

THE ASSET PRICE OF A HOUSE

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Abstract

An asset-pricing model is derived for a house based on conditions from the rental and mortgage capital markets. The house's rent-price ratio has factors for expected real appreciation, mortgage rates and inflation. Each factor's coefficient is its rent-price incidence, or proportion of shocks borne by tenant users. Over 1981-2013 U.S. houses are near bonds. Rent-price yields reflect only 17% of real house asset price or mortgage shocks. A house's equity premium is bond-like at 1.05% annually, one-quarter that of stocks. During 1998-2004 houses earn a stock-like equity premium above 5% annually before reverting, potentially presaging the crisis.

Keywords: houses, asset pricing, mortgages, rental yields.

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1. Introduction

This paper derives an asset-pricing model for a house. Housing returns have two long-term phenomena in developed countries. One is that prices appreciate at a rate only slightly above inflation. Shiller (2015) reports a series of real house prices since 1890 in the United States with ongoing updating. Over 1890-2016 house prices increased in real terms at an annual rate of 0.3%. For the century between 1890-1990 real house price did not increase at all.

The other is that the rent-price dividend yield has bond coupon features. The yield fluctuates around a constant. Much of the volatility in rents is borne by those who move, exercising the flexibility of mobility. More than half of U.S. tenants renting a house and staying in place pay the same nominal rent on renewal.¹ These two phenomena make a house a near bond, with low real appreciation, and stable rent-price dividend yields.

Yet there are other conditions where house prices rise more rapidly than inflation. At the neighborhood level, attractive amenities such as schools are capitalized in nearby property. In cities, houses in agglomeration economies near Silicon Valley technology or Manhattan finance capture a nearby equity premium. Countries with capital controls and limited financial markets create in houses a domestic store of value. In the limit, expected appreciation creates ghost cities where houses have no occupancy, growth-stock assets with no dividend yields.

In the asset-pricing structure, a house's return is the summed product of coefficients and associated factors. The factors are not arbitrary, but emerge from the capital decisions on a house. Each factor's coefficient is the tenant's proportion of risk in the rent-price ratio. Lower

¹ Nominal rents are flat for more than half of tenants during 1974-1981 in Genesove (2003). The proportion has increased since to almost two-thirds for houses over 1998-2011 (Verbrugge and Gallin (2012)).

incidence or tenant risk allocation reduces volatility of the rent-price ratio. This low rent-price volatility is consistent with constrained tenants and limited markets to lay off cash flow risks. In the limit when with all coefficients zero, tenants bear none of the risks of housing and the rent-price ratio is constant. A house is a pure bond.

The factors emerge from an intertemporal condition equating the return to adding a unit of housing services with its cost. In a complete capital market, the rent-price ratio is the difference between the mortgage rate and capital gains. Adding capital gains to each side, the return to holding a house is the mortgage rate. Since the capital market is complete, the mortgage rate prices debt, equity and rent payments. There is no separation between owners and tenants.

In an incomplete capital market, households have constraints in accumulating rents and security deposits, equity down payments or qualifying for a mortgage. These constraints lead to incidence coefficients of the mortgage rate and capital gains that are different from one, or 100%. In the complete capital market, households are willing to accept 100% of the volatility of rent-price ratios. The absence of markets forces down the willingness of tenants to accept volatility in mortgage rate and capital gains. To the extent that there are transaction costs or cash requirements for rent, inflation is an additional factor.

Lower incidences are the market solution to insuring risk for constrained tenants. These reduce the dividend volatility of a house. Households retain the alternative of ownership, receiving the rental dividend yield and capital gains as a total return. Since households have the option to rent and make bond-like payments, their expected capital gains in ownership fall to near zero. At the aggregate level with exceptions near high-performing schools or

agglomeration locations, houses become bond-like. In the exceptions, households take on rent-price volatility as part of the return from living nearby.

In the asset-pricing condition, the rent-price yield is equal to a fundamental plus the weighted sum of the factors for the mortgage rate, capital gains and inflation. The weights are the incidences or tenant risk proportions. The return is the sum of the rent-price yield plus capital gains. The return to holding a house is the fundamental yield plus the weighted factor sum as the equity premium.

The equity premium for holding a house has components for each factor. It is the mortgage capitalization plus the asset equity claim, adjusted for inflation. The capitalization is the product of the tenant's risk allocation and the real mortgage rate. Mortgage rates and ultimately interventions such as quantitative easing move housing volumes only if they change the rent-price ratio. The homeowner's proportion of a house's asset risk multiplied by real appreciation is the asset equity claim.

To change a house from being a near-bond requires a structural break that shifts incidences toward one in absolute value. These shifts make tenants more willing to accept volatility from shocks in the rent-price ratio. Tenants' compensation is removing the incomplete capital markets for rents, down payments or qualification for homeownership.

The application is to quarterly aggregate data for the United States from 1981 to 2013. A requirement is rent and price data be in currency, to determine yields and total returns. Typical house price data have several issues. Data in index form make it not possible to determine the price of a house in dollars. Data on rents are in index form as well, requiring them to be converted to dollars.

In the United States a house is a near bond. The incidence or tenant risk proportion of expected real house price appreciation on the rental yield is -0.17. Users of houses bear only 17% of asset-price shocks as passed through to rental yields. Owners bear the remaining 83% of house price shocks.

The mortgage market is fully capitalized. The tenant risk proportion of mortgage-rate shocks is the same 0.17. A 100 basis point decrease in mortgage rates leads to a decrease in the rent-price ratio of 17 basis points.

The mortgage capitalization, the product of the 0.17 tenant incidence and the real rate is 0.35% annually. The asset claim of a house is the product of the 0.83 owner incidence and real appreciation of 0.84% or 0.70% a year. Adding the two and in real terms, a house earns an equity premium of 1.05% annually. This is about one-quarter of the 4.04% that stocks earn as an equity premium over 1981-2013.²

There is an exception. Structural break tests across separate data sets reveal a difference during 1998-2004. A house changes from being a bond, with tenants accepting 65% of house price volatility in the rent-price ratio. A house earns an equity premium of 5.2% annually, above that of stocks. Implied price elasticities of demand for houses fall to as low as -0.02, virtually panic buying. The near-elimination of capital gains taxes, low-interest mortgages and notably no-income, no-job, no-asset (ninja) subprime loans qualification all occur during this period. Ninja loans allow all households to become homeowners, removing the demand for bond-like rentals and capitalizing the policy benefits in real asset prices.

Section 2 provides more detail on long-term patterns in housing returns, in some cases with centuries of data. Section 3 derives the house asset pricing. Section 4 describes the data

² The equity premium on stocks and other assets throughout is accessed from Aswath Damodaran's website at <http://pages.stern.nyu.edu/~adamodar/>.

construction on returns to holding housing, requiring rents and prices in currency. Section 5 has empirical results and Section 6 concluding remarks.

These aggregate data for the United States indicate that a house is largely a bond. This result does not have to occur everywhere. The structure is flexible, to accommodate any allocation of risk between tenants and owners in neighborhoods, metropolitan areas, countries and specific assets.

2. Background

Houses have long time series on returns, as they have served as institutional investments for centuries. The evidence is that capital gains are at a rate only slightly above general inflation, at 0.6% annually or less. Rent-price ratios have limited volatility.

On capital gains, Shiller (2015) finds that over the 125 years from 1890 to 2015 real United States house prices increase by 0.3% annually.³ The result applies to other real assets. A repeat-sales index for New York skyscrapers for 1899-1999 finds virtually zero real appreciation. The conclusion is that “the long-term historic return to New York commercial property must mostly comprise yield with capital gains limited to general inflation.” (Wheaton, Barnaski and Templeton (2009: 69)).

In Europe, house price series have been available for nearly a millennium. Real house prices in Paris have increased by 0.6% over more than 815 years since 1200.⁴ In Oslo, real house prices increase by 0.3% annually over almost 200 years over 1819-2003 (Eitheim and Erlandsen (2004)).

³ The index splices together data for 1890-1952 (Winnick (1955), Grebler, Blank and Winnick (1956) and the Board of Governors of the Federal Reserve System for 1953-1958. After 1959 the price series is the S&P/Case-Shiller repeat-sales index (Case and Shiller (1989)) where the house is constant.

