DISCUSSION PAPER SERIES

No. 5333

THE PRICE AND QUANTITY OF RESIDENTIAL LAND IN THE UNITED STATES

Morris Davis and Jonathan Heathcote

INTERNATIONAL MACROECONOMICS and PUBLIC POLICY

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP5333.asp**

ISSN 0265-8003

THE PRICE AND QUANTITY OF RESIDENTIAL LAND IN THE UNITED STATES

Morris Davis, Federal Reserve Board
Jonathan Heathcote, Georgetown University and CEPR

Discussion Paper No. 5333
November 2005

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 5333

November 2005

ABSTRACT

The Price and Quantity of Residential Land in the United States*

A house is a bundle comprising a physical structure and the plot of land upon which the house is built. Thus changes in house prices reflect changes in the cost of structures and value of land. In this paper we apply this insight to construct the first constant-quality price and quantity indexes for the aggregate stock of residential land in the United States. We document that the value of residential land exceeds annual GDP, and that the dynamics for the prices of residential land and residential structures are quite different. For example, the real price index for residential land almost tripled between 1975 and 2005, while the real price of structures increased by only 24 percent. Fluctuations in house prices at business cycle frequencies, including the recent boom, are primarily driven by changes in the price of land.

JEL Classification: R14, R21 and R31
Keywords: housing and land prices

Morris Davis
Federal Reserve Board of Governors
Federal Reserve Board
Stop 97
20th and C Streets NW
Washington, DC 20551
USA

Tel: (1 202) 452 3628
Email: morris.a.davis@frb.gov

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=163540

Jonathan Heathcote
Department of Economics
Georgetown University
ICC 580
Washington, DC 20057
USA

Tel: (1 202) 687 5582
Email: jhh9@georgetown.edu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=147798

*This work was supported by the National Science Foundation under Grant No. 0301119. An earlier draft of the paper circulated as a FEDS Working Paper 2004-37. We thank Chris Downing, Josh Gallin, Andreas Lehnert, Robert Martin, Michael Palumbo, and seminar participants at various institutions for comments and suggestions. We are grateful to Robert Shiller (Yale), David Stiff (Fiserv CSW), Barbara Fraumeni and Brent Moulton (BEA), and Amy Crew Cutts (Freddie Mac) for data assistance. The opinions expressed here are those of the authors and not necessarily those of the Board of Governors of the Federal Reserve System or its staff. Corresponding Author: Davis.

Submitted 24 October 2005

INTRODUCTION

We estimate the market value of the housing stock in the United States to be $26.7 trillion in the fourth quarter of 2004. This figure is 2.22 times (annualized) GDP for the same period, and 1.62 times the combined capitalizations of the NYSE, Nasdaq and Amex exchanges. Because housing accounts for such a large fraction of national wealth, changes to the price of houses may have important macroeconomic effects.[2] Interest in the macroeconomic effects of house price fluctuations has been heightened by the recent boom in the housing market: the average price of existing single-family homes in the United States rose by 62 percent in real terms over the ten year period ending in the second quarter of 2005.[3]

In this paper we argue that one way to progress towards a better understanding of house price dynamics is to split house prices into two factors. The first factor, structures, can be priced explicitly for a particular house as the replacement cost, after accounting for depreciation, of the physical building. The second factor, which we call land, is the factor that makes a house worth more than the cost of putting up a new structure of similar size and quality on a vacant plot. Thus land is the market value associated with a home's location, and the size and attractiveness of the plot.

We show that the growth rate of the aggregate price of housing is a weighted average of the growth rate of the price of structures and the price of land, where the time-varying weights are given by the relative shares of land and structures in the total market value of the housing stock. This relationship allows us to construct price and quantity series for land given publicly-available (but appropriately adapted) series for house and structure

[2] A large empirical literature investigates wealth effects from house price changes on aggregate consumption and saving (see, for example, Case, Quigley and Shiller, 2005). Changes in the price of housing also have implications for risk-sharing and asset pricing (see, for example, Lustig and van Nieuwerburgh, 2004, and Piazzesi, Schneider and Tuzel, 2005), as well as distributional effects in heterogeneous-agent economies (Bajari, Benkard and Krainer, 2005).
[3] Our primary measure for house prices is the repeat-sales index published by the Office of Federal Housing Enterprise Oversight (OFHEO), discussed later. In this paper, we adjust all series for inflation using the core Personal Consumption Expenditure (PCE) price index, published by the Bureau of Economic Analysis (BEA), which excludes volatile food and energy components.

prices, and for the market values of housing and existing structures. Our series are the first constant-quality price and quantity indexes for the aggregate stock of residential land in the United States.

Note that we do not directly measure the price of land, but rather infer it from data on house prices and structures costs. With the exception of land sales at the undeveloped fringes of metro areas - where land is relatively cheap - there are very few direct observations of land prices from vacant lot sales, because most desirable residential locations have already been built on. Our indirect approach allows us to circumvent this potentially intractable measurement problem.

Decomposing the price of a house into the price of a structure and the price of land is a useful exercise, since very different forces are likely to drive prices of the two components. The cost of putting up new structures is driven largely by the productivity of the construction industry relative to other sectors of the economy, and to the cost of some basic materials.[4] Thus one should not expect changes in demand-side factors such as demographics or interest rates to have much impact on the relative price of structures, just as one would not expect such factors to impact the price of cars or any other produced goods. By contrast, desirable land is largely non-reproducible, and therefore the price of land is primarily driven by changes in the demand for housing.[5]

The distinction between structures and land may therefore shed new light on empirical work that attempts to uncover the driving forces behind house price dynamics. For example, Case and Shiller (2004) point out that income growth rates and interest rate changes, two of the most commonly-cited 'fundamentals' driving house prices, show little cross-regional variation, while there are dramatic regional differences in price

[4] Davis and Heathcote (2005) calibrate a multi-sector model in which the price of residential investment (structures) is driven by changes in relative productivity across sectors. This model is very successful in terms of replicating the dynamics of residential investment over the post-war period in the United States.
[5] We define residential land as land with a residential structure on its surface.

dynamics.[6] One important lesson from our decomposition is that one should expect house price dynamics to be quite different in regions where the value of housing is largely accounted for by the value of land (such as San Francisco and Boston) compared to regions where land's share of house value is relatively small. In particular, changes in demographics, interest rates or the tax treatment of housing might have large effects on house prices in regions where land's share is high, whereas prices should be largely pinned down by construction costs where land is cheap. Thus regions that share similar fundamentals might experience noticeably different house price dynamics.

Our distinction between structures and land is analogous to the tangible versus non-tangible capital distinction in stock market valuation. McGrattan and Prescott (2005) use the discipline of the growth model to estimate the stock of intangible capital in the United States given data on corporate profits and the returns to tangible capital. A second analogy is the decomposition of the Consumer Price Index into a core component, and a second component capturing energy (and possibly food) prices. Just as changes in interest rates may have different effects on energy and non-energy prices, we will show that interest rates correlate quite differently with land and structures prices.

Findings: Between 1975 and 2004, we estimate that land accounts, on average, for 47 percent of the value of the housing stock. Land's share in the value of the entire housing stock is large despite the fact that the cost of raw land typically accounts for a small fraction (around 11 percent) of the market value of new homes. We conclude that a large fraction of the market value of existing homes reflects the value of attractive locations.

At business cycle frequencies we find that the real price of land is 1.9 times as volatile as GDP and more than twice as volatile as the price of structures. Given that land accounts for around half the total value of housing stock, we conclude that fluctuations in house prices are primarily attributable to fluctuations in the price of land. Over the past 30 years, the real price of residential land has grown much faster than real structures prices.

[6] A well known example of a failure to predict house prices on the basis of fundamentals is Mankiw and Weil (1988), who argued that the baby bust of the 1970s would lead to declines in house prices in the 1990s.

Thus, given their different land intensities, constant-quality time series for new home prices and for existing home prices look quite different. The correlation between residential land prices and farm land prices is low.

Our decomposition has some testable implications for house prices at the regional level. First, we verify that over the current land price boom, house price gains have typically been largest in regions where house prices (and thus land's share) were relatively high at the start of the boom. Second, regions where prices are higher (indicating higher land values) tend to be the same regions where prices are more volatile, consistent with our claim that land prices are more volatile than structures prices. Third, there is a long-run correlation between initial price levels and subsequent price growth, consistent with the finding that the trend growth rate for land prices exceeds that for structures.

Finally, we look for factors that might be able to account for land price dynamics by running some simple regressions. We regress house prices, structures prices and land prices on income and interest rates. Interestingly we find that while the coefficient on nominal interest rates in the land price regression is negative, as one might expect, the coefficient on the same variable in the structures regression is positive (though insignificant). One consequence of this off-setting interest rate effect is the apparent absence of a co-integrating relationship between house prices, income and interest rates.

