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

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In this Appendix, we document data sources and methods we use to create quarterly price and quantity indexes for residential land from 1975:1 through 2005:4. We also document our sources and methods for constructing estimates for changes to land's share in housing from 1880 - 2000.

1 Quarterly price- and quantity- indexes, 1975:1-2005:4

1.1 Overview

We use two sets of equations to construct quarterly price and quantity indexes for residential land. The first set of equations expresses the growth rate of house prices as a weighted average of the growth rate of structures costs and land prices. This set of equations takes advantage of the fact that a house is a bundle of structures and land, and that the nominal value of housing ($p_t^h h_t$) can be defined as the sum of the nominal replacement cost of residential structures ($p_t^s s_t$) and the nominal market value of land ($p_t^l l_t$),

$$p_t^h h_t = p_t^s s_t + p_t^l l_t. \tag{1}$$

"Land" is anything that makes a house more valuable than the replacement cost of the physical structure.

Given a house is a bundle of structures and land, the growth rate of constant-quality house prices between any periods t and $t+1$ (denoted $g_t^h = p_{t+1}^h / p_t^h$) is a weighted average of the growth rate of constant-quality cost of structures ($g_t^s = p_{t+1}^s / p_t^s$) and growth in the constant-quality price of land ($g_t^l = p_{t+1}^l / p_t^l$),

$$g_t^h = \left(1 - w_t^l\right) g_t^s + w_t^l g_t^l. \tag{2}$$

We rewrite equation (2) as

$$g_t^l = \frac{1}{w_t^l} \left[g_t^h - \left(1 - w_t^l\right) g_t^s \right], \tag{3}$$

to uncover the sequence of growth rates of constant-quality land prices that are consistent with the time-series observations on g_t^h, g_t^s, and w_t^l. Arithmetically, the weight on the growth rate of land prices, w_t^l, is

equal to land's share of housing in period t,

$$w_t^l = \frac{p_t^l l_t}{p_t^h h_t} = 1 - \frac{p_t^s s_t}{p_t^h h_t}. \tag{4}$$

Summarizing, equations (1)-(4) document the relationship between growth in house prices, structures costs, and land prices given the growth rate of house prices, the growth rate of structures costs, and land's share of housing value in period t are all known.

Good data on the growth rate of house prices and the growth rate of structures costs are publicly available. Land's share of aggregate home value can be constructed using publicly available data from the *Flow of Funds Accounts of the United States* (published by the Federal Reserve Board), but our knowledge of this data suggests that it may not be accurate.[1] Therefore, we construct our own quarterly estimate of w_t^l, and the the other equations in the paper document our method. Summarizing the essential ingredients, we take as given (with some modifications, discussed later) a time-series of the nominal replacement cost of residential structures ($p_t^s s_t$) from the Bureau of Economic Analysis's (BEA) *Detailed Data for Fixed Assets*. We also construct a time series of nominal market values of housing ($p_t^h h_t$), which when combined with our estimates of $p_t^s s_t$, allows us to generate a time-series of values of w_t^l via equation (4).

We construct a sequence of $p_t^h h_t$ using the following perpetual-inventory system:

$$p_{t+1}^h h_{t+1} = g_t^h p_t^h h_t + p_{t+1}^h \Delta h_{t+1}. \tag{5}$$

In equation (5), the nominal market value of housing at period $t+1$, $p_{t+1}^h h_{t+1}$, is defined as the nominal market value of housing at period t ($p_t^h h_t$) after re-valuing for changes in constant-quality house prices (g_t^h),

[1] In earlier drafts of this paper, we noted that periodically capital gains to the market value of owner-occupied housing in the Flow of Funds Accounts (FFA) do not track capital gains of the OFHEO house-price index: One example is the 1983-1987 period). At these times, the FFA are switching data sources used to derive aggregate house value; in the 1983-1987 period, the FFA switched from benchmarking to the Annual Housing Survey to the American Housing Survey. Economists that construct the FFA are aware of this issue and are working to resolve it.

plus nominal net new additions to the stock of housing, denoted as $p^h_{t+1}\Delta h_{t+1}$. In addition, as long as (1)-(4) hold, nominal net new additions to the stock of housing can be written as

$$p^h_{t+1}\Delta h_{t+1} = p^s_{t+1}\Delta s_{t+1} + p^l_{t+1}\Delta l_{t+1}. \tag{6}$$

$p^s_{t+1}\Delta s_{t+1}$ denotes nominal net new investment in structures and $p^l_{t+1}\Delta l_{t+1}$ nominal net new investment in land.

We use equations (5) and (6) to update the market value of housing between any two periods t and $t+1$ and calibrate the initial (time 0) estimate of the market value of housing such that the market value of all housing units in 2000:2 (owned/rented/vacant) derived from (5) and (6) is equal to $13.9 trillion. This estimate is based on micro data from the 2000 Decennial Census of Housing and the 2001 Residential Finance Survey.

1.2 Details

1.2.1 Growth in the Cost of Structures, g^s_t

We use the price index for gross investment in "new residential structures" in the National Income and Product Accounts (NIPA) to measure the nominal growth rate of structures costs, g^s_t.[2] Gross investment in "new residential structures," as defined in the NIPA, includes gross investment in newly built housing units as well as the value of improvements or major repairs to existing housing units. It excludes expenditures on broker's commissions and net purchases of used residential structures, items that are included as part of the NIPA top-line estimate of gross investment in residential structures.[3]

[2]See NIPA table 5.3.4, "Price Indexes for Private Fixed Investment by Type," line 28.

[3]See footnote 6 of NIPA Table 5.3.5., "Private Fixed Investment by Type."

1.2.2 Growth in House Prices, g_t^h

We splice together two repeat-sales price indexes published by OFHEO ("Office of Federal Housing Enterprise Oversight") to measure the nominal constant-quality growth rate of house prices. OFHEO constructs these indexes using data on the sales price or appraised value of homes with a conforming mortgage that is provided to them by the Government-Sponsored Enterprises Fannie Mae and Freddie Mac. We use the OFHEO "purchase-only" index from 1991:1 (its start date) to the end of our sample. The OFHEO purchase-only index is constructed using data only from arms-length sale price of homes. From 1975:1 to 1991:1 we use the OFHEO price index that includes data from home sales as well as data from appraisals required for the refinance of a mortgage.

We consider the OFHEO indexes to be constant quality price indexes because they are constructed using a repeat-sales approach – that is, the indexes are constructed by comparing the sales price (or appraised value via a refinance) of the same housing unit at two or more points in time. In a recent article, McCarthy and Peach (2004) have argued that the OFHEO price indexes are biased upwards since they do not explicitly control for improvements in any given housing unit.[4] Of course, by this same reasoning, the OFHEO indexes could be biased down because they does not control for depreciation of structures. Calculations we have performed suggest that these biases largely offset in the aggregate data. The NIPA publishes estimates of gross investment in structures that are "improvements."[5] The average annual nominal value of these

[4]McCarthy and Peach argue that the least-biased price index for housing is a "constant quality" price index for *new* houses that is constructed by the Census Bureau. In our view, this price index is useful for tracking construction costs, but not existing home prices: New houses tend to be built on the least expensive land in a metro area, and further (according to the Census Bureau's estimates) land's share of the value of new houses is only around 11 percent (discussed later).

[5]The NIPA estimates of spending on improvements are derived from data published by the Census Bureau. The Census Bureau also separately tracks expenditures on maintenance and repair. We have confirmed with BEA employees that expenditures on maintenance and repair are not considered as part of gross investment in the NIPA. The exclusion of this category of spending from gross investment is consistent with the BEA's concept of depreciation, which is depreciation that is assumed to

expenditures as a fraction of our estimate of the market value of housing (land plus structures) averages 0.77 percent over the period 1975 to 2005. This is very similar to our estimate of the nominal annual depreciation of the existing stock of residential structures, about 0.93 percent of the market value of housing per year.[6] This evidence supports the OFHEO's implicit assumption that by observing repeat sales of the same homes one can effectively hold constant the quality of structures over time.

One may also worry that the OFHEO indexes under-represent expensive homes, because the data used to construct the indexes are based on housing units with mortgages that have been purchased by Fannie Mae and Freddie Mac, and these institutions can only purchase and securitize mortgages that are less than a certain size called the "conforming loan limit." In 2006, for example, the conforming loan limit is $417,000.[7] This could be problematic if prices of expensive homes exhibit different dynamics than prices of cheaper homes. However, 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

occur after basic maintenance and repair has taken place. Regardless, the results of this section would not qualitatively change if we were to include Census expenditures on maintenance and repair (but not adjust BEA depreciation) when calculating the potential for bias in the OFHEO.

