regression represents positive growth from 2010 onward. One noteworthy aspect of the empirical design is that the use of repeat home sales for the LHS variable means that a different set of homes is used for each forecast horizon.[18]

Table 1 shows the results from the contemporaneous regression. Column 1 shows the OLS estimate. Column 2 shows the 1st stage of the IV estimation, and column 3 shows the 2nd stage. Both the OLS and IV estimates are statistically insignificant, and are economically quite small as well. Column 2 shows that the instrumental variable has a strong first stage; the partial F-stat is 12.8 after clustering at the level of the government network. Because the set of homes changes with each forecast horizon, the first stage in the IV is mechanically slightly different in each regression. However, the changes are very small and the instrument has a strong first stage in each specification; I do not revisit first stage results in the discussion below.

Table 2 shows the results for the long-horizon regression which tests capitalization over the 2010–2016 period. The OLS and IV estimates are quote close at just over 3 percentage points smaller growth in response to a 1-unit shock to unfunded liabilities (equivalent to a year's worth of revenue across all governments touching a given home). While the OLS estimate is highly significant, the IV estimate is significant only at 10%. Translating this estimate into real impact: the median value for $\Delta UAAL$ in the data is .42. For the median home, transacting for 200k in 2010, situated in a region facing a median shock, the IV estimate implies a negative capitalization of $2,604 over the next six years.

Together, these two findings establish slow capitalization of unfunded pension liabilities into home prices. Next, I exploit the richness of the house price data to provide a series

[18] I do not preclude overlap in sample; a home selling in 2010 and again in 2012 as well as 2016 would be included in both the 2-year forecast regression and the 6-year forecast. Multiple repeat sales are relatively uncommon and results are robust to excluding such homes.

of cross-sectional forecast estimates that trace out the dynamics of capitalization. Tables 4 and 5 show the regression output for OLS and IV estimates respectively. Figure 2 shows the results graphically using the preferred IV specification. Two points are salient in Figure 2. First, there is very weak suggestive evidence of negative capitalization beginning after two years (in 2012). The IV point estimates are all insignificant, however, with the exception of the 2016 estimate which, as already shown, is significant only at 10%. As the next section will show, heterogeneity by home value is important for understanding results.

The second notable feature of Figure 2 is the strongly significant estimate for 2011 which denotes positive capitalization of unfunded liabilities after one year. It is standard in the real-estate literature to assume that sales in successive years are a likely signal of home-flipping. So these properties may be meaningfully different from the properties used to produce forecast estimates at longer horizons. However, it is still difficult to think of a reason that orthogonal shocks to pension fund assets should affect the incentives of home-flippers or the returns to such a strategy over the next year. Another possibility is that sponsor governments of funds which realize large shocks to fund assets are, in fact, slower to begin filling the financial hole by rerouting dollars from their operating budget than are governments which realize smaller shocks.[19] If the marginal benefit of the services provided with those dollars is initially more salient than the marginal debt, then one might expect services to be capitalized (positively) in the short run and debts only to be capitalized in the longer run (as the evidence in this paper shows). This is an ongoing avenue of research for this paper.

4.2 Heterogeneity by Home Value

In this section, I show that capitalization is starkly heterogeneous by home value. If home-owners believe that future revenues will be raised through an increased property tax levy, it is possible that owners of higher valued homes might react more strongly. Certainly this would be a reasonable expectation if the expected additional levy were substantially progressive. The use of "mansion taxes" to address pubic revenue shortfalls has been an ongoing part of the political discourse in recent years, and so this is not a farfetched possibility.[20]

Within each county, I classify homes as being "high value" or "low value" based on whether the transaction price is above or below the sample median. For all forecast regres-

[19] For future versions of this paper, I anticipate being able to add empirical evidence that can speak to whether this is a reasonable hypothesis.