ACCOUNTING AND MEASUREMENT

We start by defining the nominal market value of a home in period *t*, $p_t^h h_t$, as the sum of the replacement cost of the structure after accounting for depreciation, $p_t^s s_t$, and the market value of the land and associated amenities, $p_t^l l_t$:

(1) $$p_t^h h_t = p_t^s s_t + p_t^l l_t .$$

In the above equation, p_t^h, p_t^s, and p_t^l are the quality-adjusted prices per unit of the home, physical structure, and land and amenities (hereafter called "land") and h_t, s_t and l_t are the quality-adjusted quantities.

Our key assumption is that if the replacement cost of structures and the nominal value of land are revalued between periods t and $t+1$, then the house itself is appropriately revalued, implying

(2) $$\left(\frac{p_{t+1}^h}{p_t^h}\right) p_t^h h_t = \left(\frac{p_{t+1}^s}{p_t^s}\right) p_t^s s_t + \left(\frac{p_{t+1}^l}{p_t^l}\right) p_t^l l_t.$$

Rearranging terms, equation (2) may be rewritten as

(3) $$\left(\frac{p_{t+1}^h}{p_t^h}\right) = \left(\frac{p_{t+1}^s}{p_t^s}\right) \frac{p_t^s s_t}{p_t^h h_t} + \left(\frac{p_{t+1}^l}{p_t^l}\right) \frac{p_t^l l_t}{p_t^h h_t}.$$

Equation (3) implies that the growth rate of the nominal price of a house between periods t and $t+1$ is a simple weighted average of the growth rate of the nominal replacement cost of the structure and the growth rate of the nominal price of the land.

Based on equation (3), if we were to observe time series for the growth rate of home prices, the growth rate of structures costs, the replacement cost of structures and the market value of the housing stock, then we could infer a time series of growth rates of land prices. In principle, these data are publicly available. OFHEO ("Office of Federal Housing Enterprise Oversight") publishes two price indexes for existing homes that are based on repeat transactions. These price indexes are designed to capture the growth rate of home prices holding quality constant.[7] For 1991 to the end of our sample, we use the OFHEO index that is based only on homes that have sold. For earlier dates, we use the OFHEO index that includes data from appraisals as well as from sales.[8] The Bureau of

[7] McCarthy and Peach (2004) and others have argued the OFHEO price indexes are biased. We discuss this issue later in the text.

[8] The OFHEO purchase-only index begins in the first quarter of 1991. In a previous draft of the paper, we used the CMHPI repeat-transactions index for house prices, which starts in 1970 (as compared to the OFHEO index, which starts in 1975). We no longer use the 1970-1975 CMHPI data for three reasons: (i) the sample size for those years is very small, (ii) the published series are extremely volatile, (iii) the overall growth in the price series over this period is difficult to reconcile with estimates for the total value for the

Economic Analysis (BEA) publishes a quarterly price index for residential structures that measures the growth rate of structures costs; the BEA also publishes estimates of the aggregate replacement cost of residential structures. Finally, data from the Decennial Census can be used to estimate the market value of all homes in the United States.

We modify and adjust these data in order to produce quarterly price and quantity series for constant-quality residential land. We now highlight our most important modifications to existing data.

House Prices: We suspect that our house price index is measured with error, and that measurement error is responsible for some of the volatility in growth rates that is prevalent in the early part of our sample (see the solid line in Figure 1). To see how measurement error in our house price index would impact our estimated volatility of land prices, consider the following model for measurement error. Suppose that the natural log of the (inflation-adjusted) house price index is measured with error that is distributed independently and identically over time, that is

$$\log\left(p_{t+1}^{h}\right) = \log\left(p_{t+1}^{h*}\right) + e_{t+1}^{h}, \tag{4}$$

where p_{t+1}^{h*} is the true level of the real house price index and e_{t+1}^{h} is measurement error. Letting g_{t+1}^{h} denote the observed growth rate of house prices, and g_{t+1}^{h*} the true but unobserved growth rate, equation (4) implies

$$g_{t+1}^{h} = g_{t+1}^{h*} + \Delta e_{t+1}^{h}. \tag{5}$$

Now let the observed growth rates of structures costs and the inferred growth rate of land prices between t and $t+1$ be denoted g_{t+1}^{s} and g_{t+1}^{l} respectively. Suppose (for simplicity) that g_{t+1}^{s} is not measured with error. Equations (3) and (5) can be combined to express g_{t+1}^{l} as the true but unobserved growth rate of land prices plus a term that depends on the error in the observed growth rate of the house price index,

housing stock in 1970 based on the Decennial Census of Housing. The OFHEO series and the CMHPI are very similar after 1975.

(6) $$g_{t+1}^{l} = \frac{p_t^h h_t}{p_t^l l_t}\left(g_{t+1}^{h*} - \frac{p_t^s s_t}{p_t^h h_t} g_{t+1}^{s} \right) + \frac{p_t^h h_t}{p_t^l l_t} \Delta e_{t+1}^{h}.$$

Notice that as long as house prices are unbiased and the expected value of Δe_{t+1}^{h} is zero, the inferred growth rate of land prices is an unbiased estimate. However, mis-perceptions of house prices are magnified in the implied series for land prices, since land's share of market value ($p_t^l l_t / p_t^h h_t$) is less than one. This ratio has historically ranged between 0.42 and 0.54 (discussed later), implying that the unconditional standard deviation of measurement error in land prices is somewhere between 1.85 and 2.38 times the standard deviation of the measurement error in the observed growth rate of house prices (Δe_{t+1}^{h}).

To obtain an accurate estimate of the volatility of house prices and, by equation (6), of land prices, we use the Kalman Filter to uncover a series for house prices that is free of measurement error. In particular, we assume the growth rate of the true but unobserved real house price index is a random walk,

(7) $$g_{t+1}^{h*} = g_t^{h*} + u_{t+1},$$

where the growth rate shocks, u_{t+1}, are independently and identically distributed over time, with $E\left[u_t e_s\right] = 0$ for all *t* and *s*. We allow the variance of e_{t+1} to change in 1991 since the growth rate of the real OFHEO house price index is less volatile in the period when data from appraisals are excluded. Although the statistical model described by equations (4) and (7) is relatively simple, it fits the data well. The estimated standard deviation of u_{t+1} is 0.3 percent, the standard deviation of e_{t+1} from 1975-91 is 0.3 percent, and the standard deviation of e_{t+1} after 1991 is 0.1 percent.[9] The "corrected" estimates for the sequence g_{t+1}^{h*}, along with the growth rates of the unfiltered real OFHEO price index, are plotted in Figure 1. As expected, the corrected growth estimates are less volatile than the real growth rates of the OFHEO index as published, especially before 1991. The log level of the corrected OFHEO tracks the unsmoothed series extremely closely.

[9] This model is the state-space representation of the Hodrick-Prescott filter (King and Rebelo, 1993). Our estimates imply that correct HP smoothing parameter for our pre-1991 data is 1.126, and for the post-1991 data it is 0.156.

Our filtering procedure removes noise that arises from random measurement error, but it does not control for any fundamental measurement bias in the house price index. McCarthy and Peach (2004) and other authors have argued that the OFHEO index is biased (upwards) because the index calculations do not control for potential improvements to housing structures between sales dates.[10] Of course, by this same reasoning, the OFHEO could be biased down because it does not control for depreciation of structures. Some rough calculations suggest that these biases largely offset in aggregate data. The Census Bureau publishes estimates of gross investment in structures that are "improvements" or "maintenance and repair". The average annual nominal value for these expenditures as a fraction of our estimate of the market value of housing (land plus structures) averages 0.92 percent over the period 1975 to 2004. This is very similar to our estimate of the nominal annual depreciation of the existing stock of residential structures, about 0.86 percent of the market value of housing per year. Since the net bias to the OFHEO from the lack of control for improvements and depreciation is only about 0.06 percent per year, we abstract from this issue.[11]

One may also worry that the OFHEO index under-represents expensive homes, because the data used in the OFHEO index are based on housing units with mortgages that have been purchased by the government-sponsored enterprises Freddie Mac and Fannie Mae. These institutions can only purchase and securitize mortgages that are less than a certain size called the "conforming loan limit".[12] This could be problematic if prices of expensive homes exhibit different dynamics than prices of cheaper homes. However,

[10] McCarthy and Peach conclude that the least-biased price index for housing is a "constant quality" price index for new houses that is constructed by the Census Bureau. We will argue that the fact that the Census new home price series and the OFHEO existing home price series look quite different does not necessarily indicate bias in either series. Rather new homes and existing homes are simply different goods.

[11] Spending on improvements and maintenance and repair also does not fluctuate much: it ranges between 0.72 and 1.13 percent of the value of the housing stock over the sample period, and does not appear systematically correlated with the rate of house price growth. In particular, total improvement plus maintenance spending as a share of home value during the 10 year period to 2005:2 has been slightly lower than the post 1975 average, and thus cannot account for appreciation over this period. Furthermore, Baker (2004) has noted that there is little evidence of a systematic correlation between regional spending on improvements and regional price appreciation (source: "Too Much Bubbly at the Fed?," available at http://www.cepr.net/publications/fed_housing_bubble.htm).