⁴ The source is a splicing over centuries with continuing updating from the French government agency, the Conseil Général de L'Environnement et du Développement Durable (CGEDD, (2016) at <http://www.cgedd.developpement-durable.gouv.fr/> .

The other phenomenon is relatively stable dividend yields and coupon rents for those who stay in place. In Europe, houses have been institutional investments for centuries. Institutional investors including hospitals, orphanages and poorhouses have owned houses as rent-generating investments. Over more than three centuries during 1650-2005 the same house has a relatively constant yield. The rent-price ratio fluctuates around 6% annually (Ambrose, Eichholtz and Lindenthal (2013)). Real house price appreciation over the period is 0.25% annually.

A household choosing long-term tenancy as opposed to homeownership faces limited cash-flow volatility. Genesove (2003) examines the *Annual Housing Survey* of the U.S. Census and finds that a majority of tenants have no nominal rents on a house over the relatively inflationary 1974-1981. A similar finding is that 54% of tenants renewing in place have the same nominal rent during 1998-2011 from Bureau of Labor Statistics microdata (Verbrugge and Gallin (2012)). The phenomenon is not confined to the United States. In Japan, more than 90% of tenants who renew receive the same rent (Shimizu, Nishimura and Watanabe (2010)). In Hall (2005), prices are sticky over the cycle, with adjustments coming from counter-cyclical spending on search and focused on those who move.

While occurring at the aggregate level, these bond-like conditions are not universal. In some metro areas of the United States, houses have long-term positive real appreciation above 1% annually. These results suggest houses have a stock-like output claim. The S&P/Case-Shiller house prices are for 20 large U.S. cities. Near finance, technology and entertainment, over 1981-2013 real house prices grow by 1.6% in New York, 2.0% in San Francisco and 2.1% in Los

Angeles. In China since 2000, expected capital gains are so pronounced that houses are bought with no occupancy or rental yield.⁵

By incorporating an incidence for the house asset, mortgage or any potential pricing factor, the relationship between demand and supply elasticities can be determined. In Han (2013) households accept lower returns to hedge against future risks in markets with inelastic supply.

Having data on rents and price in currency form allows for the construction of the total return. The total return to holding a house is the dividend yield in a rent-price ratio plus capital gains. Favilukis, Ludvigson and Van Nieuwerburgh (2015) view financial innovation as driving the housing rent-price ratio. The return is the capital gain adjusted for depreciation plus the ratio of rent to the price of a house. Prices are more volatile than rents and adjust to shifts in underwriting and transaction costs. Positive shocks in eased loan standards raise relative prices in 2000-2006, reducing the rent-price ratio. Households balance this hedging against the financial costs of being locked in, given the lack of diversification and transaction costs (Han (2010)).

Sinai and Souleles (2005) show that rents are persistent, with first-order correlation of 0.85. Institutional rigidities limit long-term rental contracts, with 98% of residential rental leases being of one year or less. To hedge against residual rental and duration risks households buy houses. Brunnermeier and Julliard (2008) examine the relationship between the rent-price ratio, interest rates and inflation. The rent-price ratio is decomposed into a rational and a mispricing effect, the latter influenced by inflation. The nominal rather than the real mortgage rate affects the rent-price ratio if there is money illusion.

⁵ Ghost cities have emerged, such as Ordos in Inner Mongolia Ordos is viewed as the burial place of Genghis Khan and has become characteristic of ghost cities.
<http://content.time.com/time/photogallery/0,29307,1975397,00.html>

3. Asset Pricing

A house's asset pricing is based on two conditions that determine volume and return. The volume condition is for housing services from the tenant as compared with the offerings by owners. The return condition is from an intertemporal structure of adding to a house.

The tenant pays a contractual rent and the landlord receives it. There are shocks not necessarily incorporated in the rental contract. The shock becomes a difference between the payment and receipt, and this risk is allocated between the tenant and landlord.

The volume condition determines the risk allocation. A house has price H . The house produces shelter services as a flow with rent R . The gross rental yield or rent-price ratio is $c = \frac{R}{H}$. A house is subject to shocks from factors x . The net rental yield n to the owner after shocks is

$$(1) \quad n = c - x.$$

Each shock has an associated volume, such as for housing services or a mortgage balance. The user or tenant pays a rental yield c with change dc . The volume growth from tenants is $v = \eta_D dc$ with elasticity η . The owner or landlord sees a net return $c - x$. An owner-occupier is both a renter and landlord. The volume growth by owners is $v = \eta_S(dc - dx)$. The risk allocation of a shock between the tenant and owner is the solution of $v = \eta_D dc = \eta_S(dc - dx)$, implying

$$(2) \quad \frac{dc}{dx} = \frac{\eta_S}{\eta_S - \eta_D} \equiv \beta \quad 0 \leq \beta \leq 1.$$

A shock's impact on the rental yield is the risk proportional or incidence β . When $\beta = 0$ the tenant bears none risk and there is no rent-price volatility. When $\beta = 1$ the tenant

bears all the rent-price volatility. The complement $1 - \beta$ is the landlord or owner's proportion of the risk. Integrating, the rent-price ratio satisfies

$$(3) \quad c = \alpha + \beta x \quad 0 \leq \beta \leq 1 \quad c \geq \bar{c}.$$

This is the asset-pricing equation for a house for factors x . The constant of integration α is the yield fundamental.

While consistent with linear regression for estimation, there are constraints. The parameters must lie within a bound of zero and one $0 \leq \beta \leq 1$. When tenants bear no risk, the rental yield is α and a house is a pure bond. The rent-price ratio is bounded below at minimum by zero. The limit \bar{c} is applied since rental must cover at least the marginal costs of occupancy such as wear-and-tear.

The volume condition establishes the risk allocation β and imposes parameter restrictions. To estimate requires specific factors for x . These factors come from the valuation of a house in the capital market.

A house contains a stock of existing services A , aggregated in a concave function $F(A)$. Net additions after depreciation are \dot{A} where a dot denotes a time derivative. The value of a house is the sum of the existing stock and additions or $F(A) + b\dot{A}$ with b is the price of construction. The owner maximizes the house's value subject to financial market conditions. The asset price of a house per unit is H_t at time t .

In a limiting base case there is a complete capital market at mortgage rate m . Households have unrestricted access at m for debt, down payment equity, rent and security deposits. In this complete capital market $H_t = He^{-mt}$, with H the fundamental price of the house. The owner equates the return to housing services with the financial cost. The return to housing services is the rent, or $F'(A) = R$. The financial or mortgage cost satisfies the capital

condition $-\dot{H}_t = -\frac{\partial}{\partial t}[He^{-mt}] = mH - \dot{H}$. Equating the return and mortgage cost, under complete markets the rent-price ratio is

$$(4) \quad c \equiv \frac{R}{H} = m - h.$$

Comparing with the incomplete markets case, the pricing factors are the mortgage rate m and capital gains h both with coefficients of one. Tenants have full access to the capital market, so bear all rent-price risks. As markets are less complete, incidences fall below one and tenants bear less risk and volatility in rent-price ratios. So the condition $c = m - h$ is a limiting test of the asset-pricing condition. An inflation factor p under complete markets has a zero coefficient.

Combining the risk allocation (3) with the pricing factors (4) the asset-pricing estimating equation is

$$(5) \quad c = \alpha + \beta_m m_p - \beta_h h_p + \beta_p p \quad 0 \leq \beta_m, \beta_h \leq 1, c \geq \bar{c}.$$

The real mortgage rate and rate of appreciation are $m_p = m - p$ and $h_p = h - p$.

As an asset-pricing model, the rent-price ratio offers discipline and structure. Its parameters are constrained and are the risk allocations of shocks. The dependent variable is bounded.

The return to holding a house is the sum of $z = c + h_p$ or

$$(6) \quad z = \alpha + \beta_p p + \beta_m m_p + h_p - \beta_h \min(h_p, \bar{c}) \quad 0 \leq \beta_m, \beta_h \leq 1 \quad .$$

Above a fundamental α and adjusted for inflation, a house earns an equity premium $\beta_m m_p + h_p - \beta_h \min(h_p, \bar{c})$.