[20] See, for instance, "NYC Brokers Relieved as Mansion Tax Replaces a Pied-a-Terre Levy", Bloomberg News, April 1, 2019.

sions, I classify homes on the basis of the 2010 transaction price. For the contemporaneous regression, I use the 2007 value for classification. This ensures that the classifying variable is predetermined with respect to the capitalization I am testing for. I then repeat each analysis of the preceding section with this sample split.

The findings are presented in Figures 3 and 4. These figures use the preferred IV specification, and show the contemporaneous estimate to the left of the dotted red line, with the full set of estimates between 2011 and 2016 to the right of the red line. The regression table for the estimates underlying these figures is shown in Table 6.[21] Figure 3 shows the dynamic capitalization for low valued homes. As before, there is no evidence of contemporaneous capitalization. Also as before, this estimation reflects a positive capitalization in 2011. Over the remaining period, all point estimates are not only statistical zeros but are also positive.

Figure 4 shows that high valued homes are driving the finding of negative capitalization. Both the contemporaneous and the 1st year (2011) point estimates are zero. Beginning in 2012, estimates are negative and strongly statistically significant. Although the largest point estimate is for the 2016 horizon, there is no evidence to suggest a downwards drift in capitalization. Rather, this looks like full negative capitalization of the shock to pension debts within approximately two years. In terms of magnitudes, the 2016 estimate suggests a reduction in appreciation of $10,250. This figure is based on a median high value home (330k) facing a median shock to pension debts of 42% of sponsor government revenue. The lowest point estimate, at the 2013 horizon, suggests a reduction in appreciation of $5,550. Table 6 shows the regression output underlying Figure 4.

5 Conclusion

I test whether unfunded public pension liabilities are capitalized into house prices. Using data from public accounting documents, I assemble a novel panel data set of annual financial flows for more than 200 of the largest defined benefit public pension plans in the United States. I observe large quasi-exogenous shocks to fund investments during the Great Recession, which induce changes in unfunded liabilities. Given that individual taxpayers are the ultimate source of public revenues, and that local governments rely very heavily on property tax receipts, I argue that a rational homeowner would internalize increased expected future tax payments (or future curtailment of services) into home valuation. I show that changes in unfunded pension liabilities are not contemporaneously capitalized into home prices, and

[21] Regression output for all OLS estimates and/or 1st stage estimates are available upon request. The sample-split regression output for the 2016 forecast horizon in Table 3.

therefore focus the analysis on forecast regression of changes in home price between 2010 and 2016 regressed on changes in UAAL between 2007 and 2010.

I estimate several versions of this regression using both OLS and two-stage least squares. The IV specifications rest on an instrument for changes in unfunded liabilities between 2007–2010 which I construct from pension fund asset allocations and investment returns during 2008 and 2009. Any correlation between future home price movements and contemporaneous pension fund returns represents a source of endogeneity bias. In particular, if a region forecasts economic difficulty that will depress both home prices and public revenues, it is possible the pension fund would deliberately seek more risk in its investment allocations. During the Great Recession, then, large losses would positively covary with lower home price growth.

To address this, I instrument changes in UAAL between 2007–2010 with asset-class idiosyncratic return. I first obtain fund disclosures of asset class allocation. Then, for every asset class, I select a passive benchmark. I use an asset pricing model to construct factor loadings for each asset class, and then in conjunction with realized returns to these factors, I compute the expected return to each asset class, conditional on market-wide performance. I use as my instrument the weighted sum of residuals across asset classes. During 2008–2009, asset classes performed slightly better or worse than the standard asset pricing model would have predicted. As long as these broad asset-class residuals are uncorrelated with local conditions, this instrument satisfies the exclusion restriction.

I test for capitalization across different horizons by using repeat sales to measure home price growth. From a dataset covering the near-universe of home transactions, I isolate properties which transact in both 2010 and in a future year (or in 2007 in the test for contemporaneous capitalization). I then take the log difference of transaction prices as my independent variable. I aggregate UAALs to the level of a government network – ensuring that I capture the totality of pension debts attached to any given property. I scale these unfunded liabilities by the total amount of 2010 general revenue within a government network. My results show slow capitalization of unfunded liabilities into property prices. There is no evidence for contemporaneous capitalization. At the longest horizon, I do find evidence of negative capitalization, though the statistical significance is weak. I show that this arises from heterogeneous effects by home price.