[12] For example, in 2005 the conforming loan limit is $359,650 for single-family properties.

large numbers of expensive home purchases are financed with combinations of conforming loans, secondary liens, and cash, and there is little evidence that expensive homes are significantly under-represented. Consider California, the state with the most expensive housing in the nation after Hawaii. The OFHEO reports that in 2002, the median sales price of homes in California financed with a conforming mortgage was approximately $300,700, which was also the conforming loan limit for that year.[13] This is close to the median state-wide sales price in 2002 for existing detached single-family homes, which was $316,130[14] (the corresponding figure for the United States was $156,200).

Replacement Cost of Structures: We make two adjustments to the BEA's published series for the replacement cost of residential structures. First, the BEA treats expenditures on commissions from existing home sales as if it is residential investment when calculating an estimate of the replacement cost of structures. We believe this is a conceptual error and subtract our estimate of the accumulated value of commissions on existing home sales from the BEA's published estimate of the replacement cost of all residential structures.[15] This correction reduces the BEA's published estimate of the replacement cost of structures by about 8.5 percent. Second, we use quarterly National Income and Product Accounts (NIPA) data on gross investment in residential structures, along with a quarterly estimate of depreciation, in a perpetual inventory accounting system that converts the published annual replacement cost series to a quarterly series. The appendix provides details on both of these adjustments, and also contains a discussion of various alternative series for home prices and structures costs.

Residential Land: Our estimate of net new additions to residential land is based on assumptions the Census Bureau uses to estimate the value of structures put in place. The Census does not observe the value of structures put in place directly, but rather infers a

---

[13] Source: OFHEO Press Release, available at http://www.ofheo.gov/media/pdf/2q05hpi.pdf
[14] Source: California Association of Realtors, available at http://www.car.org/index.php?id=MzMzNzI=
[15] Our reasoning is the following: if a house transacts three times in one year, the cost of rebuilding the structure should not automatically increase by 18 percent (as is currently assumed by the BEA). We derive an estimate of the stock of commissions implicit in the BEA's published estimate of the replacement cost of structures using a perpetual inventory system.

value given data on the prices at which new homes sell, and estimates of the fraction of sales prices that are attributable to the cost of raw land and other non-structure costs (landscaping, appliances, realtor fees, marketing and financing costs). For homes built for sale, the Census estimates the value of structures put in place to be 84.2 percent of the average sales price, while the cost of raw land accounts for 10.6 percent of the price.[16] Thus we assume net new additions to residential land account for 10.6/84.2 = 12.6 percent of NIPA gross investment in structures. Given this assumption, our series for net new additions to the stock of housing is consistent with the way the Census Bureau constructs its series for residential investment.[17]

Market Value of Homes: We create an estimate of the market value of all homes (owned, rented, and vacant) from 1975:Q1 to 2005:Q2 using the following perpetual inventory system:[18]

$$p_{t+1}^{h} h_{t+1} = \left(\frac{p_{t+1}^{h}}{p_{t}^{h}} \right) p_{t}^{h} h_{t} + p_{t+1}^{h} \Delta h_{t+1}. \tag{9}$$

In this system, the market value of housing at $t+1$ (the left-hand side) is set equal to the revalued market value of housing at t (first term, right-hand side) plus any net-new additions to the stock of housing (second term, right-hand side).

To generate a time series for the market value of all residential housing units, we benchmark equation (9) to an estimate of the market value of the housing stock in 2000:Q2 ($17,199 billion) that is derived from micro data from the 2000 Decennial Census of Housing, and use the corrected house price index to revalue the stock between

[16] The Census estimates are based on an unpublished study in 1999 that is summarized in a memorandum from Dennis Duke to Paul Hsen entitled, "Summary of the One-family Construction Cost Study" dated August 1, 2000.

[17] Implicitly the Census assumes a unitary elasticity of substitution between structures and land in the production of new homes. This assumption is consistent with Thorsnes (1997).

[18] The Flow of Funds Accounts, published by the Federal Reserve Board, has an estimate of the market value of owner-occupied housing. We do not use this estimate because it does not include the value of rental homes or vacant homes. Also, we have uncovered measurement problems with the published Flow of Funds estimates - specifically, the growth rate of capital gains implied by the published series tend to be unusually large or small when data sources used to benchmark the estimates change. One such example is the 1980-1985 period, when the benchmark data source changed from the Annual Housing Survey to the American Housing Survey. As a consequence of these findings, the Flow of Funds estimates are currently under review by staff members of the Federal Reserve Board.

any two periods. We calculate net new additions to the stock of housing as the sum of net new additions to the replacement cost of structures and net new additions to the stock of residential land, i.e.[19]

(10) $$p^h_{t+1}\Delta h_{t+1} = p^s_{t+1}\Delta s_{t+1} + p^l_{t+1}\Delta l_{t+1}.$$

where net new additions to structures, $p^s_{t+1}\Delta s_{t+1}$, is NIPA gross investment in structures minus estimates of expenditures on commissions and depreciation, and net new additions to land, $p^l_{t+1}\Delta l_{t+1}$, is 12.6 percent of NIPA gross investment in new permanent-site structures (see above).[20]

We compare the predicted market value of all housing units for 1980 and 1990, calculated via equations (9) and (10) and benchmarked exclusively to the 2000 Census, to the aggregate market value of housing units when calculated using micro data from the 1980 and 1990 Decennial Census of Housing. In 1990, we under-predict the market value relative to the Decennial Census by 3% and in 1980 we over-predict by 5%. We view a 5% discrepancy over a twenty year period as broadly vindicating our methodology.[21]

ANALYSIS

The approach outlined above delivers a current dollar price index for residential land.[22] In the data analysis that follows, to compute a real price series we deflate using the BEA

[19] Note that equations (1) and (10) jointly imply equation (3), the equation from which our land price series is derived.
[20] Expenditure on permanent-site structures is exclusive of spending on improvements, manufactured homes, dormitories, commissions and used structures.
[21] Our estimate of the market value of all housing units (except mobile homes, boats, tents, and vans) based on the 1980 and 1990 Decennial Census of Housing is $5,356 and $11,214 billion respectively.
[22] All of our data are available for download at http://www.marginalq.com/morris/landdata.html. On this site we report current dollar price indexes for houses, land and structures, as well as series for the values of the stocks of houses, land and structures, and series for nominal net investment. Note that the values and percentages reported in this section are different from those of earlier versions of this paper; in earlier drafts, we reported the value of value of residential land under 1-4 unit structures. In this paper, we report the value of residential land under all structures, including structures in 1-4 unit buildings and 5+ buildings.

price index for core Personal Consumption Expenditure (PCE).[23] In Figure 2 we plot real price indexes for residential land, existing homes, and the replacement cost of structures. Land prices have increased by a factor of 2.9 since 1975, while home and structures prices have increased by 88 percent and 25 percent respectively. In addition to having different trend growth rates, land and structures prices also exhibit different patterns within the sample. For example, between 1979 and 1982, the real price of land declined by 13 percent, whereas real replacement costs did not change, on-net. By contrast, from 1982 through the end of 1995, land prices rose by 33 percent (mostly between 1982 and 1989), while structures prices fell by almost 10 percent. From 1995:Q2 to 2005:Q2, real house prices have increased by 62 percent. Over the same period, replacement costs rose by only 23 percent. Thus rising land prices account for most of this house-price boom; the cumulative appreciation in the real price of land implied by our methodology is over 100 percent.[24]

Averaging over our sample period, residential land accounts for 47 percent of the value of the housing stock and 89 percent of GDP.[25] There is some evidence of an upward long-run trend in the share of the market value of housing accounted for by land (see Figure 3) and since the mid 1990s the value of land has been rising quickly. By the second quarter of 2005, residential land accounted for 54 percent of the value of the housing stock, and equaled 124 percent of GDP, records for our sample. The constant-quality stock of residential land has grown at a pretty stable annualized rate of 0.41 percent since the first quarter of 1975 (see Figure 4). Cumulatively, the real stock of land has increased by 13 percent over the past 30 years. For comparison, the growth rate of the real stock of residential structures has been larger and more volatile, averaging 2.42 percent per year. The fact that the real quantity of residential land has risen so slowly and

---

[23] Users of our data may deflate our nominal price series using their favorite price index. We convert the BEA core PCE deflator (a middle-of-quarter measure) to an end-of-quarter measure by using the geometric mean of the published data for the current and subsequent quarter.

[24] Others have also noted that house prices have been rising more rapidly than construction costs (see, for example, Glaeser and Gyourko, 2003, or Quigley and Raphael, 2004).