[6]Spending on improvements also does not fluctuate much: it ranges between 0.67 (1982:4) and 0.88 percent (1986:3) 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 improvements as a share of home value during the 10 year period to 2006:2 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/housing_bubble_2004_06.htm).

[7]The loan limit in Alaska, Hawaii, Guam and the U.S. Virgin Islands is 50 percent higher.

mortgage was approximately $300,700, which was also the conforming loan limit for that year.[8] This is close to the median state-wide sales price in 2002 for existing detached single-family homes, which was $316,130[9] (the corresponding figure for the United States was $156,200).

1.2.3 Replacement Cost of Structures, $p_t^s s_t$ (an input into the calculation of w_t^l)

A summary of our basic procedure to construct a quarterly estimate of the replacement cost of structures follows:

- First, we use year-end annual capital stock data from the BEA's *Detailed Data for Fixed Assets* to construct year-end estimates of the stock of residential structures exclusive of mobile homes, farm structures, residential structures owned by nonprofit organizations, and residential equipment.
- Second, we adjust these annual estimates to account for conceptual errors in the BEA's definition of gross investment in structures.
- Third, we use quarterly NIPA data on gross investment in residential structures and changes in the price index for residential structures to produce quarterly estimates that are consistent with the annual estimates from the 2nd step.

After these three steps, our estimates of the nominal replacement cost of residential structures are about 17 percent lower than the BEA's published estimate of "Total Private Residential Fixed Assets."[10]

Starting with the first step, from the estimate of "Total Private Residential Fixed Assets" in the BEA's *Detailed Data for Fixed Assets*,[11] we subtract private fixed residential assets held by nonprofit institutions

[8] Source: OFHEO Press Release, available at http://www.ofheo.gov/media/pdf/2q05hpi.pdf

[9] Source: California Association of Realtors, available at http://www.car.org/

[10] Our estimate ranges from 16-18 percent lower over the 1975-2004 time period.

[11] These data are available at http://www.bea.gov/bea/dn/FA2004/Details/Index.html

(such as dormitories), owner-occupied private fixed residential assets held by sole-proprietors (farm houses), all manufactured homes, and all residential equipment. These adjustments align our estimate of the replacement cost of structures with our estimate of the market value of housing (discussed later), and reduce the BEA's estimate of Total Private Residential Fixed Assets by about 6-1/2 percent over the 1975-2004 period

In the second step, we correct for a conceptual flaw in the BEA's definition of gross investment in residential structures. The BEA treats expenditures on broker's commissions[12] as gross investment when it computes the stock of residential structures via perpetual inventory accounting.[13] We believe this is a conceptual error because the physical replacement cost of any particular structure should not change with the number of times that structure is sold.[14]

We estimate a real stock of commissions (implicit in the BEA's estimate of the real stock of residential structures) using a perpetual inventory equation of

$$s^c_{t+1} = (1 - \delta_c)\, s^c_t + i^c_{t+1}. \tag{7}$$

s^c_t is the real stock of commissions at period t (year-end), i^c_{t+1} denotes real gross expenditures on commissions as published in the NIPA during year $t+1$, and δ_c is the implicit annual depreciation rate on commissions used by the BEA, about 1.5 percent per year. To set an initial value for s^c_t in equation (7), we assume that the real stock of commissions in 1929 is equal to the real stock of "new 1-4 unit structures" (as labeled by the BEA in the *Detailed Data for Fixed Assets*)[15] in 1929 times the average ratio (14.2 percent from

[12]See NIPA table 5.4.4A line 34 and 5.4.4B line 43.

[13]In our conversations with BEA staff, we have confirmed that this is the case.

[14]For example, if a house transacts three times in one year, the cost of rebuilding the structure according to BEA accounting would increase by 18 percent in that year.

[15] Expenditures on broker's commissions are treated by the BEA in the *Detailed Data for Fixed Assets* as gross investment in "new 1-4 unit structures." Confusingly, the word "new" in the estimate of "new 1-4 unit structures" as published in the *Detailed Data for Fixed Assets* does not have the same interpretation as the word "new" in the NIPA estimate of gross investment for

1929-2004) of real annual expenditures on broker commissions from the NIPA to the real gross investment (as reported in the *Detailed Data for Fixed Assets*) in "new 1-4 unit structures."[16] To convert the real stock of commissions to a nominal stock, we multiply the real stock by the NIPA price index for broker's commissions.[17]

We set our annual estimate of the nominal replacement cost of residential structures equal to the nominal estimate computed in step 1 less the estimate of the nominal stock of commissions. From 1975-2004 our estimate of the nominal stock of commissions accounts for about 8-1/2 percent of the BEA's published estimate of "Total Private Residential Fixed Assets."

In our third and final step, we convert the year-end annual estimates to quarterly estimates using quarterly NIPA data on investment in structures and changes to the price index for residential structures. Our quarterly estimates are generated using a perpetual inventory system of

$$p^s_{t+1}s_{t+1} = \left(\frac{p^s_{t+1}}{p^s_t}\right) p^s_t s_t + p^s_{t+1}\Delta s_{t+1} + \phi_{t+1}. \tag{8}$$

$p^s_t s_t$ denotes the nominal replacement cost of structures in period t; $p^s_{t+1}\Delta s_{t+1}$ denotes nominal net investment during period $t+1$ and is set equal to NIPA quarterly current-cost gross investment in "new residential

"new residential structures." In the accounting of the *Detailed Data for Fixed Assets*, the real net stock of "new 1-4 unit structures" is defined as the net stock of all 1-4 unit structures exclusive of the net stock of any additions and alterations or major replacements in 1-4 unit structures that may have occurred. The depreciation rate for the category of "new 1-4 unit structures" is approximately 1.5 percent; see the BEA's *Detailed Data for Fixed Assets* for details.

[16]The NIPA data on real annual expenditures on commissions is derived from NIPA tables 5.4.3A and 5.4.3B, lines 34 and 43 respectively.

[17]NIPA table 5.4.4A line 34 and 5.4.4B line 43.

structures"[18] less an estimate of the nominal value of depreciation of structures in quarter $t+1$;[19] and p^s_{t+1} is the NIPA quarterly price index for "new residential structures" at period $t+1$; it is the same price index we use to compute g^s_t (and discussed earlier in this appendix in section 1.2.1). ϕ_{t+1} is an adjustment factor we construct to ensure that the quarterly data derived from equation (8) is consistent with our annual estimates. ϕ_{t+1} is set such that our quarterly estimates from (8) exactly equal our annual estimates in the fourth quarter of each year.[20] The value of the adjustment factor is quite small relative to the nominal replacement cost of structures: The mean of $\phi_{t+1}/\left(p^s_{t+1}s_{t+1}\right)$ is -0.0017 and its standard deviation is 0.007.

Finally, note that our annual estimates end in 2004 (the last year of data in the BEA's *Detailed Data for Fixed Assets*). To construct estimates after 2004:4, we use equation (8) assuming that the depreciation rate in 2005 is the same as in 2004 (1.6 percent annually). We also set ϕ_{t+1} such that $\phi_{t+1}/\left(p^s_{t+1}s_{t+1}\right)$ is 0.0045, its value in 2004.

1.2.4 Market Value of Housing, $p^h_t h_t$ (an input into the calculation of w^l_t)

We construct the aggregate non-farm market value of housing using the perpetual inventory system listed in equations (5) and (6). This system takes as given an estimate of the market value of housing in period t, $p^h_t h_t$. The period t estimate is adjusted for constant-quality growth in house prices $g^h_t = p^h_{t+1}/p^h_t$, and

[18] As mentioned, NIPA defines gross investment in "new residential structures" as top-line investment in residential structures less expenditures on commissions and net purchases of used residential structures; it includes both the value of brand new housing as well as expenditures on improvements and repairs. The gross investment data we use are available in NIPA Table 5.3.5, line 28.

[19] In the BEA's *Detailed Data for Fixed Assets*, data on annual nominal depreciation is available. Using this data, we estimate an annual depreciation rate for each year. We also assume the depreciation rate in any quarter of the year is equal to the depreciation rate for that year (quarterly rate). Our estimate of nominal deprecation in any quarter t is the depreciation rate in quarter t multiplied by the value of the nominal stock of structures in $t-1$, $p^s_{t-1}s_{t-1}$.