Using the property-level data, I split the sample into "high" and "low" valued homes – properties above and below the 2010 median price within a government network. It is clear that capitalization is driven by higher valued homes. While estimates for low valued homes are statistical zeros in all cases except at the one-year horizon, high valued homes show statistically and economically significant capitalization beginning two years after the shock to unfunded liabilities. The magnitudes are large: for the median high-valued home, the longest horizon estimate reflects reduced price appreciation of $10,250.

The totality of the evidence suggests that off-balance sheet debt represented by unfunded public pension liabilities does affect local real estate markets. The effects appear to differ by home value. It seems also very plausible that there is regional heterogenity based on existing public financial conditions. The potential for different responses by either existing level of public debt or by other measures of fiscal capacity are anticipated future areas of research. Given the extremely large total stock of unfunded pension liabilities, and the central role of housing wealth in household finance, understanding these relationships better will help inform difficult public finance trade-offs that face retirement systems during any period of fiscal stress.

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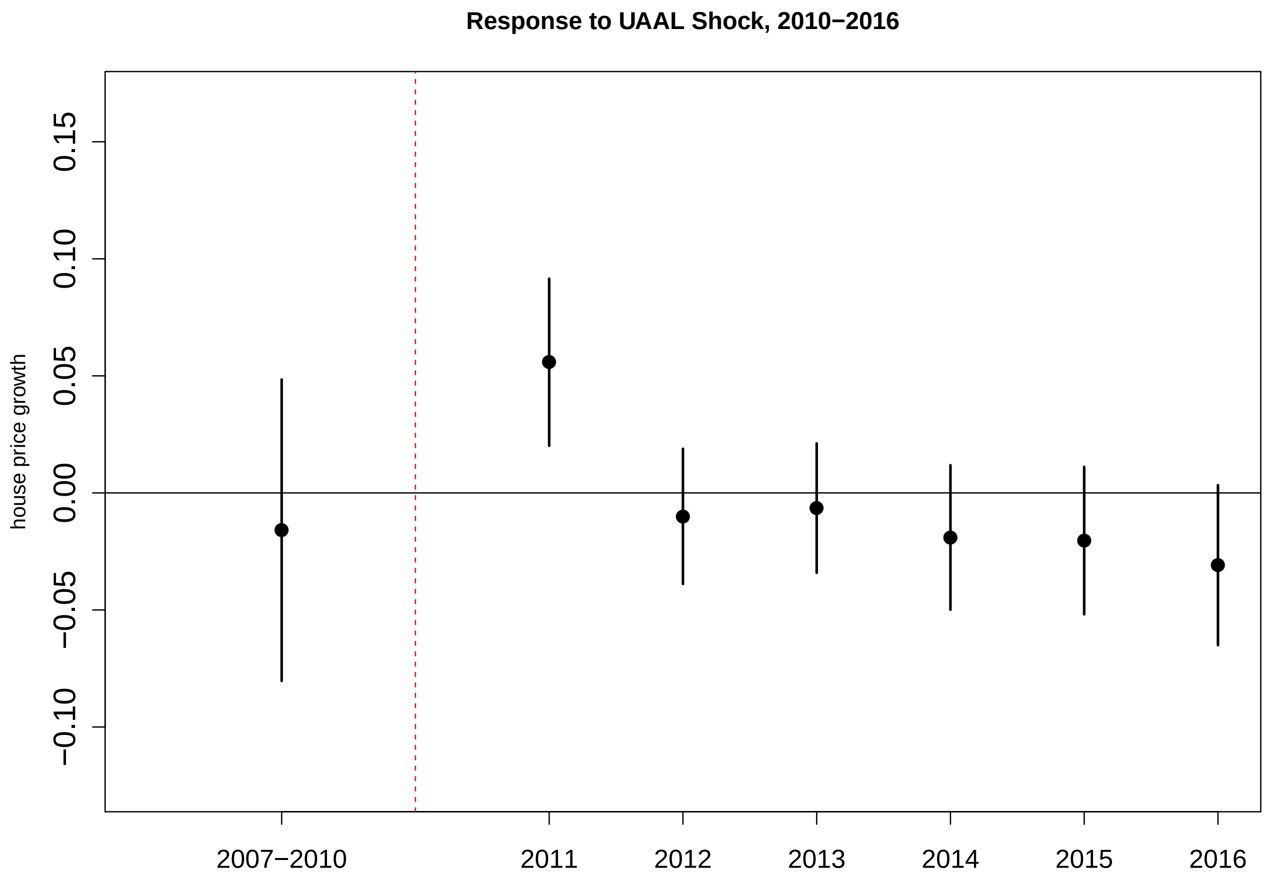
Figure 1: Asset Classes and Benchmarks