[25] A common reaction to these numbers is that they are implausibly large for the aggregate United States. However, these ratios are not really sensitive to the details of our methodology. In particular, one can see that structures can only account for around half of the value of housing simply by comparing estimates for the value of the housing stock derived from the Decennial Census to BEA estimates for the value of the stock of structures (excluding commissions).

smoothly over time means that fluctuations in the value of the stock of land are almost entirely attributable to fluctuations in land prices. The average annual growth rate of the real housing stock is 1.46 percent per year, which is larger than the growth rate of the resident population over this period, but slightly smaller than the growth rate in the number of households.[26]

Table 1 documents some statistical properties of our price index for residential land at business-cycle frequencies. First, note that land prices are volatile: the real price series for land is 1.9 times as volatile as real GDP, 1.6 times as volatile as real home prices, and 2.1 times as volatile as real structures prices. This last finding, coupled with the fact that land accounts for around half the total value of housing stock, suggests that fluctuations in house prices are primarily attributable to fluctuations in land prices rather than fluctuations in structures prices.[27] Indeed, the contemporaneous correlation between detrended real land and home prices is 0.94, while the correlation between land and structures prices is only 0.54. Interestingly, residential investment leads the price of residential land.[28] This suggests that changes in the demand for housing, which should show up immediately in land prices, are not the primary factor driving changes in residential investment.

Prices for new versus existing homes: There is evidence that typical new homes and typical existing homes are quite different goods. First, while land accounts for over half of the value of the existing housing stock, the cost of purchasing raw land for newly-built houses is only around 11 percent of these houses' market value. Put differently, our estimates suggest that in 2005 home-buyers are paying twice as much on average for existing homes relative to similar newly-built structures. The implication is that a large fraction of the market value of land under existing houses reflects the value placed by home-buyers on these older homes' locations, and that the locations of newly-built houses, on average, are considered much less desirable. Second, the National Income

[26] According to the Census, the number of U.S. households grew at an average annual rate of 1.61 percent between 1975 and 2003.
[27] This mirrors the widely-held view (see, for example, Hall 2001) that most fluctuations in the value of corporate capital are driven by fluctuations in the value of intangible rather than tangible capital.
[28] Residential investment also leads the cost of structures, and the price of houses.

and Product Accounts recognize that new homes and existing homes are different goods. In fact, the NIPA price index for the replacement cost of structures is derived from the Census price index for new one-family houses under construction, and, as noted earlier, this index exhibits quite different dynamics to the OFHEO index for existing homes (see Figure 2).

Prices for residential land versus farm land: Figure 5 compares our land-price series to the price-per-acre of farm land for the aggregate United States.[29] This is the only other published aggregate price series for land in the United States of which we are aware. First, we note that the market value of residential land dwarfs the value of farmland. In 2002 there were 938.3 million acres of farmland in the United States (2002 Census of Agriculture, USDA). The average price per acre was $1,210 for a total farmland value of $1,135 billion.[30] Our estimate for the value of residential land in 2002:Q2 is an order of magnitude larger, $10,374 billion.[31]

Second, Figure 5 indicates that farm land prices and our measure of the price of residential land have little in common. One might expect to see a connection between farm prices and residential land prices, especially at the urban-rural fringe where agriculture and residential development are competing for land. Recall, however, that fluctuations in aggregate land value primarily reflect changes to the value of land under existing homes, both because the quantity of new development is small relative to the existing stock of housing, and because land accounts for a smaller fraction of the price of new homes. We conclude that at the aggregate level, farm land and residential land are essentially different goods, whose prices are determined by different factors.

---

[29] The annual farm price-per-acre series is available from the United States Department of Agriculture web site, http://www.ers.usda.gov/Briefing/LandUse/aglandvaluechapter.htm. We linearly interpolate the annual data to generate a quarterly price-per-acre series.,

[30] The official USDA estimate for total farm real estate assets in 2002 is $1,304 billion.

[31] There is little data on the value of corporate land. Following IRS estimates, McGrattan and Prescott (2005) assume an average value for corporate land relative to GDP of 3.3 percent between 1990 and 1999. Our corresponding value for residential land is 82.8 percent. If these numbers are both correct, the fraction of market value accounted for by land in non-residential real estate is much lower than in housing. Further research on the value of corporate land is needed.

There is, however, evidence that demand for housing is an important determinant of farm land prices. In particular, farm land prices tend to be highest in regions where future non-agricultural development is most likely. In January 2003, the average price per acre of farmland exceeded $9,000 in four states: Massachusetts, New Jersey, Connecticut and Rhode Island.[32] These same states are also at the top of the rankings for house prices: according to data from the 2000 Census, among the 48 states for which farmland price data is available, average prices for single-family homes in Massachusetts, New Jersey and Connecticut exceed all other states except California.

REGIONAL IMPLICATIONS

Our analysis has some interesting testable predictions for prices at the regional level. We do not have estimates for land's share by region, but it is reasonable to assume that cross-regional differences in construction costs are small relative to differences in land prices, and therefore that differences in house prices are primarily attributable to differences in the fraction of a typical home's market value attributable to the value of the associated land.[33] Three implications follow.

First, regions in which house prices (and thus land's share) are higher should exhibit more dramatic house price appreciation in periods when land prices are rising faster than construction costs. In particular, regions in which prices were already highest at the start of the most recent boom should have also experienced the fastest subsequent price growth. Second, regions with more expensive housing (and higher land shares) should exhibit greater house price volatility, since land prices are more volatile than structures prices. Third, over the past 25 years or so, price growth in regions with high initial prices should exceed growth in regions with low initial prices, since the trend growth of land prices has exceeded that of structures prices, especially since the early 1980s.

---

[32] Source: "Agricultural Land Values and Cash Rents", March 2004, USDA Statistical Bulletin Number 993, available at http://usda.mannlib.cornell.edu/usda/reports/general/sb/sb993.pdf The average price per acre of farmland in the lower 48 US states in 2003 was $1,270, while the average for the Northeast region was $3,200.

[33] See Gyourko and Saiz (2004) for evidence on regional variation in construction costs.

Table 2 reports MSA ("Metropolitan Statistical Area") level data that we use to formally test the first two of these predictions. In the first column, we list the estimated average price of a single-family owner-occupied detached house for various MSAs in 1998, sorted from most expensive to least expensive. The average house prices for these metro areas were calculated using micro data from the 1996 and 1998 Metropolitan American Housing Surveys (AHS-M).[34] The second column of Table 2 lists the cumulative nominal percentage growth to house prices from 1998:Q2 to 2005:Q2 as measured by the MSA-specific OFHEO index. The final column of Table 3 lists the standard deviation of quarterly log difference in the MSA-specific OFHEO index from 1991:Q2 to 2005:Q2.[35]

Casual inspection suggests that the MSAs with the highest home values experienced both the fastest house price appreciation and highest price volatility, consistent with our estimates of the relative appreciation and volatilities of land prices and structures costs. The top-five MSAs in this table, ranked by average house value in 1998, experienced average cumulative growth in nominal house prices over the past 7 years of 128 percent and a standard deviation of growth in the past 14 years of 2.0 percent, while the bottom five MSAs experienced average nominal growth in house prices of 38 percent and average standard deviation of 0.7 percent. The Spearman rank-correlation coefficients between 1998 price levels and subsequent appreciation, and between price levels and price volatility, are, respectively, 0.64 and 0.73.[36] Formal testing of the Spearman rank-correlation coefficients allows us to reject the hypotheses that the rank of the MSA-level average house price in 1998 is (i) uncorrelated with the rank of the subsequent growth in home prices and (ii) uncorrelated with the rank of the standard deviation of growth in home prices.

[34] The cities listed in this table are the complete set of MSAs sampled in the AHS-M in either 1996 or 1998. For the 1998 sample, the listed average house prices are calculated directly from the AHS-M micro data. For cities in the 1996 sample, we calculate a 1998 estimate by multiplying our estimated average value from the 1996 AHS-M micro data by growth in the city-specific OFHEO from 1996 to 1998. In both years, the AHS-M top codes the top 3 percent of reported house values in each city; we correct for the top code by multiplying each top coded value by 1.5. Our work with the 2000 Decennial Census of Housing and proprietary 2001 Survey of Consumer Finances data leads us to believe that this is an accurate adjustment.

[35] We chose 1998 as a starting point for looking at growth since it is the approximate starting point of the most recent boom and it corresponds to an AHS-M interview year. Standard deviations are calculated going back to 1991 so that the 1998 rankings of house values reflect the middle of the sample period, 1991-2005.

[36] The corresponding correlation coefficients (based on values rather than rankings) are 0.58 and 0.67.

Finally, to investigate the long-run correlation between initial price levels and growth, we selected the MSAs for which house price data is available in either the 1979 or the 1980 Metropolitan Annual Housing Surveys (the predecessor to the American Housing Survey) and correlate average house prices in the second quarter of 1980 with cumulative house price growth between 1980:Q2 and 2005:Q2.[37] The associated Spearman rank-correlation coefficient is positive (0.60) and statistically significant, as expected.