[20] ϕ_{t+1} changes from year to year, but we set the same value of ϕ_{t+1} to every quarter of a given year.

net-new investment in housing $p^h_{t+1}\Delta h_{t+1}$ (the sum of net-new investment in structures and land) is added to estimate the nominal market value of housing in $t+1$, $p^h_{t+1}h_{t+1}$. This system is calibrated such that in 2000:2 it is exactly equal to our estimate of the market value of all housing units, $13,770 billion. This estimate is derived from micro data from the 2000 Decennial Census of Housing (DCH) and the 2001 Residential Finance Survey (RFS). Details are itemized below:

- $\mathbf{g^h_t}$: For g^h_t, we use the data listed in section 1.2.2. This ensures that growth rate of house prices used in equation (3) for the purposes of measuring the growth rate of the price of land is consistent with estimates of the market value of housing from equations (5) and (6).

- $\mathbf{p^h_{t+1}\Delta h_{t+1}}$: To estimate $p^h_{t+1}\Delta h_{t+1}$, we add estimates of nominal net new investment in structures $p^s_{t+1}\Delta s_{t+1}$ and nominal net new investment in land $p^l_{t+1}\Delta l_{t+1}$: see equation (6).[21]

  Our estimate of nominal net investment in structures is described in section 1.2.3: It is equal to $p^s_{t+1}\Delta s_{t+1} + \phi_{t+1}$ from equation (8).

  Our estimate of nominal net-new additions to residential land $p^l_{t+1}\Delta l_{t+1}$ is based on assumptions the Census Bureau uses to estimate the value of structures put in place. The Census Bureau does not observe the value of structures put in place directly, but rather infers a value given data on the prices at which new homes sell, and estimates 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.[22] Thus, we assume net new additions to residential land account for 10.6/84.2 = 12.6 percent of NIPA

[21] As noted earlier, equation (6) is implied by equations (1), (2), and (5).

[22] The Census Bureau 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.

gross investment in permanent-site residential structures.[23] Implicitly, the Census Bureau is assuming a unitary elasticity of substitution between structures and land in the production of new homes.[24]

- **Calibration to 2000 DCH and 2001 RFS**: We use micro data from the 2000 DCH (a 1 percent sample of all households) to determine the market value of all non-farm owner-occupied housing units and micro data from the 2001 RFS to determine the market value of all non-farm vacant and rented housing units.[25]

  To compute the market value of the entire non-farm residential stock, we use the distribution of housing units (owned/rented/vacant) from the DCH. We drop from the DCH data all housing units that are (a) farm units, (b) mobile homes, boats, or tents counted as housing units, and (c) housing units where respondents are classified as living in "group quarters."

  For owner-occupiers in the DCH sample – housing units classified as "owner-occupied" or "vacant: for sale only" – the owner's self-assessed market value of the housing unit is always reported.[26] Note that the market value of housing units in the DCH worth more than $1 million are top-coded. Based on

[23]See NIPA table Table 5.3.5., "Private Fixed Investment by Type," line 19, permanent-site residential structures.

[24]This assumption is consistent with Thorsnes (1997).

[25]The DCH micro data are available at the Integrated Public Use Microdata (IPUMS) web site, http://www.ipums.org/, and the RFS micro data are available at the Census Bureau's web site, http://www.huduser.org/datasets/rfs.html

[26]The question that is asked of respondents is "What is the value of this property; that is, how much do you think this house and lot, apartment, or mobile home and lot would sell for if it were for sale?" The potential answers are: Less than $10,000; $10,000 to $14,999; $15,000 to $19,999; $20,000 to $24,999; $25,000 to $29,999; $30,000 to $34,999; $35,000 to $39,999; $40,000 to $49,999; $50,000 to $59,999; $60,000 to $69,999; $70,000 to $79,999; $80,000 to $89,999; $90,000 to $99,999; $100,000 to $124,999; $125,000 to $149,999; $150,000 to $174,999; $175,000 to $199,999; $200,000 to $249,999; $250,000 to $299,999; $300,000 to $399,999; $400,000 to $499,999; $500,000 to $749,999; $750,000 to $999,999; and $1,000,000 or more. The midpoint of the bin is recorded in the micro data.

confidential data from the 2001 *Survey of Consumer Finances*, we assume the market value of any top-coded unit is $1.86 million.[27]

For the values of vacant and rental units in the DCH sample, we assign the values reported in the column marked "2001 RFS" of table 2 after adjusting for growth in home prices between 2000:2 and 2001:2. The column marked "2001 RFS" lists the average value-per-unit of rented and vacant units by the number of units in the building, when nonzero values are reported, that are directly calculated from raw 2001 RFS micro data.[28] The values we assign to rental and vacant units in 2000 are equal to the values reported in this table less growth in home prices of 7.46 percent between 2000:2 and 2001:2, reported in the bottom row of table 4.

After applying sample weights, we estimate the aggregate market value in 2000 of the non-farm stock of housing (assigned to 2000:2) to have been $13,770 billion, reported in the bottom row of table 1. In earlier drafts of the paper, we reported a much higher estimate of the market value of the housing stock in 2000. The difference is entirely due to a change in our estimate of the market value of rental and vacant units.[29]

[27]The average value of housing in the 2001 *Survey of Consumer Finances*, conditional on the housing being worth more than $1 million, is $2 million. We adjust this estimate for growth in home prices between 2000 and 2001 of 7.46 percent, calculated from our data on g_t^h. The identical adjustment will also be applied to micro data from the 2001 RFS survey, discussed later.

[28]The RFS micro data we use are not top-coded. From the RFS sample, we drop all respondents who do not own land (*sametime=3*) and we also drop respondents owning mobile homes (*mhcond=1*).

[29]In earlier drafts, we had assumed that the market value of rentals and vacants was approximately the same as the market value of owner-occupied units. The RFS data suggests that the market value of rental and vacants is much lower than for owner-occupied units. For example, after-accounting for top-coding, the average value of 1-family owner-occupied housing units in 2000 (according to DCH micro data) was about $160 thousand, whereas we report in table 2 an average value for 1-family rental and vacant units of less than $115 thousand.

2 Land's Share of Home Value, 1880 - 2000

2.1 Census and BEA Data, 1930 - 2000

In this section, we describe how we estimate land's share of value for non-farm housing units from 1930-2000 using data from the BEA on the replacement cost of structures and micro data and printed tables from the DCH and data from various Statistical Abstracts of the United States for the market value of residential housing units. Generally speaking, we are most confident in our estimates for 2000, and our confidence in each of the estimates declines as we move backwards from 2000.

Table 1 in this appendix summarizes our estimates. The left-hand column of this table, marked "Adj. Repl. Cost, Structures," is simply $p_t^s s_t$ and is computed using the same method as documented in section 1.2.3 of this paper. Our estimate of the market value of all non-farm housing units is shown in the second column, and in the rest of this section we document our procedure to compute this market value for each of the years shown in table 1. Our estimate of land's share of home values that is derived from the first two columns is listed in the third column.

The last column of table 1 shows estimates of the market value of housing that we derive from the Flow of Funds Accounts of the United States (FFA), the only source of continuous time series data for aggregate home value for which we are aware. The FFA data are derived, to the best of our knowledge, from DCH and RFS data from 1950 - 1970, Annual Housing Survey and RFS data for 1980, and American Housing Survey and RFS data for 1990 and 2000.[30]

[30]The FFA estimates are computed as the sum of B.100 line 3 (real estate held by households at market value) and B.103 line 4 (residential real estate held by nonfarm noncorporate businesses at market value) less the value of all residential mobile homes from the BEA's *Detailed Data for Fixed Assets*, less an unpublished estimate of the value of vacant land held by households that is embedded in B.100 line 3.

2.1.1 Details of the Estimates of the Market Value of Housing, 1930-2000

- **1990 and 2000**. Our procedure to estimate the market value of housing in 2000 is detailed in section 1.2.4. For 1990, we use basically the same procedure as 2000 except (a) the top-code for owner-occupied properties in the 1990 DCH of $400 thousand is replaced with $662 thousand (based on confidential data from the 1989 *Survey of Consumer Finances*) and (b) for rental and vacant units, we use the average value per unit for from the 1991 RFS in table 2 after adjusting for the growth in home prices between 1990 and 1991 reported in table 4.

  Tables 5 and 6 show our estimates of the aggregate value for 2000 and 1990 when broken down into the number of units and value-per-unit of owner-occupied, renter-occupied, and vacant units. Shown in table 6, our estimate of the market value in 1990:2 is $8,483 billion; for comparison, the market value of housing we derive using equations (5) and (6) is about 2-1/2 percent lower, $8,279 billion.