Asset Class (from Fund Allocation)	Passive Benchmark	Benchmark Ticker or Series No.
US Treasury	Vanguard Intermediate Treasury	VFIUX
Savings	FRED 3-month or 90-day US CD Rates	IR3TCD01USM156N
Fed Agency Debt	Vanguard GNMA Fund Admiral	VFIJX
State-Local Debt	S&P National AMT-Free Municipal Bond Index	n/a
Corporate Bonds	iShares iBoxx Investment Grade Corporate Bond ETF	LQD
Corporate Stocks	Vanguard Total Stock Market Index Fund	VTSAX
Mortgages	Pimco Mortgage-Backed Securities Fund	PTRIX
Foreign Stocks	Vanguard Total International Stock Index Fund	VGTSX
Real Property	Vanguard REIT Index Admiral Fund	VGSLX
Miscellaneous	Cambridge Associates LLC US Private Equity Index	n/a

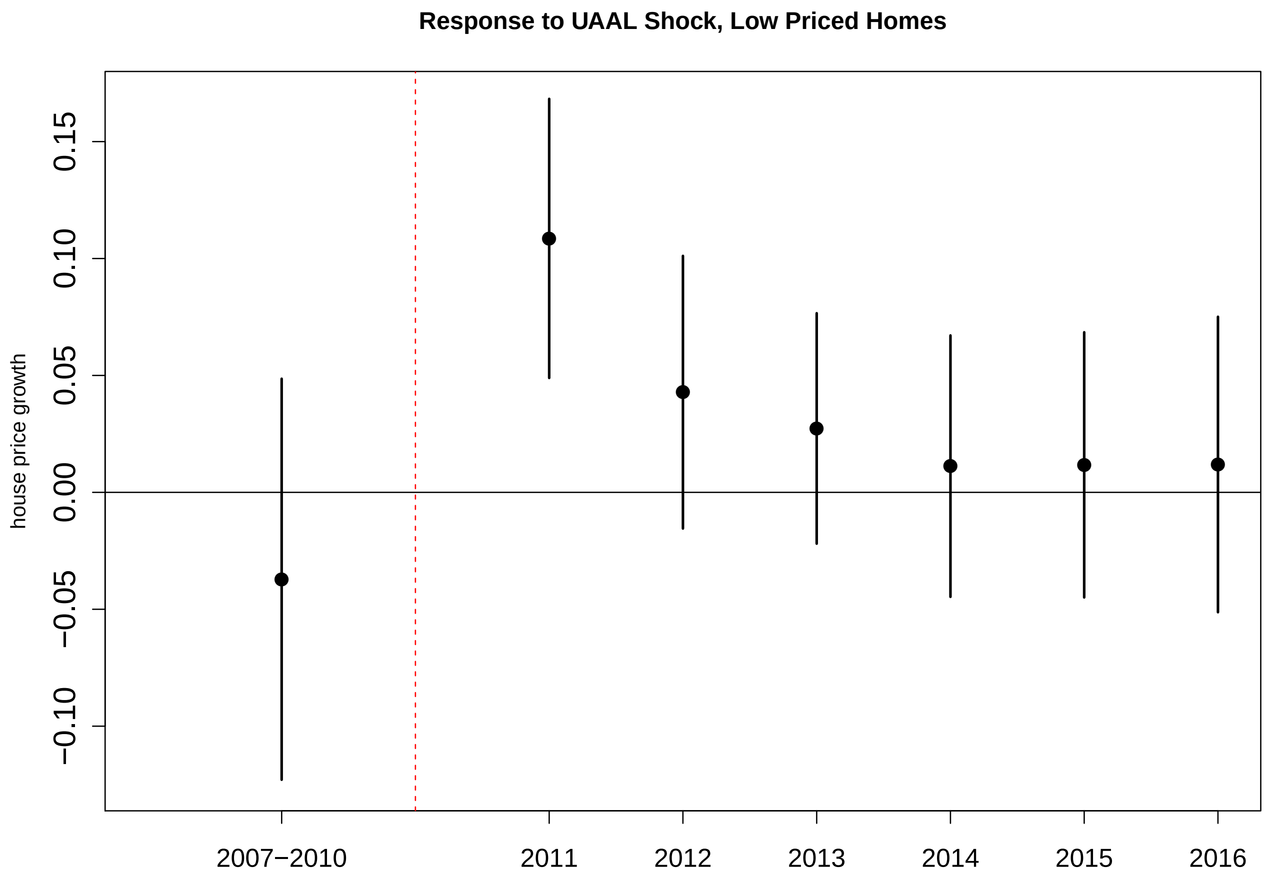
Note: This table lists the pension fund asset classes categories from Census of Governments data (leftmost column), along with the passive benchmark selected to represent the asset class. When applicable, the ticker for the passive benchmark is listed as well. The S&P National AMT-Free Municipal Bond index is not a traded vehicle and does not have a ticker. A private equity index produced by Cambridge Associates is used for the miscellaneous category; this also does not have a ticker. The benchmark for savings is a data series of 3-month CD rates obtained from FRED at the St. Louis Federal Reserve Bank. All other benchmarks are traded and the data on returns is obtained from CRSP.

Figure 2: Asset Classes and Benchmarks



Note: Note.

Figure 3: Asset Classes and Benchmarks