REGRESSION ANALYSIS

There is a large literature that attempts to link house prices to fundamentals (see, for example, Poterba, 1991 or Case and Shiller, 2004). To explore the relationship between prices and fundamentals, we regress log real house prices, structures prices, and land prices on log real aggregate personal disposable income, the log nominal 3-month annualized T-Bill rate, and the log of the inflation rate. The coefficient estimates, adjusted standard errors, and unit root tests on residuals are reported in Table 3.[38]

Consider first the land price regression in the third row of the table. We find that real land prices are (i) negatively correlated with nominal interest rates, (ii) strongly increasing in real income, and (iii) co-integrated with income, nominal interest rates and inflation. These findings are consistent both with conventional wisdom in the real estate profession, and with our argument in the introduction that land prices should be primarily determined by demand-side factors. Note also that the coefficient on inflation is positive and significant. Thus land appears to be a good hedge against inflation.

In contrast to the land price regression, the structures price regression indicates little evidence of a systematic relationship between real structures prices on the one hand and either real income, nominal interest rates or inflation on the other: coefficients are

[37] Note this is not the same set of cities reported in Table 2. A table summarizing the 1980-2005 data is available on request.

[38] See the footnotes to Table 3 for more details on the reported coefficients, standard errors, and unit root tests. Qualitatively, our results appear to be robust to different variable choices and functional form specifications. The difference between the coefficients on nominal interest rates and inflation is informative about the relationship between prices and real interest rates

insignificant, and unit root tests suggest a spurious regression. This is consistent with our prior that real structures prices, like the prices of any produced goods, should be largely driven by supply-side factors, such as productivity in the construction sector relative to the rest of the economy.

Focusing on the first row of Table 3, the house price regression, it appears that house prices are uncorrelated with nominal interest rates. Recall that house prices are a weighted average of land prices and structures costs. Thus the near-zero coefficient estimate on interest rates in the house price regression is a mix of the insignificant positive estimate from the structures price regression (row 2) and the significant negative estimate from the land price regression (row 3). The possible absence of a co-integrating relationship between house prices, income and interest rates is a further consequence of this off-setting interest rate effect, coupled with the lack of a clear relationship between structures prices and fundamentals.[39]

CONCLUSIONS

We have used publicly available data on the prices of houses and structures to construct time series for the price and quantity of residential land. We are not the first to realize that one can learn something about land prices by comparing house prices to structures costs. Rather, our contribution is to formalize the exact relationship between house, land, and structures prices in the aggregate, and to produce price and quantity series for residential land in the United States that we hope will prove useful in future research. We now discuss some implications of these series for understanding house price dynamics, and some potential future applications.

We argue that to understand house price dynamics, it is extremely helpful to decompose prices into structures and land components, since these two components are likely driven by very different factors. Structures costs, except in the short run when temporary capacity constraints may play a role, are driven primarily by materials costs and

[39] Using panel data, Gallin (2003) also finds that it is difficult to reject the hypothesis of no co-integration between house prices and income.

variations in relative sectoral productivity. In this sense, structures are just like cars or any other produced good. Land prices, on the other hand, are likely driven by a combination of supply and demand factors.

On the supply side, many have argued (see, for example, Glaeser, Gyourko and Saks, 2005 or Quigley and Raphael, 2005) that increasing difficulty in obtaining regulatory approval for building new homes is an important driver of recent house (land) price increases. Our analysis does not directly address this issue. However, we have two related findings. First, we find that growth in the real stocks of housing, land and structures has been very stable over the past thirty years, with no evidence of a recent slow-down (see Figure 6). Thus increased demand must have played a role in the recent boom in house prices. Second, new homes and existing homes are different goods: existing homes are much more land-intensive, and new and existing homes exhibit quite different price dynamics. If the elasticity of substitution between new and existing homes is small, then building more homes on the urban / rural fringe will have a limited impact on prices in more central and desirable locations.

Our finding that the stock of constant-quality land is growing at a very slow and stable rate is consistent with the view that the supply of residential land in the United States is essentially fixed.[40] This leads us to expect that demand-side shocks should have a strong effect on real land prices. Consistent with this expectation, we found that land prices are co-integrated with real income, interest rates, and inflation. Since the dynamics of income, interest rates and inflation have important national and international components, our land price series should prove useful for understanding why the current housing boom appears to have extended both across U.S. states (Otrok and Del Negro, 2005) and across countries (Otrok and Terrones, 2005). In work that applies the methodology developed in this paper to regional data, Davis and Palumbo (2005) produce a set of MSA-level series for land prices. They show that the real price of land has appreciated since 1998 in 45 out of 46 major metropolitan areas in the United States.

[40] In the very long run, some cities grow while others decay. Rossi-Hansberg and Wright (2005) is a recent paper that models this process. As new cities (such as Las Vegas) emerge, the supply of desirable residential land increases.

Shiller (2005) constructs a series for house prices going back to 1890, and finds little evidence of a substantial long-run upward trend in real home prices. Thus the recent boom is anomalous from an historical perspective. However, past house price growth, in periods when land was cheap and house prices were largely determined by structures costs, may not be informative for today's housing market, where land accounts for over half the value of existing homes.

Recently there has been a resurgence of interest in the interaction between housing and financial markets (see, for example, Lustig and van Nieuwerburgh, 2004, or Piazzesi, Schneider and Tuzel, 2005). Our finding that house prices fluctuations are primarily driven by changes in the price of land suggests that land price dynamics play a key role in connecting housing to issues of risk-sharing, portfolio choice, or asset pricing puzzles. For example, the regional results we report suggest that in cities where homes are expensive (reflecting pricier land), house prices have historically been more volatile, but have also appreciated more rapidly on average. To the extent that individuals cannot diversify their housing portfolio, we should therefore expect people in high price areas to buy more low-risk bonds and fewer risky stocks, because high-price housing offers both higher risk and higher returns.[41] In addition, since individuals have a well-documented preference for buying local stocks, perhaps because they are better informed about local companies, the low appetite for risky equity in areas with high and volatile house prices may show up in lower prices for local stocks. Interesting Hong, Kubik and Stein (2005) find that stock prices in high-population density areas in the United States are significantly higher than prices in low density areas.

Finally, our results have implications for macroeconomic analysis and policy. The fact that the value of residential land exceeds GDP has implications for the appropriate capital-output ratio to target in calibrating macro models. Our finding that interest rates are negatively correlated with real land prices suggests that house prices in regions where

[41] Flavin and Yamashita (2002) explore the implications of life-cycle variation in housing's share of total wealth for optimal non-housing portfolios.

land's share is high should be more sensitive to changes in monetary policy. A similar conclusion extends to changes in fiscal policy that impact the tax treatment of housing. For example, the President's Advisory Panel on Federal Tax Reform has recently proposed limiting mortgage tax deductions. Such reforms could have a large negative impact on house prices in the aggregate, and particularly in regions where prices primarily reflect the value of existing land.

APPENDIX

Stock of Commissions: The BEA treats expenditures on broker's commissions (NIPA table 5.4.4) as gross investment when the replacement cost of residential structures is computed. We construct a guess of the real stock of commissions that is included in the published series for the real replacement cost of residential structures using a perpetual inventory equation,

$$s_{t+1}^{c} = \left(1-\delta_{c}\right)s_{t}^{c} + i_{t+1}^{c}, \tag{11}$$

where s_t^c is the stock of commissions at time (year) t, i_{t+1}^c denotes real gross expenditures on commissions as published in the NIPA in year $t+1$, and δ_c is the implicit depreciation rate on commissions used by the BEA, which we assume to be equal to the published depreciation rate on the stock of residential structures, about 1.5 percent per year. To set an initial value for equation (11), we assume that the real stock of commissions in 1929 is equal to the average ratio of gross expenditures on commissions to total gross investment in residential structures.[42] In a final step, we convert the estimate of the real stock of commissions to a nominal stock by multiplying by the NIPA price index for commissions. We estimate that since 1975, the stock of nominal commissions has accounted for 8.5 percent of the reported stock, on average.