- **1960, 1970, and 1980**. For these years, we use micro data from the 1960, 1970, and 1980 DCH to estimate the market value of the stock of non-farm owner-occupied housing, but use information from printed tables from the 1961, 1971, and 1981 RFS to estimate the market value of rental and vacant units.[31] As with 1990 and 2000, we use the distribution of housing units (owned/rented/vacant) from the DCH, excluding farm units, mobile homes, boats, or tents counted as housing units, and housing units where respondents are classified as living in "group quarters."

  Our estimates of the aggregate market value when broken down into the number of units and value-per-unit of owner-occupied, renter-occupied, and vacant units, are reported in tables 7 (1980), 8 (1970), and 9 (1960).

  Our procedure for computing the market value of the stock of non-farm owner-occupied housing is

[31] RFS micro data is unavailable for these years.

similar to that in 1990 and 2000, but with a few differences. First, the value of top-coded units in 1960, 1970, and 1980, \$35, \$50, and \$200 thousand respectively, has been replaced with 1.75 times the top code (\$61.2, \$87.5, and \$350 thousand). We use 1.75 because this is approximately equal to the adjustment we use in 1990 and 2000, and the top-code percentages in 1960, 1970, and 1980 are similar to those in 1990 and 2000.[32] Second, in these DCH years, not all owner-occupiers report the market value of the homes. For each type of housing unit (1-family detached, 1-family attached, etc.) we replace missing values for owner-occupiers with the average reported value.

The per-unit average value of rental and vacant units that we derive from the printed RFS tables, by number of units in the building, is listed in table 3. These averages are derived from tables listing the distribution of "value per housing unit," by the number of housing units in each building (1-4 family, 5-49, and 50+) and for each RFS survey year. The averages shown in table 3 are adjusted according to the percentages reported in table 4 to account for growth in home prices between the DCH and RFS years. Note that for the 1960-1961 and 1970-1971 periods, we adjust the RFS estimates using growth in the constant-quality cost of residential structures, g_t^s, and not growth in constant-quality house prices, g_t^h: Data on g_t^h is unavailable in these years.[33]

Additionally, the 1960 and 1970 DCH each lack key pieces of information. In the 1970 DCH available at IPUMS, the market value of owner-occupied units 2+ buildings is not reported at all. For this special case, we assume that the market value of owner-occupied non-farm units in 2+ buildings is 18.5

[32]The top-code percentages of owner-occupied units reporting house value in our sample, after adjusting for sample weights, are 0.68% in 2000; 2.85% in 1990; 1.27% in 1980; and 2.50% in 1960. The top-code percent in 1970 is 2.74%, but house value is not reported for owner-occupied units in 2+ buildings in 1970 and so this percentage is not directly comparable to the estimates from the other years.

[33]Land's share of home value is relatively low in 1960 (18 percent) and 1970 (20 percent), and therefore the gap in growth rates between house prices and construction costs for those years may be relatively low.

percent greater than the average market value of 1-family (detached and attached) owner-occupied units; this adjustment is based on data in the 1960 and 1980 DCH.

In the 1960 DCH available at IPUMS, no information on vacant units is provided. Using data from our 1970 and 1950 estimates, we guess a vacancy rate of 6.9 percent for 1960.[34] We set the average value of vacant units in 1960 ($8,108) to be equal to 59% of the average value of owner-occupied units ($13,805), the same ratio as in 1970.[35] Our estimated market value of the vacant units is therefore $28.8 billion, 5.1% of the entire market value of housing in 1960.

As a final note, our estimate of the market value of the non-farm stock of housing in 1980:2 using these data sources is $3,888 billion. For comparison, the market value of housing we derive using equation (5) and calibrated only to the market value in 2000 is $4,159 billion, about a 7 percent difference. Accordingly, land's share of home value according to the 1980 DCH and 1981 RFS is 27.0 percent, whereas using equations (5) and (6) we estimate land's share to be 31.8 percent.

- **1930, 1940, and 1950**. The micro data for the 1930, 1940, and 1950 DCH available at the IPUMS are incomplete. House value is not reported at all in the 1950 DCH micro data, and similar to 1960, data on the number or value of vacant units is not included in the DCH micro data on IPUMS for

[34]This is the average of the 1970 vacancy rate and 1950 vacancy rate, 7.4% and 6.4% respectively. It also is very close to the vacancy rate for housing units in 1960 inside Statistical Metropolitan Areas (SMSAs), 6.6%, which is the only vacancy rate we can find published for 1960 that is somewhat relevant to our sample of nonfarm housing units: See the 1960 Decennial Census of Housing, Summary of Findings for States and Small Areas, Table L on page xxx.

[35]This ratio is much smaller than the ratio of the average value of vacant units to owner-occupied units in 1940, 95%, which we use to calculate the average value of rental units in 1950. If we were to use the 95% ratio, the average value-per-unit of vacant units would jump to $13,078 and our estimate of the aggregate market value in 1960 would increase from $569.33 to $587.01. One reason we prefer the $7,890 estimate is that it is close to the estimate of the average value of rental units ($7,374), which is in the spirit of the underlying RFS data used to calculate the average value of rental units.

1930 and 1940. To supplement the IPUMS micro data, we use data from from various printed DCH tables and Statistical Abstracts.[36] The DCH tables and Statistical Abstracts vary across publications in the data that are provided, explaining some of the variation in our data sources.

Our estimates of the aggregate market value when broken down into the number of units and value-per-unit of owner-occupied, renter-occupied, and vacant units, are reported in tables 10 (1950), 11 (1940), and 12 (1930).

Details on our calculations are provided below.

- **1950** Table 10 lists important details of our calculations for the market value of non-farm housing in 1950. The distribution of housing units into owner-occupied, renter-occupied, and vacant units is taken from table 11 of Part I of the published report on the 1950 Decennial Census of Housing. The split of owner-occupied units into 1-family detached and all other units is also taken from this same table. The 1950 DCH only reports median values and median rents, not average values. For average values, we turn to the sources listed below.

  Owner-Occupied Units: The average value of owner-occupied 1-family detached units of $10,800 is taken from table 869 (page 724) of the 1951 Statistical Abstract of the United States. We use the ratio of the average value of 1-family detached owner-occupied units to all other owner-occupied units from the 1960 DCH micro data available at IPUMS (1.142) to estimate the average value of all other owner-occupied units, $9,457.[37]

[36] Print editions of all Statistical Abstracts are available online at http://www.census.gov/compendia/statab/past_years.html and print editions of the Decennial Censuses are available online at http://www.census.gov/prod/www/abs/decennial/index.htm

[37] It may seem confusing that the average value of owner-occupied 1-family detached units is greater than the average value of all other units, while the average value of owner-occupied 1-family detached and attached units is less than the average value of all other units (see notes to 1970). The reason is that the market value of owner-occupied 1-family attached units is relatively

Renter-Occupied Units: Table 868 (page 724) of the Statistical Abstract of the United States reports the average monthly contract rent ($39) of renter-occupied units. We set the value of renter-occupied units equal to 100 times this average monthly contract rent. This is a common assumption used by researchers studying valuations in this time period.[38]

Vacant Units: We set the average value of all vacant units, $9,990, equal to 95 percent of the average value of all owner-occupied units, $10,545. This ratio is based on data from 1940.[39]

Total: After adding the value of all these units together, we estimate the total non-farm market value to be about $299 billion in 1950. We should note that in their table D-3, Grebler Blank and Winnick (1956), hereafter GBW, estimate the market value of the housing stock in 1950 to be $260 billion. GBW set the average value of all vacant units and the average value of non 1-family detached housing to $3,900, the rental-occupied average: When we make these same assumptions, our estimate of the market value in 1950 falls to $262.68.[40]

– **1940** Our estimates of the number and average value of owner-occupied and renter-occupied non-

low; and, there are not many owned-occupied 1-family attached units relative to detached units, but the number of 1-family owner-occupied attached units is quite sizeable compared to the number of owner-occupied units in 2+ family buildings. For reference, the average market value of owner-occupied 1-family detached houses in 1960 is $13,893; for 1-family attached houses it is $10,569; and for units in 2+ family buildings the average market value is $15,413.

[38]See, for example, Grebler, Blank, and Winnick (1956) or Wickens (1941). Also note that the same assumption is used by the Census Bureau in the 1951 Statistical Abstract of the United States to estimate the value of rental units in 1940: See table 873 (page 726) of the 1951 Statistical Abstract.

[39]In the printed tables of the 1950 DCH, vacant units are subdivided into two categories: "Vacant Nonseasonal not dilapidated, for rent or sale" (639 thousand units) for which some information on rents and values is provided, and "All Other," (1.88 million units) for which no information on rent or value is provided. Because no information is provided for most of the vacant units, we do not use the information in the printed tables.