This equity premium is the capitalized value of the mortgage market $\beta_m m_p$ plus an output claim $h_p - \beta_h \min(h_p, \bar{c})$. When a house is a pure bond, rental yields are constant and $\beta_m = \beta_h = 0$. The absence of rental yield volatility reduces the incentive to hold a house and

real capital gains fall toward zero. Monetary policy has limited impact on the housing market, by not being able to shock the rent-price ratio.

When tenants accept more risk in the rent-price ratio, the coefficients β_m, β_h rise above zero and towards one. A house shifts away from a bond to being a more-risky asset, with real capital gains rising and generating an output claim. The constrained estimation of the asset-price equation determines what type of asset a house is.

4. Data

The data required are rent and price series in currency form. Currency data generate the rent-price ratio or dividend yield as the dependent variable. The data are quarterly aggregate time series for United States rents and house prices over 1981Q3 to 2013Q3. The data procedures for the rents and prices in currency are based on Davis, Lehnert and Martin (2008) at the aggregate level at www.lincolnnst.edu/resources. The currency benchmarks for rents and prices use data from decennial Census. An alternative set of benchmarks is from the Annual Housing Survey conducted by the Census, from which rents and prices of comparable housing are available.

The Census years 1980, 1990, 2000 and 2010 provide rent and house price data in currency form, which can be corrected for quality. A rent-price ratio is available in these years once there are currency data in each case.

The Bureau of Labor Statistics residential rent index as part of the Consumer Price Index is converted to currency using the currency benchmark. This benchmark is anchored to the third quarter of Census years, while retaining the volatility of the index. The price levels of owner-occupied houses from the Census similarly anchors an analogous currency series.

One price series is the S&P/Case Shiller national index. This index uses matched paired repeat-sales transactions based on a set of metro areas. Another price series is the purchase-only index for mortgages purchased by the entities Fannie Mae and Freddie Mae across the country. The series uses repeat sales of the same house and is prepared by the entities' regulator, the Federal Housing Finance Agency (FHFA), also the Office of Federal Housing Enterprise Oversight (OFHEO).

The ratio of the rent to price in currency is the dividend yield and dependent variable. The total return to holding a house is the sum of the dividend yield plus capital gains. The yield and return are available from the series on currency.

The pricing factors are expected real capital gains, the real mortgage rate and expected inflation. Expected real capital gains are estimated as the best-fitting lag of actual outcomes. Lags are from 6 months to up to three years. Inflation is measured from the BLS in the Consumer Price Index. Real expected appreciation is for the relevant growth of the house price index less the rate of inflation. Real mortgage rates are based on the 30-year fixed-rate mortgage from Freddie Mac.

Figure 1 shows a scatter of United States quarterly data on the rent-price ratio on the vertical axis in percentage points. On the horizontal axis is the S&P/Case-Shiller house price index growth in percentage points. The house price index is lagged by two quarters. The fitting red line is virtually flat, suggesting bond-like house behavior. The intercept is at 4.7% annually for the rent-price ratio. Figure 2 shows the rent-price ratio against capital gains. Prices are measured by the FHFA or OFHEO price index. The results are almost identical with an intercept at 4.7%, with the the rent-price ratio even more bond-like.

5. Empirical Results

Houses As Bonds

Table 1 estimates the asset pricing equation with its three pricing factors for expected real capital gains, mortgage rates and inflation. The dependent variable is the rent-price ratio taking account of co-integration and estimated by dynamic ordinary least squares. The last column reports the unit root tests for stationary time series with a constant and time trend.

Expected real capital gains are obtained by testing for the best-fitting actual lagged value. The lags are by quarters from one to 12. Under four of the criteria, the best-fitting lag is at eight quarters. A two-year lag is best fitting for FHFA and S&P/Case-Shiller prices, but results at six months and one year are reported for comparison.

The first three columns use the FHFA price index. The results for the main factor of interest for expected real capital gains are in boldface. The next three columns use S&P/Case-Shiller for house prices. Each set of three columns are in order, at lagged actual outcomes for six months, one and two years.

All three pricing factors have predicted signs and are within their boundaries for tenant risk proportions. From the discipline of the pricing factors, the mortgage incidence is bounded between zero and one. The expected real capital gains coefficient is predicted to be negative from the capital market condition. The bound for the portion of house price risk borne by the tenant is between zero and negative one. Inflation's bound is the sum of the two tenant risk proportions with no money illusion.

Houses are bond-like. For the best-fitting two-year lag on expected appreciation, the incidence is -0.163 for FHFA prices and -0.178 for S&P/Case-Shiller, within the zero and negative one bound. While significant at the 1% level, only one-sixth of asset price shocks shift to rental yields. Rental yields are relatively resilient and unchanged with asset price movements. A 1% increase in expected house price appreciation reduces rental yields by 0.16 to 0.18 of 1%.

At shorter lags on expectations a house is even more bond-like. At one year, the tenant house price risk proportions are -0.068 for FHFA prices and -0.093 for S&P/Case-Shiller. A tenant bears only 6.8% of real house price shocks with FHFA prices and 9.3% of shocks for S&P/Case-Shiller. The owner bears the remaining 93.2% and 90.7% of real house price volatility.

When a lag of six months on expectations of capital gains is used, a house is a pure bond. For the FHFA price index the coefficient of -0.028 is not significantly different from zero. For S&P/Case-Shiller prices the estimate is -0.056. While significant at the 5% level, no more than 6% of asset price shocks are shifted to tenants in the rental yield. There is little volatility in rental yields facing tenants from expected real house price shocks. Tenants are relatively immune, and their rental yields remain stable.

The mortgage factor in the FHFA price series has a tenant risk proportion of 0.146 at a two-year lag on expectations and 0.161 for S&P/Case-Shiller. Rental yields are highly insensitive to the mortgage market. The results are relatively robust across specifications with the incidence ranging from 0.139 to 0.161. Only at most one-sixth of a mortgage market or rate shock feeds through to the rental yield that is pricing housing services. The remaining five-sixth of the shock is absorbed by asset holders. The mortgage interest rate is the 30-year Freddie Mac contract, the subject of intensive quantitative easing and other interventions.

The mortgage and housing asset markets are integrated and capitalized when the tenant liability and asset risk proportions are equal in absolute value. A Wald test of equality is imposed on the mortgage and asset coefficients. For the two-year expectations, the sum of the mortgage and asset incidences is -0.0178 with a standard error of 0.035 for the S&P/Case-Shiller price index. For the FHFA, the sum of the tenant house price and mortgage risk allocations is -0.017 with a standard error of 0.037. The sum is not significantly different from zero at a 1% level,

indicating that the mortgage market is fully capitalized. Mortgage market institutions are capitalized in U.S. house asset prices. With capitalization, a monetary policy intervention is not different from an asset price shock.

The lower panel reports results for cointegration. Estimation is in first differences, including an error correction using the residuals of the first stage asset pricing equation. The error correction as the lagged residual has a quarterly adjustment rate of between 1.6% and 1.9%. This coefficient is not significant at the 5% level in any of the specifications, supporting the underlying specification of the asset pricing equation.

A set of robustness specifications is carried out, apart from different lags on expectations and separate price indexes. One is to replace expected with unexpected inflation. A four-lag autoregressive process on inflation is used for forecasting expected inflation. The difference between the actual outcome and this forecast is the rate of unexpected inflation. The other is to use clustered volatility and determine the sensitivity of results. The clustered volatility is with the generalized autoregressive conditional heteroskedasticity GARCH (1,1) specification frequently observed for financial asset returns.

Table 2 examines the asset price equation under unexpected inflation and with clustered volatility. Unexpected inflation replaces its expected counterpart as a pricing factor. That leads to holders having unexpected real house price appreciation. Unexpected inflation is the residual from the difference between the actual outcome and a four-quarter weighted autoregressive lag. A GARCH(1,1) specification the variance depends on its lag and that of squared residuals from the asset pricing equation. These forms are estimated for FHFA and S&P/Case-Shiller prices. In all specifications, unexpected and expected capital gains are at the best-fitting two-year lag.