Quarterly Replacement Cost of Structures (ex. Commissions): The BEA publishes annual, year-end estimates of the nominal replacement cost of structures. We subtract from the published replacement cost our estimate of the nominal value of the stock of commissions (see previous section) to yield a commissions-free estimate of the nominal replacement cost of structures for the fourth quarter of each year. To calculate the commissions-free nominal replacement cost of structures in the first, second, and third quarters of each year, we use a perpetual inventory equation, starting from the fourth quarter of the previous year, of

$$p_{t+1}^{s}s_{t+1} = \left(\frac{p_{t+1}^{s}}{p_{t}^{s}}\right)p_{t}^{s}s_{t} + p_{t+1}^{s}\Delta s_{t+1}, \tag{12}$$

[42] The average ratio is 13.7 percent.

where $p_t^s s_t$ denotes the nominal replacement cost of structures in period *t*; $p_{t+1}^s \Delta s_{t+1}$ (nominal net investment in period $t+1$) is set to NIPA quarterly gross investment in residential structures, exclusive of commissions, less our estimate of the nominal value of depreciated structures (the depreciation rate varies, but averages around 0.4 percent of the nominal value of structures per quarter); and p_t^s is the quarterly price index for residential structures. In general, equation (12) does not enable us to exactly predict the $p_{t+1}^s s_{t+1}$ in the fourth quarter of year $t+1$ after jumping off from $p_t^s s_t$ in the fourth quarter of year *t*; we evenly allocate any miss (typically small) to the estimate of nominal net investment in each of the four quarters of year $t+1$.

Alternative Series for Home Prices and Structures Costs: The National Association of Realtors publishes price series for existing single-family homes and for condos and co-ops. The Census publishes similar series for new single-family homes. These series are not appropriate for our purposes, because they do not control for changes in quality over time (for example, houses have been getting larger). We compared the OFHEO index to the national index for single-family homes produced by Fiserv CSW, a private company. The CSW index tracks the OFHEO index quite closely, which is not surprising since both use versions of the weighted-repeat-sales methodology developed by Case and Shiller (1989).

We could have used private sector construction costs estimates to produce our price index for residential structures. The R.S. Means Company produces one such series. We chose not to use the R.S. Means data primarily because (i) the highest-aggregation-level cost index available is for a "National 30 City Average", and (ii) a continuous annual series for January of each year is only available beginning in 1982. Nonetheless, the broad trends in our BEA-replacement-cost-based series and the Means series are very similar: the average annual growth in nominal costs between 1981:Q4 and 2003:Q4 in the series we use is 3.1 percent, while the corresponding figure for the R.S. Means series is 2.8 percent.

Market Value of Homes, 2000 Census: We use micro data from the 2000 Decennial Census of Housing to determine the market value of all housing units in 2000.[43] Note that the market values of housing units worth more than $1 million are top-coded; we assume that the market value of any top-coded unit is $1.83 million.[44] For owner-occupiers in the sample, the market value of the housing unit is always reported; for vacant units, the market value is sometimes reported; and for rental units, the market value is never reported.[45] To impute a market value to the unreported vacant units and rental units, we assume that the average market value of these units, by type of housing unit (single-family attached, single family detached, etc.), is equal to the average market value of the reporting vacant units. After aggregating across reported and imputed market values, and applying the appropriate household weight, we estimate the market value of the housing stock in 2000 to be $17,199 billion.

[43] We do not include households living in group quarters, mobile homes, boats, tents, or vans in our calculations. The Census micro data are available at the IPUMS web site, http://www.ipums.umn.edu/usa/index.html

[44] This estimate is based on confidential data from the 2001 Survey of Consumer Finances. Note that when we perform similar calculations using the 1990 and 1980 Census micro data, we adjust top-coded values of $400,000 in the 1990 Census to $662,000; this adjustment is based on confidential data from the 1989 Survey of Consumer Finances. For our calculations with the 1980 Census micro data, we arbitrarily adjust the top-code of $200,000 to $350,000.

[45] Housing units can be vacant because they are currently for sale or for rent; they are used as vacation homes or second homes; or they are used to house seasonal or migrant workers.

References

Bajari, P., Benkard, C. and J. Krainer, 2005, "House Prices and Consumer Welfare," *Journal of Urban Economics*, forthcoming.

Case, K. and R. Shiller, 1989, "The Efficiency of the Market for Single-Family Homes," *American Economic Review* 79(1), 125-137.

Case, K. and R. Shiller, 2004, "Is There a Bubble in the Housing Market? An Analysis," *Brookings Papers on Economic Activity* (1), 299-362.

Case, K. Shiller, R. and J. Quigley, 2005, "Comparing Wealth Effects: The Stock Market versus the Housing Market," *Advances in Macroeconomics*, 5(1), 1-32.

Davis, M. and J. Heathcote, 2005, "Housing and the Business Cycle" *International Economic Review* 46(3), 751-784.

Davis, M. and M. Palumbo, 2004, "The Price and Quantity of Land in Major United States Cities," Mimeo, Federal Reserve Board of Governors.

Del Negro, M. and C. Otrok, 2005, "99 Luftballons: Monetary Policy and the House Price Boom Across U.S. States," Mimeo, Federal Reserve Bank of Atlanta.

Flavin, M. and T. Yamashita, 2002, "Owner-Occupied Housing and the Composition of the Household Portfolio," *American Economic Review* 92(1), 345-362.

Gallin, J., 2003, "The Long-Run Relationship between House Prices and Income: Evidence from Local Housing Markets," Federal Reserve Board Finance and Economics Discussion Series Working Paper no. 2003-17.

Glaeser, E. and J. Gyourko, 2003, "The Impact of Building Restrictions on Housing Affordability," *Federal Reserve Bank of New York Economic Policy Review*, June 2003.

Glaeser, E., Gyourko, J. and R. Saks, 2005, "Why Have Housing Prices Gone Up?," NBER Working Paper no. 11129.

Gyourko, J. and A. Saiz, 2004, "The Supply Side of Urban Revival," Mimeo, University of Pennsylvania.

Hall, R., 2001, "The Stock Market and Capital Accumulation," *American Economic Review* 91(5), 1185-1202.

Hamilton, J., 1994, "Time Series Analysis," Princeton University Press.

Hong, H., Kubik, J. and J. Stein, 2005, "The Only Game in Town: Stock Price Consequences of Local Bias," Mimeo, Princeton University.

King, R. and S. Rebelo (1993), "Low Frequency Filtering and Real Business Cycles," *Journal of Economic Dynamics and Control* 17, 207-233.

Lustig, H. and S. van Nieuwerburgh, 2004, "Housing Collateral and Consumption Insurance across U.S. Regions," NBER Working Paper no. 10505.

Mankiw, N. and D. Weil, 1989, "The Baby Boom, the Baby Bust, and the Housing Market," *Regional Science and Urban Economics* 19, 235-238.

McCarthy, J. and R. Peach, 2004, "Are Home Prices the Next 'Bubble'?," *Federal Reserve Bank of New York Economic Policy Review*, December 2004.

McGrattan, E. and E. Prescott, 2005, "Taxes, Regulations, and the Value of U.S. and U.K. Corporations," *Review of Economic Studies* 72(3), 767-796.

Otrok, C. and M. Terrones, 2005, "House Prices, Financial Returns, and Macroeconomic Fluctuations: International Evidence," Mimeo, University of Virginia.

Piazzesi, M., Schneider, M. and S. Tuzel, 2005, "Housing, Consumption, and Asset Pricing," Mimeo, University of Chicago.

Poterba, J., 1991, "House Price Dynamics: The Role of Tax Policy and Demography," *Brookings Papers on Economic Activity* (2), 143-203.

Quigley, J. and S. Raphael, 2004, "Is Housing Unaffordable? Why isn't it More Affordable?," *Journal of Economic Perspectives* 18(1), 191-214.

Quigley, J. and S. Raphael, 2005, "Regulation and the High Cost of Housing in California," *American Economic Review*, forthcoming.

Rossi-Hansberg, E. and M. Wright, 2005, "Urban Structure and Growth," NBER Working Paper no. 11262.

Shiller, R., 2005, "Irrational Exuberance," Second Edition, Princeton University Press.

Thorsnes, P., 1997, "Consistent Estimates of the Elasticity of Substitution between Land and Non-Land Inputs in the Production of Housing," *Journal of Urban Economics* 42(2), 98-108.

TABLE 1: BUSINESS-CYCLE PROPERTIES OF LAND PRICES, 1975:1 - 2005:2*

	p_t^l		$Corr(X_{t-s},\ p_t^l / p_t^c)$		
	SD%	rel. to X	t-s = t-4	t	t-s = t+4
p_t^l	2.7%	1.0	0.56	1.00	0.56
GDP	1.4%	1.9	0.54	0.52	0.09
RESI	9.2%	0.3	0.61	0.33	-0.29
p_t^h	1.7%	1.6	0.47	0.94	0.65
p_t^s	1.3%	2.1	0.20	0.54	0.57

* p_t^l = the price index for constant-quality residential land divided by the NIPA PCE price index excluding food and energy; GDP = real chain-weighted GDP ($2000); RESI = real chain-weighted residential investment in structures ($2000); p_t^h = the corrected OFHEO house price index divided by the NIPA core PCE price index; and p_t^s = the price index for the replacement cost of structures divided by the NIPA core PCE price index. All variables are measured quarterly; the price variables are measured at the end of the quarter; the NIPA core PCE price index is converted from an average throughout the quarter (as published) to an end-of-quarter basis by taking the geometric mean of the reported price index for the current and future quarter. All data are available for public download at http://www.marginalq.com/morris/landdata.html. GDP and RESI are taken directly from the NIPA; the OFHEO has been corrected for measurement error; and the price index for the replacement cost of structures is taken from the NIPA. All variables have been logged and Hodrick-Prescott-filtered with smoothing parameter λ=1600.