Note: Note.

Figure 4: Asset Classes and Benchmarks

Note: Note.

Table 1: Contemporaneous Capitalization

	Contemporaneous Growth in House Prices, 2007-2010		
	OLS	1st Stage	2nd Stage
	(1)	(2)	(3)
delta(UAAL), 2007-10	−0.003		−0.016
	(0.019)		(0.033)
Returns IV, 2008		-7.381^{***}	
		(1.407)	
Returns IV 2009		-6.750^{***}	
		(2.591)	
delta(Wages), 2007-10	0.715	4.078	0.773
	(1.700)	(3.385)	(1.682)
delta(Unempl. Benefits), 2007-10	0.533^{***}	0.087	0.533^{***}
	(0.111)	(0.338)	(0.111)
delta(employment), 2007-10	0.062	-10.341^{**}	−0.142
	(1.536)	(5.055)	(1.610)
delta(Population), 2007-10	4.363^{***}	7.995^{***}	4.461^{***}
	(1.402)	(2.316)	(1.495)
delta(Public Expenditures), 2007-10	0.126	−0.290	0.072
	(0.255)	(0.567)	(0.291)
Population (level), 2010	-0.049^{**}	−0.126	-0.051^{**}
	(0.022)	(0.099)	(0.022)
Fixed Effects	State	State	State
Partial F-Stat	-	12.8	-
No. Clusters	97	97	97
Observations	43,970	43,970	43,970
R^2	0.168	0.848	0.168
Note:			*p<0.1; **p<0.05; ***p<0.01

Note: This table shows the result of estimating equation 2 using home price growth during 2007-2010 as the dependent variable. The unit of observation is a home sold in an arms-length transaction in 2007 and again in 2010. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. Column (1) presents OLS estimates. Column (2) presents the first stage of a 2SLS estimation. Column (3) presents the 2nd stage estimates. All specifications include state fixed effects, and standard errors are clustered by government network.