Houses remain bond-like. The tenant risk proportions of real house price shocks are in boldface. Unexpected real capital gains have an impact on rental yields of -0.191 for FHFA and

-0.200 for the S&P/Case-Shiller price index. For the GARCH(1,1) specification, the coefficients are -0.217 and -0.290. At the largest incidence estimate, 71% of asset price shocks are borne by house owners without being reflected in rent-price ratios.

The mortgage rate incidence on the rent-price ratio is 13.4% for FHFA data with unexpected inflation, and 13.9% for S&P/Case-Shiller. The remaining 86.6% and 86.1% is borne by homeowners without being reflected in the price of housing services. For the GARCH(1,1) rising mortgage rates have less impact on tightening the market for housing services. The incidence is 9.4% and 9.8% for the FHFA and S&P/Case-Shiller series.

Table 3 constructs the equity premium for a house across the specifications of Tables 1 and 2. In the first column, for FHFA prices and expected inflation a house earns an asset premium of 0.70% annually. With only this component of an equity premium a house earns one-sixth the premium of large stocks. The real output effect of a house above its dividend yield is its real rate of appreciation multiplied by the incidence accruing to the owner. That incidence ranges between 71% and 84% across specifications. The owner receives all real capital gains. The subtraction of the incidence from 100% represents the proportion offset by the dividend yield falling as real appreciation rises.

This tenant asset incidence from Tables 1 and 2 is between 16% and 29% of real house price shocks at the two-year lag on expectations. It is smaller and in the limit is zero at a shorter lag. The relative bond-like behavior of houses forces down real appreciation, which is 0.84% annually over the 1981-2013 period for FHFA and 0.90% for S&P/Case-Shiller.

In the first column of Table 3, the owner has an asset incidence of 0.837. The owner bears 83.7% of real house price shocks, with the tenant carrying the remaining 16.3%, based on the coefficient of -0.163 from Table 1 at a two-year lag on expectations. The second row has the asset equity premium. Over the sample period from 1981Q3-2013Q3 real house prices increase

by 0.84% annually. The house's asset equity premium is the product of the owner's risk proportion and the expected real rate of appreciation $(1 - \beta_h)h_p$ or 0.70% annually. The owner receives all the real appreciation h_p as part of the return. Offsetting this real appreciation, the owner surrenders $-\beta_h h_p$ in taking a lower dividend yield. Tenants share in the appreciation by receiving lower rent-price ratios.

The third row contains the mortgage incidence estimate from Table 1 of 0.146. The rent-price dividend yield bears 14.6% of the shocks in the mortgage rate. The owner receives the benefits of the mortgage market through the rent-price ratio, capitalized at $\beta_m m_p$ as 0.35% annually.

A house's output contribution $(1 - \beta_h)h_p$ is the product of the owner's house risk proportion and real appreciation. Using 17% as the midpoint tenant risk proportion in Table 1, the owner carries 83% of asset price shocks. The product of the owner asset incidence and the real house price growth rate is the output claim or 0.70% annually.

The fifth row has the equity premium to holding a house, as the sum of the real asset and mortgage liability effects, controlling for inflation. Adding the asset and liability components together, a house's equity premium is 1.05% annually. The real output part of the equity premium from holding the asset is 0.70% annually. The capitalized benefit of the mortgage market is 0.35% annually. Over the same period 1981-2013 the equity premium on stocks is 4.04% annually from Damodaran (2016) <http://pages.stern.nyu.edu/~adamodar/>. The results confirm the bond-like behavior of a house. These results use a two-year lag on expectations of appreciation. At shorter six-month and one-year lags a house is ultimately a pure bond. Its rent-price ratio is insensitive to systematic risk shocks.

Across the last row of Table 3 the results are relatively robust to specifications about the type of price index, inflation expectations and clustered volatility. A house earns an equity

premium of between 0.93% and 1.07% annually. These estimates are based on a two-year lag of expectations about real house price appreciation. At shorter lags house become more bond-like, reducing the equity premium closer to zero.

When Houses Aren't Bonds

A house is bond-like. It earns a stable income yield. The stable income yield makes houses relatively insensitive to shocks in asset prices or interest rates. Households always hold an alternative to rent and pay an assured long-term yield. That stable yield assures that there is a limited with expected capital gains. With these expectations embedded, real house capital gains over a long term are near zero. For the United States over 1981-2013 houses earn an equity premium of 1.05% annually as compared with 4.04% for stocks.

The next set of issues is whether a house's behavior is stable over time. In particular, there is a potential link between housing and the financial crisis of 2008-2009. The strategy is to test for structural stability and whether houses have remained bond-like. Then, the model offers predictions as to what drives changes in the house asset over the short term.

Table 4 reports structural break tests under two separate expectations about real FHFA house price appreciation. The first block is at a two-year lag on expectations. The second block is where lagged six month outcomes are expected real appreciation. The first block shows three structural breaks with four estimating periods using the Bai-Perron test at 1988Q1, 1998Q1 and 2004Q4. The second block has six-month lagged expectations, where the data indicate five structural breaks.

Here the breaks of note are in 1998Q1-2004Q3 and 1999Q2-2004Q1. These two breaks are part of the 1997-2006 window where houses do not behave as they have apparently for more than a century in the United States. That behavior is consistent with estimates in Tables 1 and 2 for the entire period 1981-2013 with tenant risk proportions in a range from zero to at most 29%

of price or rate shocks. Tenants paying rental yields bear little asset price or mortgage rate volatility.

That changes during 1997 to 2006 across both types of expectations. From column (3) the tenant's risk incidence jumps to -0.878. The standard error of 0.041 puts the estimate within striking distance of negative one, its lower limit. In column (8) while for a smaller sample window from 1999Q2-2004Q1 the tenant asset incidence is -0.882 with a standard error of 0.134. A plausible confidence interval contains negative one where renters are bearing all the risk of price shocks.

At this estimate each 1% increase in expected real house prices leads to a reduction of 1% in the rent-price ratio. With increased volatility in the rent-price ratio, the nature of the house asset has changed. Holders expect greater real house price appreciation, and accept yield volatility in exchange. Households give up the base-case bond yield method of obtaining housing services.

Since rent-price ratios are bounded below at zero, for a substantial enough increase in expected real appreciation it becomes optimal to own but not occupy a house. This condition includes holding second and other houses, since a household cannot occupy both at the same time. This is the ghost-city condition. That does not require substantial expected real appreciation once the asset-price incidence is near one in absolute value. From Figures 1 and 2, the base rent-price ratio for a house in the United States is 4.7%. If expected real house price appreciation exceeds 4.7% annually and the asset incidence is one in absolute value, it will take a year to make it optimal to hold an empty house. The nature of a house changes, to one with growth prospects and low or even no dividend yields.

Since the 4.7% annual is a gross rent, it does not include the variable costs of occupancy. A landlord should collect at least utilities, cleaning, maintenance, use and search to cover the

cost of renting. For empirical purposes, this lower bound on the rent-price ratio \bar{c} is set at 2% annually.

For higher asset price incidences near but not at one in absolute value, a house is becoming a more-risky asset. From the $(1 - \beta_h)h_p$ measure of a house's asset equity premium, the owner is obtaining all the expected real appreciation from h_p . The high rental yield incidence forces down $1 - \beta_h$, as the house owner loses in a reduced rental yield $-\beta_h h_p$. Tenants are accepting higher volatility. By remaining and surrendering the option to obtain high real capital gains tenants are rewarded with lower rents relative to house prices.

During the 1981-2013 sample period house prices increase in real terms by 0.84% annually. This rate is itself higher than the 0.3% annual real increase since 1890 from Shiller (2015). During 1998-2004 a house becomes a different riskier asset. The real increase comes almost all at one time, and is 6.4% annually during 1998Q1-2004Q3.

Over 1999Q2-2004Q1 real house price growth is 6.7% annually when the tenant asset coefficient is -0.882, bearing 88.2% of house price risk. Households accept this tenant volatility despite there being no markets to lay off rental risk because of expectations of real house price appreciation. Supply is relatively constrained and by being governed by local authorities is not subject to systematic risk. Rapid real price appreciation and increasing tenant risk proportions must be associated with highly inelastic panic demand during 1998-2004.