TABLE 2: HOUSE PRICE LEVELS, GROWTH RATES, AND VOLATILITY BY CITY

MSA	AHS-M Survey Year	Estimated Average House Value, 1998*	Nominal Growth in OFHEO, 1998:Q2 - 2005:Q2	SD, Quarterly Nominal Growth 1991:Q2 - 2005:Q2
San Francisco, CA	1998	$456,669	125.3%	2.04%
San Jose, CA	1998	$416,432	113.0%	2.38%
Oakland, CA	1998	$285,177	150.7%	2.19%
Boston, MA	1998	$236,569	124.4%	1.55%
Washington, DC	1998	$223,140	126.7%	1.97%
Seattle, WA	1996	$221,344	69.7%	1.03%
Baltimore, MD	1998	$175,124	97.7%	1.69%
Sacramento, CA	1996	$173,058	156.9%	2.39%
Salt Lake City, UT	1998	$168,358	25.0%	1.32%
Hartford, CT	1996	$163,917	72.4%	1.60%
Minneapolis, MN	1998	$146,234	88.9%	0.93%
Providence, RI	1998	$145,906	128.0%	1.94%
Atlanta, GA	1996	$144,248	45.9%	0.64%
Cincinnati, OH	1998	$134,363	35.1%	0.37%
Cleveland, OH	1996	$133,498	30.8%	0.58%
Norfolk, VA	1998	$131,105	88.5%	1.65%
Birmingham, AL	1998	$121,532	38.1%	0.72%
Rochester, NY	1998	$111,519	25.4%	0.83%
Tampa Bay, FL	1998	$111,167	104.6%	1.48%
Indianapolis, IN	1996	$110,784	27.7%	0.43%
St. Louis, MO	1996	$109,694	55.5%	0.64%
Houston, TX	1998	$106,826	43.2%	0.85%
Memphis, TN	1996	$105,534	26.2%	0.80%
Oklahoma City, OK	1996	$80,497	39.3%	0.63%
Avg. House Value and Nominal Growth, Spearman Rank Correlation Coefficient				0.64
Avg. House Value and Std. Dev. of Growth, Spearman Rank Correlation Coefficient				0.73

* Average value for single-family detached homes in the MSA as defined by the AHS-M.
For AHS Survey Year 1998, the value is calculated directly from AHS-M micro data.
For AHS Survey Year 1996, the 1996 average value is calculated from the AHS-M micro data and this average is scaled by growth in the MSA OFHEO from 1996:Q2 to 1998:Q2.

TABLE 3: REGRESSIONS OF HOUSE, STRUCTURES, AND LAND PRICES ON FUNDAMENTALS

		*Coefficients and T-Statistics**			*Unit Root Tests***	
		Log real disposable income	Log nominal 3-month T-Bill***	Log inflation rate***	Augmented Dickey-Fuller	Phillips-Perron
(1)	Log real house prices	0.820 (5.84)	-0.043 (-1.23)	0.247 (4.41)	Do Not Reject	Reject at 1%
(2)	Log real structures prices	0.386 (0.83)	0.032 (0.27)	0.157 (1.33)	Do Not Reject	Reject at 10%
(3)	Log real land prices	1.316 (15.41)	-0.136 (-6.40)	0.337 (15.88)	Reject at 1%	Reject at 1%

* Coefficients are estimated using Stock-Watson procedure with two leads and two lags of the growth rates of all variables, quarterly data, sample period 1975:Q4 to 2004:Q4. T-Statistics (in parentheses) are calculated according to Hamilton (1994), p. 611.

** Unit-root tests on residuals assuming no constant and no time trend. The test statistic reports whether the null hypothesis of no unit root can be rejected.

*** The 3-month T-Bill and inflation rates are the average annualized rate during the quarter.

FIGURE 1: ANNUALIZED REAL GROWTH RATES OF THE HOUSE PRICE INDEX

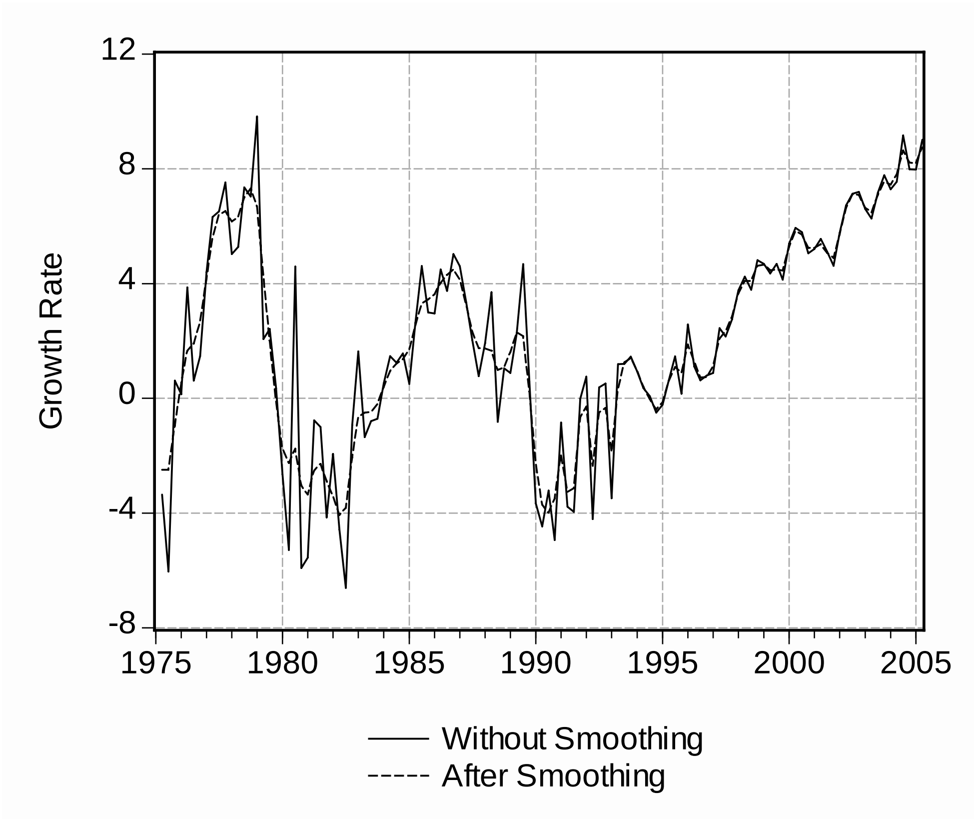

FIGURE 2: REAL LAND, HOME AND STRUCTURES PRICES (LOG SCALE)