[40]Obviously, we prefer our estimate and think it to be more accurate.

farm units are taken from the 1940 DCH micro data available at IPUMS. As with the 1950 data, we assume that the average value of rental units is 100 times estimated reported monthly contract rent. For vacant non-farm units, our estimates of the number of units and average value per unit are derived from published Tables 14 and 15 of Volume 2 of the 1940 Decennial Census of Housing.

Our estimate of the total market value of non-farm units, $90.38 billion, is higher than the Census Bureau's published estimate of the market value of all housing units, $87.4 billion, which is reported in table 873 (page 726) of the 1951 Statistical Abstract of the United States and also reported in GBW. The difference in the estimates is almost entirely attributable to the fact that we calculate the average value of rental-occupied units to be $2,706, whereas the published Census estimates from 1940 suggest it is more like $2,395.[41] The IPUMS unit counts are almost identical to those published in Tables 14 and 15, and the Census Bureau uses the same rent-multiplier (100) in its calculation of the market value of rentals, so we do not have a good explanation other than simple computation error as to why the Census Bureau's estimate of the average value of rental units is very different than ours.

– **1930** Our estimates of the number and value of owner-occupied and renter-occupied non-farm units are taken from the 1930 DCH micro data available at IPUMS.[42] For vacant units, we use a vacancy rate of 6.45% and average value of vacant units of $5,878, neither of which are reported in any Statistical Abstract or Census publication to the best of our knowledge. We set the vacancy rate in 1930 equal to the average of the vacancy rate in 1940 (6.5%) and 1950 (6.4%). The average value of vacant units is set to 95 percent of the average value of all owner-occupied units, $6,205, a ratio based on the 1940 data. Our estimate of the total market value of non-farm units, $113.82,

[41] For comparison, our estimate of the average value of owner-occupied homes, $3,472, is similar to the estimate in the Census tables published in 1940, $3,565.

[42] As with our 1940 and 1950 estimates, the value of rental units is assumed to be 100 times monthly contract rent.

is similar to Wickens' (1941) estimate, which is also based on Census data.[43]

2.1.2 Real Growth in House Prices and Land Prices, 1930-2000

We use the information in table 1 in order to generate a time-series of house prices that is reflective of decade-to-decade real growth in house prices. Consider again equation (5), but suppose that the growth rate of capital gains is unknown. In this case, define the nominal growth rate of house prices $g_t^h = p_{t+1}^h / p_t^h$ as equal to growth in real house prices, denoted as $\widehat{p}_{t+1}^h / \widehat{p}_t^h$ times growth of consumer prices p_{t+1}^c / p_t^c,

$$p_{t+1}^h h_{t+1} = \left(\frac{\widehat{p}_{t+1}^h}{\widehat{p}_t^h} \frac{p_{t+1}^c}{p_t^c} \right) p_t^h h_t + p_{t+1}^h \Delta h_{t+1}. \tag{9}$$

We set p_t^c equal to the NIPA price index for consumption excluding food and energy.[44] Then, with knowledge of annual net investment in housing $p_{t+1}^h \Delta h_{t+1}$ for every year in our sample – computed as annual gross investment in new residential structures (excluding commissions), less annual depreciation in residential structures, plus nominal investment in new land (approximated as 12.6 percent of NIPA gross investment in permanent-site residential structures) – we use a cubic spline procedure to compute a sequence of $\widehat{p}_t^h$ such that given a nominal value of housing $p_t^h h_t$ in any arbitrary starting DCH year (for example, 1950) we can match the nominal value of housing in any arbitrary future DCH year (say 1960).[45]

In particular, we assume that $\widehat{p}_t^h$ is piecewise cubic between Census dates, and continuous up to the second derivative across Census dates. We impose the not-a-knot endpoint conditions. These restrictions, plus the requirement that the nominal series generated by equation (9) pass through the Census values of

[43] Wickens' estimate of the market value of housing in 1930 is $122.6 billion, but GBW argue that this estimate is too high by 6-15 billion dollars.

[44] p_t^c is taken from NIPA table Table 2.3.4, "Price Indexes for Personal Consumption Expenditures by Major Type of Product," line 23.

[45] We also experimented with assuming the the true price series is piecewise linear between Census dates. The implied average annualized growth rates between Census dates are different in this case, but the differences are extremely small.

Table 1 are sufficient to determine a unique sequence for $\widehat{p}_t^h$. The numerical algorithm we follow is (i) guess values for $\widehat{p}_t^h$ at Census dates normalizing the price to one in 1930, (ii) interpolate to compute $\widehat{p}_t^h$ in each year between Census dates using the Matlab "spline" routine, (iii) construct an annual time series for $p_{t+1}^h h_{t+1}$ using equation (9) starting out with the Census value for 1930, (iv) check whether the implied nominal values line up with the Census values for 1950 to 2000, (v) update appropriately the guess for $\widehat{p}_t^h$ at Census dates (we use a Newton method) and return to step (ii), (vi) iterate to convergence. We ignore our estimate of the market value in 1940 because, as discussed below, we do not have much confidence in the nominal value estimate for that year.

Equation (9) allows us to compute the decade-by-decade movements in $\widehat{p}_t^h$, but conditional on $\widehat{p}_t^h$, simultaneously provides yearly estimates of the annual market value of housing. That is, given data on annual net investment in housing, we compute the market value of housing in each year that is consistent with the cubic-spline-produced estimate of $\widehat{p}_t^h$. Then, with annual estimates of the market value of housing and replacement cost of structures in hand, we compute annual land share estimates w_t^l using equation (4). Given w_t^l, estimates of the growth rate of structures costs g_t^s from the NIPA (discussed earlier), and estimates of $p_t^h = \widehat{p}_t^h p_t^c$, we use equation (3) to compute the implied growth rate of land prices, g_t^l.

Table 13 reports the annualized rate of growth of real structures costs, house prices, and land prices decade-by-decade for 1930-2000. We use the procedure outlined above to compute a real price index for housing and land, and, in the case of 1950-1960 (the other decades being similar), we report the value of the 1960 real index for housing or land divided by the value of the 1950 real index for housing (land), raised to the 1/10 power. For comparison sake, we also show the growth rates of real structures costs, house prices, and land prices from 2000-2005 that we compute using our quarterly data and methods outlined in section 1 of the paper. In all decades since 1950, the real price of land has increased and in the 1970-1980 period, land prices increased rapidly. However, at some point between 1930 and 1950, probably between 1930 and 1940, land lost significant value.

In table 14 we report our estimates of decade-by-decade real growth in house prices in the center column alongside two other estimates of house-price growth. In the left column, we report real growth in the average price of owner-occupied housing (derived from tables 5-12), and in the right column we report the decade-by-decade growth of constant-quality house prices using the price index for housing that Robert Shiller has compiled for the 2005 printing of his book *Irrational Exuberance*.

The difference of the growth rate of the average value of housing (left column) and the constant-quality price of housing (center column) provides an estimate of decade-by-decade quality change in the stock of housing. In all decades except the 1930-1950 period, quality gains to housing were modest (no more than 0.88 percentage points per year) but positive. In the 1930-1950 period, a time in which land prices were falling, housing quality on average was deteriorating by almost one percentage point per year.

Now compare the center and the right columns of this table. Our estimates of the constant-quality growth rate of housing are consistent with those of the Shiller series prior to 1960. After 1960, our constant-quality house price series has increased at a much faster rate, especially in the 1970-1980 decade. This likely reflects a bias in the data that Shiller uses that has been previously documented by Greenlees (1982) and acknowledged by Shiller in his 1982 Carnegie-Rochester Paper.[46] Our series also increases at a faster rate than the OFHEO data from 1980-1990, which either reflects a bias in the OFHEO in those years, or else indicates that our estimate of the market value of housing in 1980 that we derive from DCH and RFS data might be a bit too low.

2.1.3 Caveats

Of course, the accuracy of our estimate of the value of land depends on the accuracy of our estimates of the market value of housing and the accuracy of our estimates of the replacement cost of residential structures. We have documented our key assumptions and calculations for the market value of housing, but basically

[46] For the 1953-1975 period, Shiller uses the home purchase component of the CPI.

take as given the estimates of the replacement cost of structures that are produced by the BEA.