After 2005 FHFA houses return to their long-run performance as bonds. In column (4), after 2004Q4 the asset price incidence becomes -0.115, not different from the -0.162 that the FHFA data provide for the entire sample period. From column (9) after 2004Q2 the asset price incidence becomes -0.177. After 2009Q1, the tenant asset price incidence is -0.168. Both these estimates are similar to the -0.162 incidence for the entire sample. While this quarter is deemed

as when stocks began a sharp ascent, houses resorted to form. Houses return to long-run behavior in 2004 prior to the financial crisis. Houses are left with asset prices that rise sharply during the short-term surge from 1998 to 2004.

Table 5 shows estimates of structural breaks S&P/Case-Shiller price index. There are two sets of structural breaks from the Bai-Perron test based on different lags on expectations. Using the two-year lag for expected real house price appreciation, there are three breaks in 1988Q2, 1999Q1 and 2006Q2. The four sets of estimates are in a block in the first four columns. At a six-month lag there are three breaks in 1988Q1, 1997Q4 and 2005Q4. These estimates are in the last four columns.

During the years leading up to the financial crisis a house shifted from becoming a bond to a high-growth stock. The change in the asset occurs in the late 1990s, in the third of the four periods. A house reverts to its long-run behavior in late 2005 and early 2006, prior to the financial crisis of 2008.

In the first set of structural breaks houses have their long-run bond features until the late 1990s. The incidence of expected capital gains on house dividend yields is -0.282 for 1981Q1-1988Q1 and -0.116 for 1988Q2-1998Q2. The second set has similar estimates of -0.253 for 1981Q1-1987Q4 and -0.039 for 1988Q1-1997Q3. Houses are bond-like, with between 3.9% and 28.2% of asset-price shocks being shifted to rental yields. Rental yields are relatively resistant to movements in house asset prices.

A house changes from being bond-like during the late 1990s. In the third and seventh columns are estimates for 1999Q1-2006Q1 and 1997Q4-2005Q3. In the first of these two similar windows the asset price incidence is -0.789. The standard error of 2.2% indicates that the estimate is different from -1 but a house has become more stock-like. The S&P/Case-Shiller house price index in real terms was 195.1 at the beginning of 2006 and 120.8 at the beginning of

1999. The cumulative growth rate of real house prices over 1999-2006 was 47.9%, or an annual average of 6.9%.

A house has bond-like features in the United States since 1890 through the late 1990s. In the period from 1997 to 2006 extending the window from FHFA data a house no longer was a bond. Instead of offering a constant yield, house relative cash flow becomes more volatile. Expected real capital gains are no longer near zero. Instead, real capital gains rise sharply for a decade, exceeding 6% annually. The jump in expected real capital gains is accompanied by a rise in the proportions of risk tenants take in the rent-price ratio. The volatility of a house's return rise as the asset shifts away from being a bond. House asset holders between 1997 and 2006 expect their total return to shift away from a dividend yield and toward capital gains.

Over 1999Q1-2006Q1 real house prices rise by 6.9% annually. In exchange for surrendering their right to a bond-like housing cost, U.S. households shift their asset incidence upward to a stock-like 0.789. The story is similar in the related period 1997Q4-2005Q3 from the second block of results in Table 4. At the best-fitting two-year lag on expected real house price increases, the asset incidence is -0.654. During real house prices accelerate rapidly as the nature of the asset changes.

From Shiller (2015) and the website <http://www.econ.yale.edu/~shiller/data.htm> real house prices for more have a benchmark of 100 in 1890. The linked index including the S&P/Case-Shiller series in Table 4 is 114.8 in 1997Q4. Over 107 years, real house prices increase by 14.8% or by 0.1% annually. Houses have been virtually bonds with almost no real appreciation for more than a century. That bond comes to an end in 1997.

By 2005Q3 the real house price index is 194.6. Between 1997Q3 and 2005Q3 over eight years, real house prices rose from 114.8 to 194.6 or by 6.6% annually. That compares with 0.1%

annually for real house price growth for more than a century between 1890 and 1997.

Throughout 1997 to 2006 houses behaved differently than they had in the United States for a century or for Europe for almost a thousand years.

The structural break estimates show rising asset incidences in 1997-2006 that are different from a house's long-run behavior. That different asset type coincides with the intense demand for housing prior to the global financial crisis of 2007-2008. It is possible to estimate panic demand and higher equity premiums for 1997-2006.

Between Tables 4 and 5, the latest turning point when houses is 2006Q1. This quarter marks an all-time record for the amount of new construction of houses in the United States, at more than 2.2 million if retained at an annual rate. The source is the U.S. Bureau of the Census, *New Residential Construction* which keeps track at <http://www.census.gov/construction/nrc/index.html>. The United States at the time had 298 million people, population growth of about 1% annually and a household size of 2.7 people. The implied underlying growth for housing units is about one million per year. Construction in 2006 was therefore running at more than double fundamental demand. By the depths of the downturn in 2009 and when houses returned to being bonds, construction declined to less than 0.5 million units annually with 307 million people. This level the lowest since the Census began to report these data on a consistent basis in 1959. In that year the country had only 178 million people.

The control of housing supply is in the hands of local governments, at least in developed countries. That means that systematic shocks in fiscal, monetary and regulatory policy influence short-term demand. From the asset incidence estimates of β_h and a given $\bar{\eta}_D$ the long-run supply elasticity of housing is $\bar{\eta}_S = -\frac{\beta_h \bar{\eta}_D}{1-\beta_h}$. From Table 1, the asset-price incidence on rental

yields is 0.178 from the S&P/Case-Shiller data. The asset-price incidence depends on long-run demand and supply elasticities. The long-run price elasticity of demand for housing services has been viewed as -0.5 with little variation (Saiz (2010)). The long-run supply elasticity is derivable with maximum-likelihood properties as $\bar{\eta}_S = 0.5 * \frac{0.178}{1-0.178} = 0.108$.⁶ To raise the incidence implies tenants taking on greater rent-price risk and volatility. For any structural break β_{ht} , the short-term demand elasticity is $\eta_{Dt} = -\frac{\bar{\eta}_S(1-\beta_{ht})}{\beta_t}$. Panic buying forces down the demand elasticity and households are willing to accept increased rental risk. That demand drives up expected real house price appreciation h_{pt} in exchange for reduced dividends. The asset equity claim becomes $(1 - \beta_{ht})h_{pt}$ during t .

Table 6 shows the short-run demand elasticities and asset equity claims across sub-periods. The top panel is for FHFA prices, and the lower for S&P/Case-Shiller. The first row shows the rate of growth of real house prices in each of the determined breaks. The windows straddling 1997 and 2006 are in red. House prices rise in real terms by 6.52% in 1998Q1-2004Q3 and by 5.95% over 1999Q2 to 2004Q1. The implied price elasticity of demand is in the second row. In the third row is the house's equity premium from the asset, as real capital gains less the dividend offset $h_p - \beta_h \min(h_p, \bar{c})$.

During 1998Q1 to 2004Q3 a house earns an equity premium from the asset alone of 5.72% annually. For 1999Q2 to 2004Q1 the premium is 5.25% annually. Over 1998-2004 large stocks earn an equity premium of 3.18% annually, and 3.29% for 1999-2004 from Damodaran

⁶ The S&P/Case-Shiller aggregate price index is for 20 U.S. metro areas. Green, Malpezzi, and Mayo (2005) estimate supply elasticities for U.S. metro areas, taking account distance and commuting times. Saiz (2010) estimates supply elasticities taking account of geographical land constraints and building restrictions. Malpezzi and Mayo (1997) estimate supply elasticities from a housing market equilibrium, and then substitute plausible common demand parameters. The estimates that are common for the S&P/Case-Shiller markets are determined, with insignificant elasticities set at zero. At least two of the 20 metro areas must be in common from the three studies, and the average of those is used. Then an average or equally-weighted elasticity is constructed. The aggregate ranges between 0.1 and 0.5 depending on whether negatives are included. The results are comparable to Goodman and Thibodeau (2008) where the average is 0.35 over 133 metro U.S. areas.