Table 2: Long Horizon Capitalization: 2010 to 2016

	Growth in House Prices, 2010-2016		
	OLS	1st Stage	2nd Stage
	(1)	(2)	(3)
delta(UAAL), 2007-10	-0.032^{***}		-0.031^{*}
	(0.011)		(0.017)
Returns IV, 2008		-7.451^{***}	
		(1.455)	
Returns IV 2009		-7.074^{***}	
		(2.730)	
delta(Wages), 2007-10	-0.553	5.532	-0.558
	(0.717)	(3.680)	(0.718)
delta(Unempl. Benefits), 2007-10	-0.049	0.197	-0.049
	(0.074)	(0.393)	(0.074)
delta(employment), 2007-10	0.875	-11.001^{*}	0.887
	(0.773)	(5.919)	(0.727)
delta(Population), 2007-10	-0.324	7.980^{***}	-0.329
	(0.760)	(2.469)	(0.746)
delta(Public Expenditures), 2007-10	-0.333^{**}	-0.367	-0.330^{*}
	(0.167)	(0.558)	(0.199)
Population (level), 2010	0.017	-0.155	0.017
	(0.016)	(0.117)	(0.016)
Fixed Effects	State	State	State
Partial F-Stat	-	12.8	-
No. Clusters	94	94	94
Observations	40,315	40,315	40,315
R^2	0.074	0.877	0.074
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: This table shows the result of estimating equation 2 using home price growth bewteen 2010 and 2016 as the dependent variable. The unit of observation is a home sold in an arms-length transaction in 2010 and again in 2016. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. Column (1) presents OLS estimates. Column (2) presents the first stage of a 2SLS estimation. Column (3) presents the 2nd stage estimates. All specifications include state fixed effects, and standard errors are clustered by government network.

Table 3: Long Horizon Capitalization by Home Value

	Growth in House Prices, 2010-2016	
	OLS	2SLS
	(1)	(2)
delta(UAAL), High Value	-0.086^{***}	-0.074^{***}
	(0.026)	(0.025)
delta(UAAL), Low Value	0.023	0.012
	(0.028)	(0.032)
delta(Wages), 2007-10	−0.687	−0.662
	(0.720)	(0.719)
delta(Unempl. Benefits), 2007-10	−0.054	−0.053
	(0.074)	(0.074)
delta(employment), 2007-10	0.875	0.883
	(0.773)	(0.728)
delta(Population), 2007-10	−0.347	−0.346
	(0.756)	(0.744)
delta(Public Expenditures), 2007-10	-0.334^{**}	-0.331^{*}
	(0.167)	(0.198)
Population (level), 2010	0.017	0.017
	(0.016)	(0.016)
Fixed Effects	State	State
No. Clusters	94	94
Observations	40,315	40,315
R^2	0.095	0.094
Note:		*p<0.1; **p<0.05; ***p<0.01

Note: This table repeats the estimation of Table 2, splitting the sample into low and high valued homes. The unit of observation is a home sold in an arms-length transaction in 2010 and again in 2016. The cutpoint for the split is median home value within each government network, measured as of 2010. This ensures that the sales price in 2016 does not affect the classification into high or low value. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. Column (1) presents OLS estimates. Column (2) presents the 2nd stage estimates. Both specifications include state fixed effects, and standard errors are clustered by government network.