Because residential structures depreciate very slowly, estimates for the stock based on a perpetual inventory system are highly sensitive to how depreciation is measured. As part of recent revisions to the National Income and Product Accounts, the BEA has changed how it models depreciation for lots of different types of reproducible wealth. The key change has been to move from linear models of depreciation to geometric models. The effects of this change on estimates for net stocks of structures have been very large. For example, the effect of adopting the new methodology was to increase the previously-published estimate of the net stocks of residential structures in 1994 by 26.6 percent.[47] The new depreciation model allows for different depreciation rates for different types of residential structures. For example, 1-4 unit structures-new are assumed to depreciate at 1.14% per year, while 5-or-more-unit structures-new depreciate at 1.40% per year.[48] By comparison, under the old system, the average value of new 1-4 unit structures-new was assumed to decline linearly to zero over a period of 80 years, while 5-or-more unit structures had an assumed service life of 65 years. Under both the old and revised accounting systems, depreciation rates are assumed to have been constant since 1925.

Empirical evidence on depreciation of residential structures is difficult to obtain for a variety of reasons, some of which have to do with the fact that the direct evidence on how market value declines with age applies to houses (which include a land component) rather than to structures. Thus estimating depreciation rates requires disentangling price changes due to a deteriorating structure, and price changes to due changes in the value of the underlying land. The current BEA assumptions are similar to many recent estimates.[49]

[47]See Table C in Katz and Herman (1997). The effect of the revision on the stock of non-residential structures was an increase of 44.3% in the same year.

[48]Other types of structures, "additions and alterations," and "major replacements" are assumed to depreciate more quickly. Total nominal depreciation as a share of the total nominal stock of residential structures is around 1.6%.

[49]For example, Malpezzi, Shilling and Yang (2001) suggest an overall rate of 1.44% for single-family housing. See Gravelle (1999) for a summary of existing estimates of depreciation rates.

However, applying perpetual inventory methods to construct stocks from investment data is necessarily a delicate exercise in light of both the difficulty in estimating depreciation rates and also the sensitivity of stock estimates to the precise depreciation rate assumed. For example, consider a steady state without growth in which residential investment is 2% of GDP. A 2% depreciation rate for residential structures implies a structures to GDP ratio of one; a 1% depreciation rate implies a ratio of two.

In our opinion, the current net stock estimates might overstate the true replacement cost of residential structures in the first half of the 20th century. Grebler, Blank and Winnick (1956) carefully survey evidence on depreciation rates for this time period. Anticipating the recent BEA revisions by many decades, they applied geometric depreciation, using a 2% rate. On top of this they allowed for capital to be consumed through demolition, which effectively increased the depreciation rate to around 2.2%. The fact that this average depreciate rate exceeds the one implied by the current BEA methodology helps account for why GBW estimated smaller values for structures ($78.8 billion in 1930, $81.5 billion in 1940, and $191.6 billion in 1950, compared to our BEA-derived estimates of $96.4 billion, $100.7 billion and $267.5 billion for the same years.[50]

It is possible that GBW over-estimated depreciation. Another possibility, and one that seems quite plausible, is that the average depreciation rate for residential structures has declined over time in the United States. There are several reasons to entertain this possibility. First, and perhaps most importantly, there is evidence that rental housing depreciates more rapidly than owner-occupied housing.[51] Tables 5-12 in this appendix documents a large long-run upward trend in the share of the aggregate housing stock accounted for by owner-occupied units. By contrast, the BEA assumes that the rate at which a structure depreciates depends on how many housing units it contains, but not on whether they are owner or renter-occupied. Second, construction techniques and materials have changed over time, as have many characteristics of

[50] GBW, Table D-1.

[51] See Shilling, Sirmans, and Dombrow (1991).

residential structures themselves. It is possible that stricter building codes have reduced depreciation rates.[52]

While BEA estimates might over-state the net stock of residential structures, particularly in earlier decades, we have chosen to use their estimates in Table 1. The BEA depreciation model has the virtue of being simple, and any attempt to improve on it (beyond our correction for commissions) would require a large number of assumptions, without any guaranteed improvement in accuracy.

2.2 Estimates of Land Share, Other Sources

As discussed in the previous section, our primary sources for producing historical estimates of land's share in residential real estate are Census-based estimates for aggregate home value and BEA estimates for aggregate residential structures value. However, we noted that this approach rests heavily on the reliability of the BEA capital stock estimates, which are sensitive to how depreciation is modeled, and what depreciation rates are assumed. It is therefore useful to compare the Census-based estimates to somewhat independent estimates for land's share.

2.2.1 Estimates of Land Share from the FHA, 1935-1979

The Federal Housing Administration has collected data on the home and site value and home value of the properties for which it insures mortgages. Tables 15 and 16 of this appendix reproduce the estimates of land's share of value for these single-family properties for both existing homes and new homes. These estimates appear remarkably consistent with the Decennial Census of Housing (DCH) estimates for 1950, 1960 and 1970 (see tables 5-12). The DCH values (for the entire housing stock) and the FHA values (for existing single-family homes) are, respectively, 0.104 and 0.124 in 1950, 0.180 and 0.177 in 1960, and 0.199 and 0.216 in 1970. The Census and the FHA land's share values diverge in 1940 and at the end of the sample (the

[52]Many old houses appear very well-constructed and durable. However, the old houses still extant are the survivors, and the rate at which they depreciate is likely not representative of the entire stock of structures of the era.

FHA stopped reporting site values in 1979, so the most recent comparison we can make is between the 1980 DCH and the 1979 FHA values).

The Census based-estimate indicates negative aggregate land value in 1940, while the FHA estimates are positive. A major reason for the discrepancy is the low average self-reported value for owner-occupied housing in the 1940 Census: $3,472, versus an average value of $5,170 for existing single-family homes FHA-insured homes.[53] We have a bit more faith in the FHA estimate, since it seems to be common wisdom of researchers of the time that in the 1940 Census, home-owners value estimates were unrealistically low in the aftermath of the Great Depression.[54]

In 1950, 1960 and 1970, the average values of owner-occupied houses in the Census micro data, and the average values for existing single-family FHA-mortgage-insured homes were quite similar. The Census value was 13.4% higher than the corresponding FHA value in 1950, 4.0% higher in 1960, and 11.8% higher in 1970. At the end of the sample, however, it appears that FHA-insured properties became increasingly unrepresentative of the aggregate housing stock. The average value of existing single-family houses underwritten by the FHA in 1979 was about $39,915 while the 1980 DCH suggests that the average value of owner-occupied housing in 1980 was $58,846 (see table 7). Even allowing for some inflation between 1979 and 1980, it would appear that the FHA's focus on low-income housing increased during the 1970s, and it seems plausible that this housing was relatively structures-intensive. Thus we prefer our Census-based estimate for land's share in 1980, which is 0.270, to the FHA value for 1979, 0.204.

Our specific sources for the FHA estimates are listed below:

- 1935-1938. Data are from the 1938 FHA Annual Report, table 45.

[53]Applying the FHA value to the Census-based calculation would increase the aggregate value of the owner-occupied stock by $19.4 billion, thereby increasing land's share from -0.114 to +0.083. This is probably a conservative adjustment because in subsequent Censuses, owner-occupied values exceed FHA values.

[54]For example, according to Grebler, Blank and Winnick (1956, p.372) "there is a strong presumption that owners' estimates of market value in 1940 lagged behind actual market values because of depression experience."

- 1939. Data are from the 1939 FHA Annual Report, table 31.
- 1940. Data are from the 1940 FHA Annual Report, tables 31 and 40.[55]
- 1941-1942. Data are from table 9 of the 1945 FHA annual report. Note that for the years 1941-1949, for both new and existing homes, we use only the data from the FHA 203 program. The other FHA programs were special programs for housing for war-time workers that were probably not representative of the new housing stock in general.
- 1943-1945. Data are from table 9 of the 1945 FHA Annual Report. No data are available for new single family for section 203 housing.
- 1946-1948. Data are from table 11 of the 1946, 1947, and 1948 FHA Annual Reports.
- 1949. Data are from table 16 of the 1949 FHA Annual Report.
- 1950-1965. Data for 1950, 1952, and 1954-1965 for new single family and existing single family are from table 30 of the 1965 FHA Annual Report. Data for new and existing single family in 1951 is from table 21 of the 1951 FHA Annual Report, and data for 1953 is from table 18 of the 1953 FHA Annual Report.
- 1966-1969. Data are from table 194 of the 1970 HUD Statistical Yearbook.
- 1970-1979. Data are from table 27 of the 1979 HUD Statistical Yearbook.

2.2.2 Other Estimates for Land Share, 1880-1992

We now marshal some additional evidence from a range of sources in order to explore land's share of aggregate home value prior from 1880 forward, to further corroborate (or contradict) the Census and FHA evidence.