(2016) <http://pages.stern.nyu.edu/~adamodar/>. Houses earn an equity premium greater than stocks of 2.54% annually for 1998-2004. For 1999-2004 houses earn an equity premium of 1.99% greater than that for stocks. This is the the asset's contribution to the equity premium only. The mortgage market capitalization is separate. For the remaining periods a house earns virtually no asset equity premium and is nearly bond-like.

The lower panel has equity premiums for different sub-periods using S&P/Case-Shiller house prices. During 1999Q1-2006Q1 a house generates capital gains that are 6.52% annually above the rate of growth of the Consumer Price Index. The comparable growth for 1997Q4-2005Q3 is 6.58% annually. During this period, there emerges a type of panic demand for housing. The price elasticity of demand falls to -0.029 during 1999Q1-2006Q1 virtually perfectly price-inelastic. The next-lowest estimate of the price elasticity during this group is -0.577 after 2006Q2. Demand is rigid during 1997Q4-2005Q3, falling to -0.057.

The panic demand drives up the equity premium on the house asset to 5.14% annually during 1999Q1-2006Q1. This premium is 1.70% annually above that for stocks during a comparable period. The asset equity premium is 4.30% annually over 1997Q4-2005Q3 or 101 basis points higher than for stocks. This surge in demand and rising equity premiums made houses stock-like assets for a period from 1997 to 2006.

Over the remaining periods, a house is almost completely bond-like. The asset equity premium is 0.48% annually from 1981Q2-1988Q1 and virtually zero until 1997. After 2006 the house equity premium returns to its near-zero pattern.

The 0.7% annual equity premium for the entire 1981-2013 period is earned almost entirely during 1997-2006. While it is the case that stocks and other financial assets earn high returns over short periods, a house has remained bond-like for extensive periods.

The 1997-2006 period accompanies shifts in fiscal, monetary and regulatory policy regarding U.S. housing. On the fiscal front, capital gains taxes are reduced and largely eliminated. The Taxpayer Relief Act of 1997 and the IRS Restructuring and Reform Act of 1998 provide for an exclusion from taxable for capital gains up to \$250,000, and \$500,000 for a married couple filing jointly.⁷ Monetary policy focuses on reducing long-term interest rates on mortgages, particularly after the recession of 2001. The ultimate is the well-known shift in regulatory policy on mortgage qualification. In 2000 the number of subprime mortgages expanded, following the introduction of no-income, no job, no asset (ninja) loans. No personal qualifications were required for borrowing, allowing all households to become homeowners.

During 1997-2006 the price elasticity of demand for housing becomes as low as -0.029, an estimate with maximum-likelihood properties. Demand becomes virtually perfectly inelastic. People have incentives to buy and accumulate houses.

After 2006 houses return to their long-run asset type as near-bonds. The asset incidence after 2006Q2 in the first block of results in Table 6 returns almost identically to its long-run value at -0.158. That compares with the -0.178 of Table 1. Starting in 2005Q3 onwards the asset price incidence returns to -0.118, down from -0.654 in the ten-year period prior.

As bonds, houses offer a stable long-term rent-price ratio. Tenants use this limited volatility to have flexibility of location with no capital cost of ownership. With a bond option available, households have no requirement to bid for house ownership, unless all the rules change. Those rules all change during 1997 to 2006.

⁷ The provision applies to a principal residence. A principal residence must have owned or used for at least two years during the five-year period ending on the date of the sale. The provision can be used once every two years which need not be continuous. The effect is to eliminate capital gains taxes on a series of houses owned by households.

6. Conclusion

Rents and prices provide a mechanism that reflects the performance of a house as an asset. One widely-used form of asset pricing is for the rent paid as a proportion of the price to be equal to the cost of operating a house. If the financial cost for debt and equity are the same, the cost of operating a house is its mortgage rate as a return on capital invested. Added to the cost are the operating expenses of a house. Subtracted are expected capital gains that accrue to the owner.

This is an accounting identity, where the rental yield is the mortgage rate less expected capital gains. This accounting identity has powerful predictions. It requires that the correlation between capital gains and the rental yield be negative unity. A basis point rise in capital gains means a similar reduction in the rental yield. Rental yields are highly volatile, and ultimately tenants bear all the risk of asset price and mortgage rate shocks. For a given structure of supply and construction, housing demand is perfectly inelastic with respect to rental yields. Tenants carrying all the risk and volatility of rental yields, or there are capital markets to lay them off.

An ability to borrow unlimited rents or security deposits and markets to lay off risk are not present in the United States. Instead, the evidence from more than a century of data back to 1890 is that house prices increase in real terms at a slow but positive rate of less than 0.5% annually. Tenants are liquidity constrained and predominantly in low-income households. That supports renewal rents on what appear to be coupon bond contracts. Rent-price ratios are relatively stable, forming a bond-like dividend yield. Since all households have the choice of tenancy bond-like contracts, holding a house cannot create long-term equity-like returns.

A house's productivity contribution comes from providing shelter services, offered in a bond-like contract. Tenants are not absorbing more than 20% of the shocks in asset prices in

rental yields. Mortgage rate shocks are borne by homeowners including those without debt, not tenants.

To disrupt this asset pricing requires concentrated changes in systematic risk. In fiscal, monetary and regulatory policy, the 1997-2006 period was a disruptive one for a U.S. house. Tenants increase their asset risk proportion as ownership options to houses widen. Rents fall relative to prices, to reward the few remaining tenants and a price for surrendering the option to buy. Rent-price ratios falling and house prices rising are the exact conditions to make a house stock-like.

A relatively flat rent-price ratio insulates tenants from housing market shocks. It must be relatively constant and bond-like, given liquidity-constrained tenants and absent markets to lay off rental risk. Homeowners always have the alternative of renting in this bond-like market and their houses offer limited opportunities as output claims. Exceptions are those houses near desirable amenities such as schools or near agglomeration economies in Manhattan or Silicon Valley. These houses potentially capitalize the output effects of the schools, high finance and technology. These houses are likely to always be stocks, similar to all U.S. houses during 1997 to 2006.

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Figure 1. Rent-Price Ratio and Capital Gains, Prices S&P/Case-Shiller
 On the horizontal axis is the S&P/Case-Shiller house price index growth, in percentage points. Data are quarterly. The house price index is lagged by two quarters. The red line is the best-fitting and is virtually flat. The intercept is at 4.7% annually for the rent-price ratio.

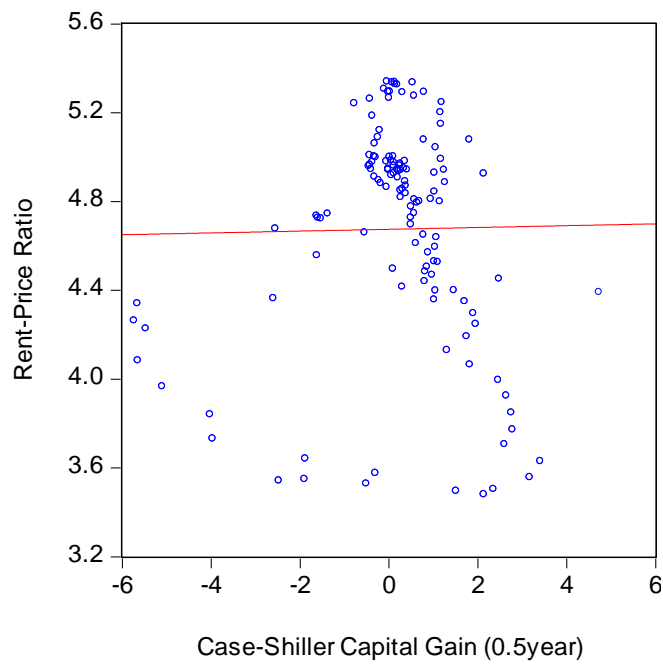


Figure 2. Rent-Price Ratio and Capital Gains, S&P/Case-Shiller

Prices are measured by the Federal Housing Finance Agency or Office of Federal Housing Enterprise Oversight price index. The results are almost identical with an intercept at about 4.7%, except that the rent-price ratio is even more bond-like when prices are measured by this more national index.