Table 4: OLS Estimates, All Horizons

	Growth in House Prices						
	07-10	2011	2012	2013	2014	2015	2016
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
delta(UAAL), 2007-10	-0.003	0.031^{***}	-0.006	-0.007	-0.022^{**}	-0.025^{***}	-0.032^{***}
	(0.019)	(0.011)	(0.009)	(0.009)	(0.009)	(0.010)	(0.011)
delta(Wages), 2007-10	0.715	0.238	-0.013	-0.594	-0.399	-0.548	-0.553
	(1.700)	(0.861)	(0.638)	(0.600)	(0.603)	(0.721)	(0.717)
delta(Unempl. Benefits), 2007-10	0.533^{***}	-0.143^{**}	-0.071	0.094	-0.013	0.013	-0.049
	(0.111)	(0.066)	(0.053)	(0.118)	(0.055)	(0.071)	(0.074)
delta(employment), 2007-10	4.363^{***}	-0.093	1.150^{**}	0.026	0.303	-0.056	-0.324
	(1.402)	(0.617)	(0.521)	(0.659)	(0.588)	(0.714)	(0.760)
delta(Public Expenditures), 2007-10	0.126	0.192	-0.310^{**}	-0.143	-0.245^{*}	-0.267^{*}	-0.333^{**}
	(0.255)	(0.117)	(0.140)	(0.143)	(0.142)	(0.147)	(0.167)
delta(Population), 2007-10	0.062	-0.309	0.527	0.275	0.520	1.106^{*}	0.875
	(1.536)	(0.846)	(0.771)	(0.686)	(0.662)	(0.656)	(0.773)
Population (level), 2010	-0.049^{**}	0.053^{***}	0.036^{**}	0.026^{*}	0.013	0.006	0.017
	(0.022)	(0.016)	(0.014)	(0.015)	(0.013)	(0.014)	(0.016)
Fixed Effects	State	State	State	State	State	State	State
No. Clusters	97	96	95	95	94	95	94
Observations	43,970	25,809	20,894	33,883	36,210	39,936	40,315
R^2	0.168	0.068	0.032	0.032	0.039	0.057	0.074

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note: This table shows OLS estimates of capitalization for a range of horizons, beginning with the contemporaneous (2007-2010) period and ending with the 2010-2016 period. Note that, for completeness, the first column repeats column (1) of Table 1, and the last column repeats column (1) of Table 2. Each specification differs only in the sample of repeat-sale homes used to construct the dependent variable. The unit of observation is a home sold in both the first and last year of the estimating horizon. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. All columns are estimated using OLS. All specifications include state fixed effects, and standard errors are clustered by government network.

Table 5: IV Estimates, All Horizons

	Growth in House Prices						
	07-10	2011	2012	2013	2014	2015	2016
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
delta(UAAL), 2007-10	−0.016	0.056***	−0.010	−0.006	−0.019	−0.020	−0.031*
	(0.033)	(0.018)	(0.015)	(0.014)	(0.016)	(0.016)	(0.017)
delta(Wages), 2007-10	0.773	0.105	0.015	−0.595	−0.417	−0.579	−0.558
	(1.682)	(0.881)	(0.640)	(0.598)	(0.610)	(0.727)	(0.718)
delta(Unempl. Benefits), 2007-10	0.533***	−0.144**	−0.070	0.094	−0.013	0.013	−0.049
	(0.111)	(0.067)	(0.053)	(0.119)	(0.055)	(0.071)	(0.074)
delta(employment), 2007-10	4.461***	−0.268	1.188**	0.025	0.281	−0.093	−0.329
	(1.495)	(0.648)	(0.538)	(0.651)	(0.594)	(0.718)	(0.746)
delta(Public Expenditures), 2007-10	0.072	0.292***	−0.330**	−0.142	−0.231	−0.244	−0.330*
	(0.291)	(0.108)	(0.167)	(0.164)	(0.170)	(0.180)	(0.199)
delta(Population), 2007-10	−0.142	0.038	0.442	0.278	0.568	1.187*	0.887
	(1.610)	(0.879)	(0.747)	(0.678)	(0.653)	(0.609)	(0.727)
Population (level), 2010	−0.051**	0.056***	0.035**	0.026*	0.013	0.007	0.017
	(0.022)	(0.016)	(0.014)	(0.015)	(0.013)	(0.013)	(0.016)
Fixed Effects	State	State	State	State	State	State	State
No. Clusters	97	96	95	95	94	95	94
Observations	43,970	25,809	20,894	33,883	36,210	39,936	40,315
R^2	0.168	0.067	0.032	0.032	0.039	0.057	0.074