Kuznets (1946):

Estimates for land's share for the period 1890 to 1930 are generally higher than for more recent years. Kuznets (1946) estimated land's share in non-farm residential realty to be 0.485 in 1880, 0.533 in 1890, 0.533 in 1900, 0.472 in 1912, and 0.530 in 1922.[56] His land-structures decompositions were produced by (i) estimating the total value of taxable real estate (agriculture, mining, manufacturing, industrial and residential real estate), (ii) estimating the fraction of this total that is attributable to land, (iii) subtracting estimates of the value of land and structures outside of residential and industrial use, and (iv) assuming the same land share in

[55] We averaged the metropolitan and non-metropolitan estimates; table 31 contains the split.

[56] See tables IV 1 and IV 2, p. 201-202.

non-farm residential real estate on the one hand, and industrial real estate on the other. Kuznets' sources for the aggregate land share estimates are from the Census Special Report "Wealth, Debt and Taxation" in 1907 and the Federal Trade Commission Report, "National Income and Wealth" in 1922 (summarized in Federal Trade Commission Annual Report of 1926). The Federal Trade Commission estimated the share of land in all real estate in 1922 to be 0.607.

Keller (1939):

Keller (1939) reports a land share of 0.527 for urban residential and commercial and industrial realty use, excluding farms.[57] Kuznets subsequently applied the same ratio. However, Keller notes that this estimate of the "percentage of land in non-farm realty seems to be too large" and suggests a share of 0.25 might be more reasonable.

Wickens (1941):

Wickens (1941) reports that "for non-farm dwellings, the site accounts on the average for about one-fifth of the value of the property; for new dwellings the percentage is somewhat smaller."[58] The source of the 0.2 estimate is unclear, but it was subsequently adopted by Goldsmith (1955).[59]

Winnick (1953):

Winnick (1953) cites various pieces of evidence on land's share over the first half of the 20th century.[60] An abridged version of his dissertation was incorporated in the book by Blank, Grebler and Winnick (1956). In that book, an estimate of land's share of aggregate residential value is reported annually from 1890 (40 percent) to 1950 (18 percent). The decline in land share is linear over the entire time period. The exact

[57] See Appendix F, p. 120.

[58] See p. 4.

[59] Wickens' claim that land share is lower for new homes is based on FHA estimates of land share for new and existing single-family homes in 1937.

[60] See Chapter 5, "The Proportion of Land in Residential Wealth."

estimates are informed by estimates of land's share in housing at various times and for different locations, evidence which we discuss below.

In his dissertation, Winnick used FHA estimates (that begin in 1938) and an estimate of land's share in new housing in 1929 from Whitten and Adams (1931) to construct an estimate of land's share in residential housing in 1929.[61] Under the assumption that the ratio between land shares for existing versus new homes in the FHA estimates for the 1938-42 period could be applied to 1929, Winnick estimated a land's share for existing homes of 0.268 in that year.[62] For 1936, he reports a land's share of 0.275 for on the basis of an average of land assessments from 15 cities (0.261 when 2+ family homes were excluded).[63] Comparing these figures to somewhat lower FHA estimates and preliminary estimates from Goldsmith (see below), Winnick concludes (p.132) that one "can assume an intermediate site ratio of 0.23 as being roughly typical of non-farm real estate in the middle of the 1930s."

Winnick argued that there was a general downward trend in land's share in residential use starting in 1890. He pointed to scattered pieces of evidence, for different regions of the country over different time periods. In 1907, a report by the Seattle Real Estate Board (1907) provides data on lot values for houses in a number of cities. Information for seven of these cities in 1929 was also contained in Whitten and Adams (1931). Averaging across these cities suggests a decline in land's share for new homes from 0.244 in 1907 to 0.176 in 1929 (Table V-7, p.137). Over the period 1939-1950, land's share for the whole of New York City declined from 0.404 to 0.347.[64]

[61] The Whitten and Adams estimates were based on a survey of builders in 89 cities, and a separate Department of Commerce of 23 cities, cited by the same authors. These two estimates for land's share in new homes were 0.181 and 0.193 respectively. Winnick used an average value of 0.187 for 1929 – see p. 133-135.

[62] Winnick used a ratio of 1.43 for the site value in existing homes relative to the site value in new homes.

[63] See table V-2, p. 120.

[64] See table V-10, p. 149. Winnick also notes that land's share in the Lower East Side of Manhattan declined from 0.714 in 1904 to 0.498 in 1950.

As noted, Winnick assumes a linear decline in aggregate land's share between 1890 and 1953. He notes this trend is broadly consistent with the seven-city decline for new homes between 1907 and 1929, assuming land ratios to be 40% higher for existing relative to new homes, and also with the 15-city numbers for 1936. The FHA numbers are consistent with a decline from 1936 to 1949. Whether or not this decline had an earlier origin is more speculative.

Goldsmith (1955) and (1962):

Goldsmith (1955 and 1962) produces series for land's share from 1900 to 1958, though these are largely derived from other studies.[65] Prior to 1939 he assumed a land share of 0.2 for 1-4 unit structures based on Wickens (1941), while from 1939 to 1949 he assumed a declining land share for 1-4 structures in line with Housing Financing Agency (FHA) Annual Reports. In his 1955 volume he assumed the same 0.2 share for 5+ unit structures for the entire period prior to 1949, citing an appraisal of 270 such properties by MetLife. Goldsmith's aggregate land share estimates in this volume tend to slightly exceed 0.2.[66] In his 1962 volume, Goldsmith revised downwards his assumption on land's share for 1-4 unit structures post 1945, adopting a value of 0.13, reflecting a land / structures ratio of 0.15. This lower value was based on the FHA estimates (discussed previously). He did not change his 0.20 estimate for 5+ unit structures. All considered, this implied an aggregate land share of around 0.136.[67]

Manvel (1968):

[65]The first book had estimates from 1900 to 1949, though not for every year. The second book produced revised, extended and continuous figures for the period 1945 to 1958, and also reproduced, unrevised, some of the earlier numbers.

[66]Mechanically, this is because his figures suggest a larger land share in the corporate sector than in the household sector, to which the shares above strictly apply.

[67]The 0.136 number is computed as private residential land (column 12 in Table A-5) relative to private residential land and the net stock of residential structures owned by non-farm households, unincorporated business and corporations (columns 2, 3 and 5 in Table A-35). The residential structures excluded are farms and government owned-structures.

Manvel (1968) produced perhaps the most careful and widely-cited estimate of land's share.[68] His key data source was a special tabulation by the Census for the National Committee on Urban Problems conducted in 1966. In 12 large assessing areas, the Census had a separate recording for land and improvement values of individual pieces of taxable realty. The median area land share for single-family homes was 25.6%, while the corresponding figure for multi-family homes was 17.0%. Manvel applied slightly higher ratios, arguing that these assessments understated land's true share. His resulting aggregate urban residential land share was 0.259 for 1966 (an appropriately-weighted average of 0.270 for 1-4 unit structures, and 0.200 for 5+ unit structures). Manvel compares his estimates to the land share for all taxable realty (not just residential) in the 1967 Census of Governments, which was 0.344. His methodology produces a comparable figure of 0.414 for all taxable realty in 1966. He argues that the difference is readily reconciled if the gap between assessed and true value is larger for land than for structures. Manvel also reports land shares for 1956, but these are not derived independently: rather the change from 1956 to 1966 is based on the trend in FHA appraisal data.

Census of Governments, 1982, 1987, 1992:

We explored land's share in all taxable realty in the 1982, 1987 and 1992 Censuses of Government.[69] This data is not ideal for two reasons: (1) it is not possible to disentangle residential non-farm realty from other taxable property, and (2) the structures-land decomposition is only reported for between 19 and 21 states.[70] Nonetheless, the data is informative about trends in land's share because there is large cross-state variation in the ratio of the gross assessed value of residential property relative to the gross assessed value of all

[68] For example, the BLS uses Manvel's ratios to estimate the value of land in different sectors which enter their multi-factor productivity estimates.

[69] This information is in the "Taxable Property Values" volume. This volume was discontinued after 1992.

[70] There are fifteen states in which data is available for both 1982 and 1992, and fourteen for which data is available in all three years.

property, and this ratio turns out to be correlated with the state-level change in land's share over the period.