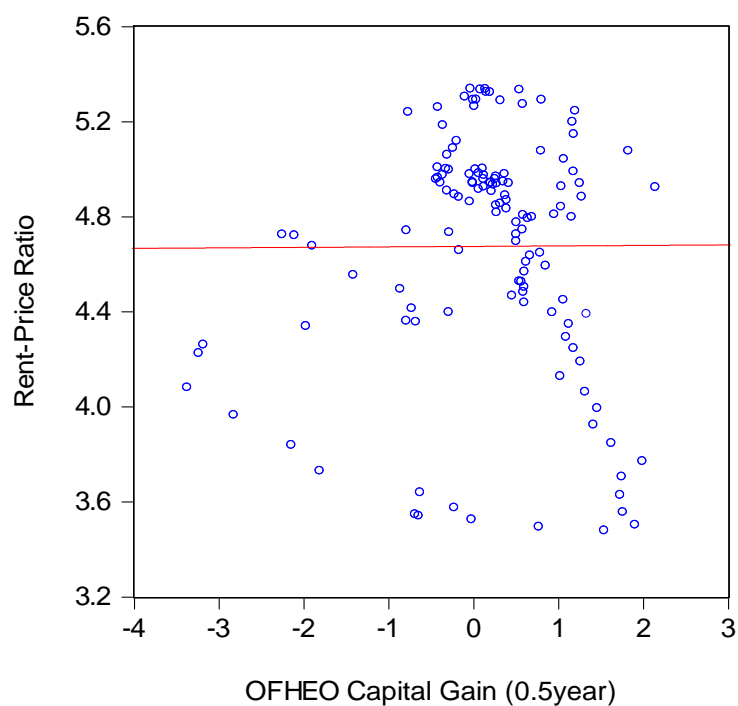


Table 1. House Asset Pricing

Estimation is for the asset pricing equation with dependent variable the rent-price ratio for a house quarterly for 1981Q3-2013Q3 by dynamic ordinary least squares (DOLS). Pricing factors are expected real house price appreciation, the real mortgage rate and inflation. Standard errors are in parentheses. Significance at 1% is *** and at 5% **. The first column is the unit root test statistics, with p-values in parentheses. The next three columns use the S&P/Case-Shiller house price index, with real expected appreciation at the actuals at 0.5, 1 and 2 year lags. The last three columns use the FHFA house price index. The real mortgage is the 30-year fixed rate Freddie Mac contract.

A house is a near bond. At two-year lagged expectations, only 16.2% to 17.8% of asset price shocks pass through to the rent-price ratio. At shorter lags a house is even closer to a bond, with asset-price coefficients of -0.068 at one year and -0.028 at six months for the FHFA series. In the lower panel is the related cointegrating equation in first differences. The lagged residual or error correction is from a first stage of the asset-pricing equation and is not significant at the 5% level.

	(1) FHFA $t - 0.5$	(2) FHFA $t - 1$	(3) FHFA $t - 2$	(4) S&P/CS $t - 0.5$	(5) S&P/CS $t - 1$	(6) S&P/CS $t - 2$	Unit Root
Rent-Price Ratio							-3.572 (0.036)
Independent							
Constant	3.916 *** (0.092)	3.906 *** (0.091)	3.853 *** (0.087)	3.884 *** (0.122)	3.862 *** (0.119)	3.781 *** (0.111)	
Real Capital Gains	-0.028 (0.031)	-0.068 *** (0.034)	-0.163 *** (0.036)	-0.056 *** (0.025)	-0.093 *** (0.027)	-0.178 *** (0.030)	-2.751 (0.068)
Real Mortgage Rate	0.139 *** (0.015)	0.141 *** (0.015)	0.146 *** (0.014)	0.161 *** (0.020)	0.161 *** (0.019)	0.160 *** (0.018)	-3.444 (0.050)
Inflation	-0.448 *** (0.121)	-0.441 *** (0.119)	-0.407 *** (0.113)	-0.645 *** (0.163)	-0.611 *** (0.156)	-0.494 *** (0.146)	-3.680 (0.027)
R ²	0.452	0.466	0.525	0.371	0.401	0.488	
Cointegrating							
Constant	-0.001 (0.004)	-0.005 (0.005)	-0.006 (0.003)	-0.006 (0.006)	-0.006 (0.006)	-0.007 (0.005)	
Change, Capital Gains	0.005 (0.038)	-0.085 *** (0.017)	-0.154 *** (0.024)	-0.038 *** (0.009)	-0.086 (0.013)	-0.011 (0.030)	
Change, Mortgage Rate	-0.002 (0.009)	-0.007 (0.008)	-0.001 (0.007)	0.019 ** (0.012)	-0.018 (0.011)	-0.011 (0.011)	
Change, Inflation	-0.002 (0.009)	-0.069 *** (0.021)	-0.129 (0.024)	-0.038 (0.024)	-0.075 *** (0.023)	-0.122 *** (0.025)	
Lagged Residual	-0.017 (0.011)	-0.019 (0.011)	-0.019 (0.011)	-0.015 (0.011)	-0.026 (0.013)	-0.029 (0.012)	
R ²	0.148	0.276	0.426	0.215	0.346	0.444	

Table 2. House Asset Pricing, Unexpected Inflation and GARCH (1,1)

The first two columns estimate the rent-price ratio in asset pricing factors using unexpected inflation. Unexpected inflation is the residual from actual inflation less an AR(4) forecast. Expectations are at a two-year lag and house prices are for the S&P/Case-Shiller and FHFA price indexes for 1982Q2-2013Q3. The unexpected inflation is used to obtain unexpected real capital gains as the asset pricing factor. Significance at 1% is with *** and at 5% with **.

The last two columns estimate the asset pricing equation as a GARCH(1,1) process over 1981Q2-2013Q3. The related GARCH variance equation with lagged squared residuals and lagged GARCH variance are reported below.

	(1) Unexpected Inflation FHFA	(2) Unexpected Inflation S&P/CS	(3) GARCH(1,1) FHFA	(4) GARCH(1,1) S&P/CS
Rent-Price Ratio				
Constant	3.624 *** (0.096)	3.541 *** (0.125)	4.276 *** (0.025)	4.259 *** (0.036)
Real Capital Gains	-0.191 *** (0.036)	-0.200 *** (0.031)	-0.217 *** (0.015)	-0.290 *** (0.018)
Mortgage Rate	0.134 *** (0.011)	0.139 *** (0.014)	0.094 *** (0.003)	0.098 *** (0.005)
Inflation	-0.136 (0.146)	-0.119 (0.191)	-0.213 *** (0.022)	-0.193 *** (0.026)
Variance GARCH				
Constant *10			0.008 *** (0.002)	0.038 *** (0.011)
Lagged Residual Squared			1.030 *** (0.436)	1.101 *** (0.283)
Lagged GARCH			-0.009 (0.086)	-0.234 *** (0.056)
R^2	0.534	0.479	0.353	0.253

Table 3. House Equity Premium

Specifications are for the best-fitting two-year lag on expectations. The first three columns are for FHFA price data using expected and unexpected inflation and GARCH(1,1). The last three columns are for the S&P/Case-Shiller house prices. The owner asset incidence is the proportion of real house price shocks borne by the holder. This incidence is one minus that borne by the tenant in the rent-price ratio in absolute value. The rent-price ratio asset incidence is from Tables 1 and 2. The asset equity premium is the produce of the owner asset incidence and real house price appreciation under the column's specification. The mortgage incidence is from estimates in Tables 1 and 2. The product with the real loan rate is the mortgage capitalization. The house's equity premium is the sum of its asset and mortgage liability components. Estimates are annually percentage rates.

Houses are robustly bond-like across specifications. A house's equity premium is between 0.93% and 1.07% annually. This estimate is about one-quarter of the 4.04% equity premium on stocks over the same period. That equity premium is about two-thirds composed of the real output of a house, and one-third the capitalization of mortgage market institutions.