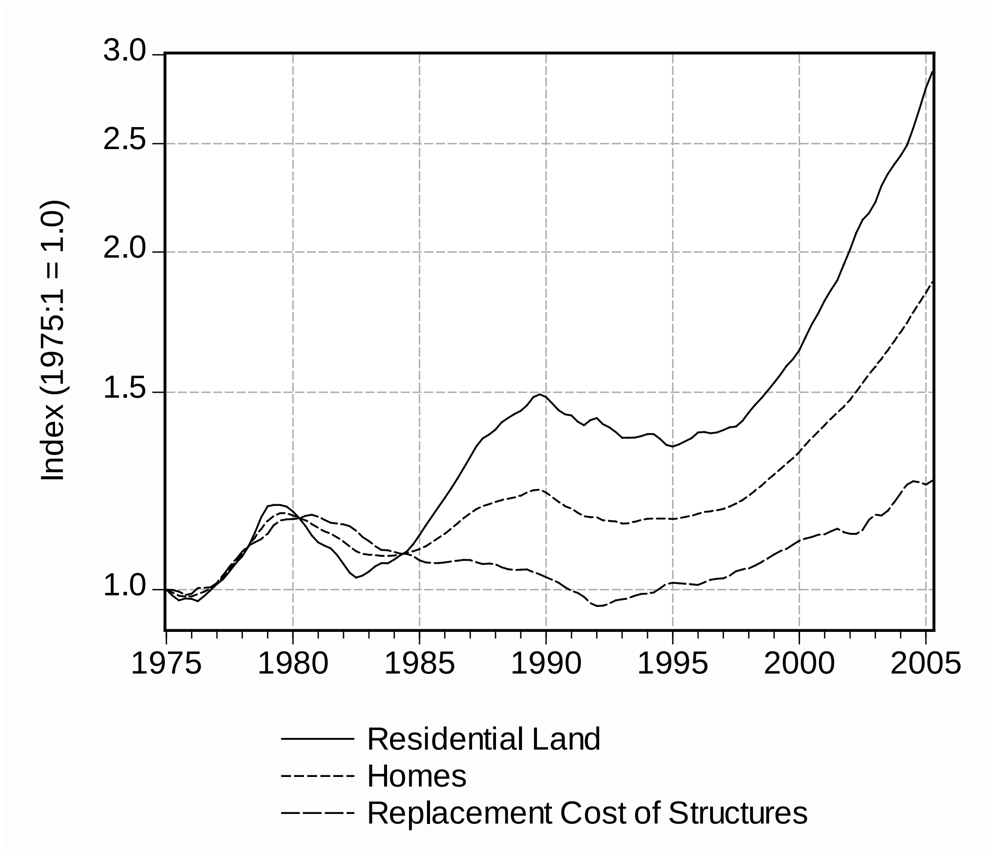

FIGURE 3: LAND'S SHARE OF HOME VALUE

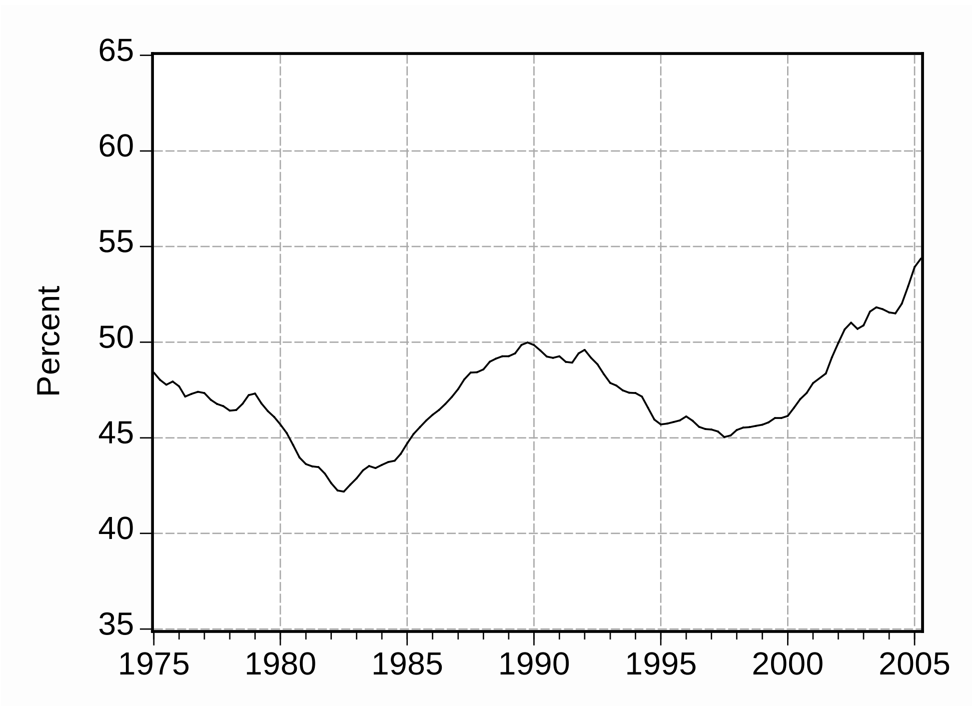

FIGURE 4: YEAR-ON-YEAR GROWTH OF REAL LAND, HOME AND STRUCTURES QUANTITIES

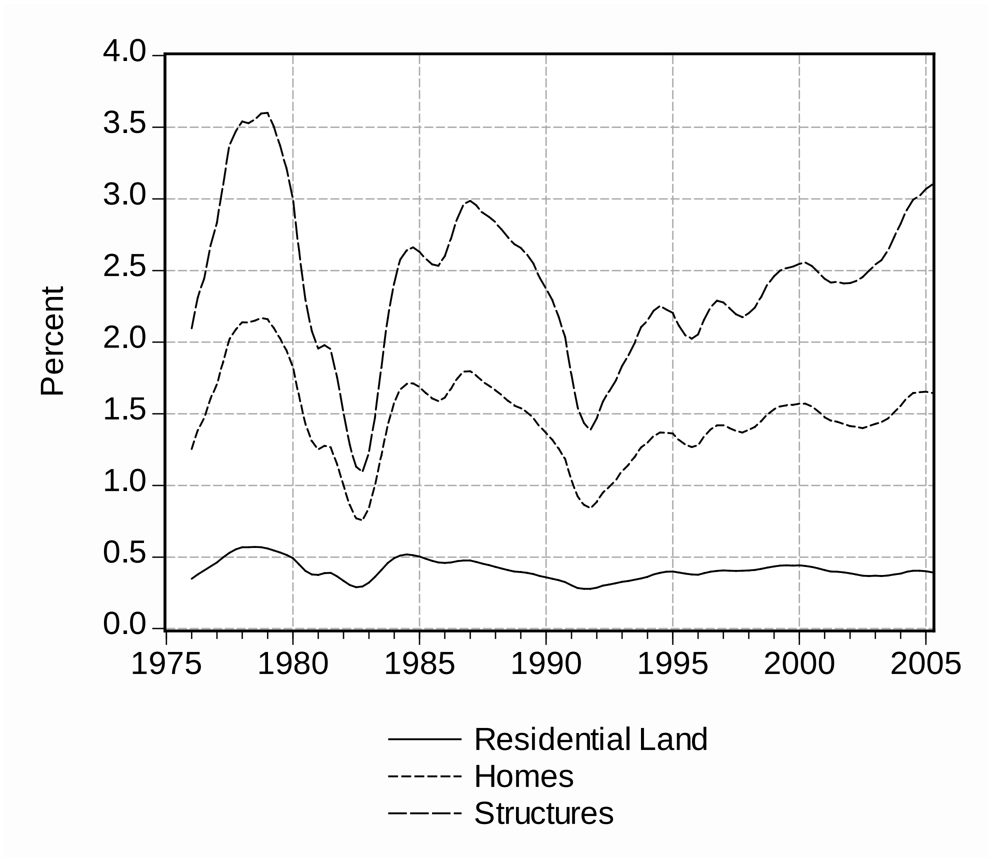

FIGURE 5: REAL RESIDENTIAL LAND AND FARM LAND PRICES (LOG SCALE)

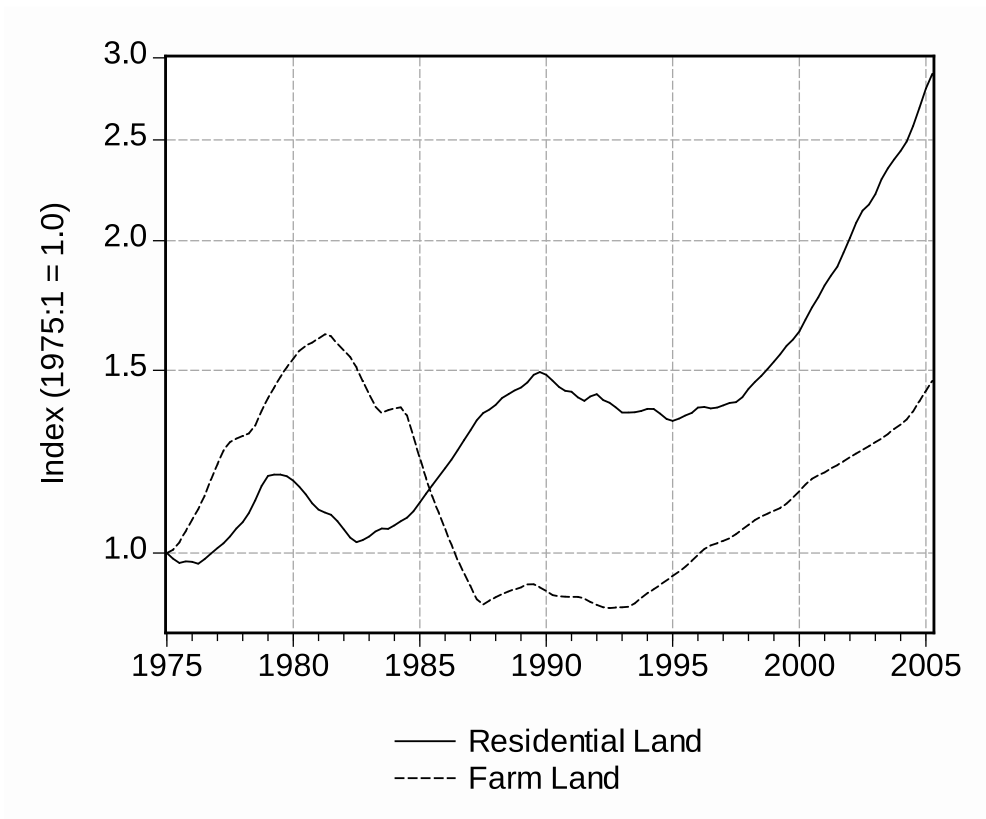

FIGURE 6: LAND, HOME AND STRUCTURES QUANTITIES (LOG SCALE)