Note: *p<0.1; **p<0.05; ***p<0.01

Note: This table shows IV estimates of capitalization for a range of horizons, beginning with the contemporaneous (2007-2010) period and ending with the 2010-2016 period. Note that, for completeness, the first column repeats column (1) of Table 1, and the last column repeats column (1) of Table 2. Each specification differs only in the sample of repeat-sale homes used to construct the dependent variable. The unit of observation is a home sold in both the first and last year of the estimating horizon. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. All columns are estimated using 2SLS. All specifications include state fixed effects, and standard errors are clustered by government network.

Table 6: IV Estimates by Home Value, All Horizons

	Growth in House Prices						
	07-10	2011	2012	2013	2014	2015	2016
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
delta(UAAL), High Value	0.006	0.002	-0.066^{**}	-0.040^{**}	-0.051^{**}	-0.053^{**}	-0.074^{***}
	(0.030)	(0.030)	(0.030)	(0.019)	(0.020)	(0.021)	(0.025)
delta(UAAL), Low Value	-0.037	0.109^{***}	0.043	0.027	0.011	0.012	0.012
	(0.044)	(0.030)	(0.030)	(0.025)	(0.029)	(0.029)	(0.032)
delta(Wages), 2007-10	0.820	0.024	-0.109	-0.676	-0.497	-0.651	-0.662
	(1.655)	(0.832)	(0.619)	(0.597)	(0.625)	(0.740)	(0.719)
delta(Unempl. Benefits), 2007-10	0.534^{***}	-0.147^{**}	-0.075	0.091	-0.016	0.010	-0.053
	(0.110)	(0.066)	(0.053)	(0.119)	(0.055)	(0.072)	(0.074)
delta(employment), 2007-10	4.473^{***}	-0.272	1.149^{**}	0.004	0.266	-0.106	-0.346
	(1.494)	(0.651)	(0.538)	(0.649)	(0.589)	(0.714)	(0.744)
delta(Public Expenditures), 2007-10	0.073	0.291^{***}	-0.332^{**}	-0.143	-0.233	-0.246	-0.331^{*}
	(0.291)	(0.109)	(0.167)	(0.164)	(0.169)	(0.179)	(0.198)
delta(Population), 2007-10	-0.145	0.017	0.423	0.280	0.564	1.183^{*}	0.883
	(1.610)	(0.878)	(0.749)	(0.680)	(0.653)	(0.609)	(0.728)
Population (level), 2010	-0.051^{**}	0.056^{***}	0.035^{**}	0.026^{*}	0.013	0.007	0.017
	(0.022)	(0.016)	(0.014)	(0.015)	(0.013)	(0.013)	(0.016)
Fixed Effects	State	State	State	State	State	State	State
No. Clusters	97	96	95	95	94	95	94
Observations	43,967	25,808	20,893	33,883	36,210	39,935	40,315
R^2	0.170	0.094	0.055	0.048	0.052	0.071	0.094
Note:					*p<0.1; **p<0.05; ***p<0.01		

Note: This table shows IV estimates of capitalization for a range of horizons, beginning with the contemporaneous (2007-2010) period and ending with the 2010-2016 period. The sample is split into low and high valued homes. The cutpoint for the split is median home value within each government network, measured as of 2010 (and as of 2007 for the contemporaneous regression). Each specification differs only in the sample of repeat-sale homes used to construct the dependent variable. The unit of observation is a home sold in both the first and last year of the estimating horizon. The regressor of interest, $delta(UAAL)$ is the change in unfunded liabilities between 2007 and 2010 for all pension funds associated with a sponsor government that contains the home in question. This variable is scaled by a measure of available funds: the total amount of general revenue raised by all sponsoring governments in 2010. All columns are estimated using 2SLS. All specifications include state fixed effects, and standard errors are clustered by government network.