		(1) Expected Inflation FHFA	(2) Unexpected Inflation FHFA	(3) GARCH (1,1) FHFA	(4) Expected Inflation S&P/CS	(5) Unexpected Inflation S&P/CS	(6) GARCH (1,1) S&P/CS
Asset Incidence	β_h	0.163	0.191	0.217	0.200	0.178	0.290
Output Claim	$h_p - \beta_h \min(h_p, \bar{c})$	0.70%	0.68%	0.70%	0.67%	0.74%	0.64%
Mortgage Incidence	β_m	0.146	0.134	0.094	0.160	0.139	0.098
Mortgage Claim	$\beta_m m_p$	0.35%	0.32%	0.23%	0.39%	0.33%	0.24%
Equity Premium	$\beta_m m_p +$ $h_p - \beta_h \min(h_p, \bar{c})$	1.05%	1.00%	0.93%	1.06%	1.07%	0.98%

**Table 4. Structural Stability, House Asset Pricing
FHFA Prices**

Dependent variable is the rent-price ratio based on currency. The numerator is the rent component of the Consumer Price Index. The denominator is the Federal Housing Finance Administration house price index. Both are converted to currency at Census benchmarks, allowing the rent-price ratio to be an equivalent dividend yield. The real mortgage rate is from the Freddie Mac 30-year fixed rate series. Real capital gains are based on optimal lagged expectations, at two years. There are two blocks, the first having four and the other five segments or four breaks. The four columns are from one group of three structural breaks identified by the Bai-Perron test with a two-year lag on house price expectations. The six columns of the second group are for a six-month lag on expectations.

During the 1998Q1-2004Q3 period the coefficient rises to -0.877. Houses shift from their long-run bond-like features. The same shift occurs in the second block, over 1999Q2-2004Q1 with a rise in the tenant asset incidence to -0.882

	(1) 1981Q2- 1987Q4	(2) 1988Q1- 1997Q4	(3) 1998Q1- 2004Q3	(4) 2004Q4- 2013Q3	(5) 1981Q2- 1988Q1	(6) 1988Q2- 1993Q1	(7) 1993Q2- 1999Q1	(8) 1999Q2- 2004Q1	(9) 2004Q2- 2008Q4	(10) 2009Q1- 2013Q3
Rent-Price Ratio										
Constant	6.028*** (0.176)	5.082*** (0.067)	5.319*** (0.152)	6.070 *** (0.095)	6.028*** (0.176)	5.823*** (0.071)	4.891 *** (0.193)	5.438 *** (0.331)	5.186 *** (0.321)	5.074 *** (0.500)
Real Capital Gains	-0.252*** (0.066)	-0.045 (0.035)	-0.878*** (0.041)	-0.115*** (0.013)	-0.253*** (0.066)	-0.281*** (0.029)	-0.075 (0.057)	-0.882*** (0.134)	-0.148*** (0.019)	-0.104** (0.046)
Real Mortgage Rate	-0.039*** (0.008)	-0.008 (0.009)	0.037** (0.016)	-0.361*** (0.017)	-0.039*** (0.009)	-0.022*** (0.006)	0.015 (0.027)	0.018 (0.028)	-0.177 *** (0.058)	-0.168 (0.094)
Expected Inflation	-0.159*** (0.057)	-0.092** (0.043)	-0.529*** (0.050)	-0.161*** (0.043)	-0.159*** (0.057)	-0.166*** (0.032)	-0.119** (0.073)	-0.578*** (0.081)	-0.343*** (0.097)	0.134 (0.174)
N	27	40	27	36	28	20	24	20	19	19

**Table 5. Structural Stability, House Asset Pricing
S&P/Case-Shiller Prices**

The dependent variable is the rent-price ratio, with the pricing factors for expected real capital gains, mortgage rate and inflation. There are two blocks of four columns. The first four columns are from one group of three structural breaks identified by the Bai-Perron test. The next four columns are from a separate group of three structural breaks. The break dates are in boldface with N the number of quarters during the break. The real capital gains factor incidences are in boldface. Significance at 1% is with *** and at 5% with **.

In red is indicated the breakout period when a house does not behave as a bond. During the 1999Q1-2006Q1 period in the first specification and 1997Q4-2005Q3 in the second the coefficient jumps to -0.789 and -0.654. Houses shift from their long-run bond features to become similar to stocks. In the second to last row is the implied short-run demand elasticity.

	(1) 1981Q2- 1988Q1	(2) 1988Q2- 1998Q4	(3) 1999Q1- 2006Q1	(4) 2006Q2- 2013Q3	(5) 1981Q2- 1987Q4	(6) 1988Q1- 1997Q3	(7) 1997Q4- 2005Q3	(8) 2005Q4- 2013Q3
Rent-Price Ratio								
Constant	5.822 *** (0.068)	4.857 *** (0.061)	5.704 *** (0.184)	6.562 *** (0.316)	6.028 *** (0.176)	5.111 *** (0.057)	5.273 *** (0.232)	7.136 *** (0.234)
Real Capital Gains	-0.282 *** (0.028)	-0.116 *** (0.031)	-0.789 *** (0.022)	-0.158 *** (0.016)	-0.253 *** (0.066)	-0.039 (0.035)	-0.654 *** (0.023)	-0.119 *** (0.011)
Real Mortgage Rate	-0.022 *** (0.005)	0.023 *** (0.008)	-0.027 (0.019)	-0.474 *** (0.055)	-0.039 *** (0.009)	-0.012 (0.008)	-0.002 (0.030)	-0.541 *** (0.044)
Inflation	-0.166 *** (0.031)	-0.138 *** (0.035)	-0.516 *** (0.063)	-0.134 (0.130)	-0.159 *** (0.057)	-0.085 ** (0.043)	-0.253 *** (0.084)	-0.441 *** (0.124)
N	28	43	29	30	27	39	32	32

**Table 6. House Asset Premium
FHFA, S&P/Case-Shiller Prices**

The upper panel is with prices for the FHFA index, and the lower for S&P/Case-Shiller. The implied short-run price elasticity of demand for housing is the respective asset incidences from Tables 3 and 4 for the time periods implied by the structural breaks. The long-run supply conditions are held constant, and systematic shocks alter the short-run demands. Real house price appreciation is for the actual performance during the particular time window. The product of the real appreciation and the asset-price incidence is the equity premium or output claim.

During the periods prior to 1997 houses have bond-like features. The equity premium on a house is less than 0.5% annually. During 1997-2006 the equity premium shifts upward, with the entries indicated in red. The lowest annual equity premium of a house is 4.3% annually, between 1997Q4 and 2005Q3. The demand for houses becomes highly inelastic, at -0.06 or below. After 2006 a house returns to its bond pattern, generating equity premiums of no more than 0.5% annually

FHFA

	(1) 1981Q2 - 1987Q4	(2) 1988Q1 - 1997Q4	(3) 1998Q1 - 2004Q3	(4) 2004Q4 - 2013Q3	(5) 1981Q2 - 1988Q1	(6) 1988Q2 - 1993Q1	(7) 1993Q2 - 1999Q1	(8) 1999Q2 - 2004Q1	(9) 2004Q2 - 2008Q4	(10) 2009Q1 - 2013Q3
Real Capital Gains	0.0177	-0.0098	0.0652	-0.0226	0.0172	-0.0262	0.0081	0.0595	-0.0228	-0.0075
Demand Elasticity	-0.321	-2.298	-0.115	-0.833	-0.320	-0.277	-1.335	-0.014	-0.623	-0.933
Equity Premium, Asset	0.0044	0.0004	0.0572	-0.0026	0.0043	-0.0074	0.0006	0.0525	-0.0033	-0.0008
N	27	40	27	36	28	20	24	20	19	19

S&P/CS

	(1) 1981Q2- 1988Q1	(2) 1988Q2- 1998Q4	(3) 1999Q1- 2006Q1	(4) 2006Q2- 2013Q3	(5) 1981Q2- 1987Q4	(6) 1988Q1- 1997Q3	(7) 1997Q4- 2005Q3	(8) 2005Q4- 2013Q3
Real Capital Gains	0.0172	-0.0068	0.0652	-0.0389	0.0177	-0.0106	0.0658	-0.0375
Demand Elasticity	-0.276	-0.825	-0.029	-0.577	-0.320	-2.668	-0.057	-0.802
Equity Premium, Asset	0.0048	-0.0007	0.0514	-0.0061	0.0045	-0.0004	0.0430	-0.0089
N	28	43	29	30	27	39	32	32