In 1986 residential non-farm real estate accounted for 61.2% of the gross assessed value of all taxable property in the United States in 1986, and single-family houses alone accounted for 53.1%.[71] Across states, this ratio varied from 31.6% for North Dakota (where real estate is dominated by acreage) to 73.6% for Connecticut. Aggregating across the 15 states for which data is available in each of 1982, 1987 and 1992, and weighting each state in proportion to the estimated state-aggregate market value of taxable real estate in 1982, we computed the share of land in the value of (locally-assessed) property.[72] This share was stable over the period: 0.336 in 1982, 0.330 in 1987 and 0.335 in 1992.[73]

This stability at the aggregate level hides large variation in the path for land's share at the state level. Moreover, the states which are especially reliant on non-farm residential realty for local tax revenue typically exhibit an increase in land's share of market value over the period, while the states in which residential realty is less important typically exhibit a decline in land's share. For example, comparing the 15 states for which land shares are reported in both 1982 and 1992, New Jersey had the highest share of residential real estate in total taxable property in 1982 (69.9%) and also exhibited a large increase in land's share between 1982 and 1992 (from 0.325 to 0.397). By contrast, North Dakota (the state least reliant on residential property in 1982) saw a decline in land's share over the same period (from 0.617 to 0.546). Thus it seems highly likely that land's share in residential real estate was increasing over this period, but that this did not translate into a higher land's share in all real property. Mechanically, this could either be because (i) land's share within other types of property was declining, and (ii) the relative share of land-intensive types of property

[71] See the 1987 Census of Governments, Vol. 2, Taxable Property Values, No. 1, Table C.

[72] See the 1982 Census of Governments, Vol. 2, Taxable Property Values and Assessment-Sales Price Ratios, Tables 3 (land's share) and 11 (market values); and, 1987 and 1992 Censuses of Governments, Vol. 2, Taxable Property Values, No. 1, Table 3 (1987) and Table 1 (1992). The 1992 volume is available online at http://www.census.gov/prod/2/gov/gc/gc92_2_1.pdf.

[73] Note that these figures are very similar to the 0.344 number that Manvel (1968) reports for the 1967 Census of Governments.

in all real property was declining. One specific trend that falls into the second category is that the share of the most land-intensive form of real property - agriculture - has been declining steadily, from 13.9 percent of all real property in 1956 to 11.8 percent in 1976 and 7.5 percent in 1986.[74]

Summary of the Evidence:

The early estimates from Kuznets (1946) and Keller (1939) suggest a land's share in excess of 0.5 over the period 1880 to 1922. Their estimates should be treated with some caution, primarily because they apply to a broader class of real estate than simply residential property. Winnick also argued that land's share was high in this period, providing evidence for a range of different cities, though his estimates were generally somewhat lower than Kuznets and Keller. Goldsmith (1955), by contrast, assumed a land's share of around 0.2, following Wickens (1941), although this figure appears to have simply reflected conventional wisdom in the real estate industry.

It appears that land's share declined dramatically during the Great Depression. Hoyt (1933) documents this in great detail for the city of Chicago. In the immediate aftermath of the Depression there is some uncertainty about land's share, since FHA estimates and the Census point in different directions in 1940. Sill, it is safe to conclude that between the Depression and the early 1950s, land's share was quite low.

Finally, over the past 50 years, the evidence at hand indicates that land's share has increased dramatically. The increase to 1970 in our Census-based estimates is also reflected in FHA estimates and the increase over the 1980s is consistent with state level evidence from the Census of Governments.

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[74] See the 1987 Census of Governments, Vol. 2, No. 1, Table C. More recent numbers on agriculture's share are not available, but its importance has likely declined still further: According to estimates from the USDA, the price per acre of farmland (adjusted for CPI inflation) declined by 42 percent between 1981:2 and 1991:2.

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Table 1: Market Value and Replacement Cost Statistics, From BEA, DCH, and RFS, All Nonfarm Housing Units

Year	Adj. Repl. Cost, Structures ($billions)	Total Market Value ($billions)	Land Share (Percent)	Flow of Funds Estimate ($billions)
1930	96.4	113.8	15.3	
1940	100.7	90.4	-11.4	
1950	267.5	298.7	10.4	$337.8
1960	466.7	569.33	18.0	$597.8
1970	847.3	1058.14	19.9	$1,117.7
1980	2836.4	3887.93	27.0	$3,558.6
1990	5090.3	8483.38	40.0	$8,254.6
2000	8763.5	13770.04	36.4	$13,552.0

Table 2: Average Value of Vacant and Rental Units in 1991 and 2001, from 1991 and 2001 RFS micro data

Units in Building	2001 RFS	1991 RFS
1 family*	$113,505	$77,183
2 family	$74,585	$53,228
3-4 family	$62,484	$44,331
5-9 family	$67,754	$46,914
10-19 family	$69,799	$44,279
20-49 family	$56,472	$44,476
50+ family	$49,761	$44,958

* Includes attached and detached units.

Table 3: Average Value of Vacant and Rental Units in 1961, 1971, and 1981 from Printed RFS Tables

Units in Building	1981 RFS	1971 RFS	1961 RFS
1-4 family*	$39,900	$12,648	$8,114
5-49 family	$22,700	$8,442	$4,404
50+ family	$24,400	$12,053	$6,744

* Includes attached and detached 1-family units.

Table 4: Adjustment Factors that Map Average Values in RFS Years to Average Values in DCH Years

DCH Year	RFS Year	Growth in Prices Between Years*
1960	1961	0.25%
1970	1971	2.77%
1980	1981	5.93%
1990	1991	0.21%
2000	2001	7.46%

* Growth in constant-quality structures costs (g_t^s) for 1960-61 and 1970-71, and growth in constant-quality home prices (g_t^h) for 1980-81, 1990-91, and 2000-01.

Table 5: Market Value of All Nonfarm Housing Units, 2000

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	64,401,760	$164,829	$10,615.27
Renter-occupied	34,034,928	$73,186	$2,490.89
Vacant	7,646,673	$86,820	$663.88
All units	106,083,361	$129,804	$13,770.04

Table 6: Market Value of All Nonfarm Housing Units, 1990

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	53,565,180	$116,889	$6,261.17
Renter-occupied	31,028,452	$55,784	$1,730.90
Vacant	7,712,747	$63,701	$491.31
All units	92,306,379	$91,905	$8,483.38

Table 7: Market Value of All Nonfarm Housing Units, 1980

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	48,394,212	$58,846	$2,847.79
Renter-occupied	27,071,732	$30,548	$826.99
Vacant	6,360,896	$33,509	$213.15
All units	81,826,840	$47,514	$3,887.93

Table 8: Market Value of All Nonfarm Housing Units, 1970

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	36,729,400	$20,409	$749.62
Renter-occupied	22,804,836	$11,107	$253.28
Vacant	4,735,955	$11,664	$55.24
All units	64,270,191	$16,464	$1,058.14

Table 9: Market Value of All Nonfarm Housing Units, 1960

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	29,128,114	$13,805	$402.11
Renter-occupied	18,871,172	$7,374	$139.15
Vacant	3,557,412	$7,890	$28.07
All units	51,556,698	$11,043	$569.33

Table 10: Market Value of All Nonfarm Housing Units, 1950

Type of Housing Unit		Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	1-family detached	15,843,299	$10,800	$171.11
	all other	3,717,035	$9,457	$35.15
	total	19,560,334	$10,545	$206.26
Renter-occupied	total	17,242,051	$3,900	$67.24
Vacant	total	2,520,196	$9,990	$25.18
All units		39,322,581	$7,604	$298.68

Table 11: Market Value of All Nonfarm Housing Units, 1940

Type of Housing Unit		Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	total	11,410,688	$3,472	$39.61
Renter-occupied	total	16,346,128	$2,706	$44.24
Vacant	for sale or rent	1,428,973	$3,260	$4.66
	other	505,243	$3,709	$1.87
	total	1,934,216	$3,377	$6.53
All units		29,691,032	$3,044	$90.38

Table 12: Market Value of All Nonfarm Housing Units, 1930

	Number of Units	Average Value per Unit	Total Value ($billions)
Owner-occupied	10,430,062	$6,205	$64.72
Renter-occupied	12,532,551	$3,176	$39.80
Vacant	1,583,205	$5,878	$9.31
All units	24,545,818	$4,637	$113.82

Table 13: Decade-on-Decade Growth of Constant-Quality Real Structures Prices, House Prices, and Land Prices

	Real Growth, Structures Prices (ann. pct.)	Real Growth, House Prices (ann. pct.)	Real Growth, Land Prices (ann. pct.)
1930-1950	2.08	1.73	-3.27
1950-1960	-0.87	0.10	5.39
1960-1970	0.21	0.62	1.76
1970-1980	2.94	4.35	8.36
1980-1990	-1.30	1.32	6.12
1990-2000	0.87	1.01	1.08
2000-2005*	2.97	6.95	13.05

* Derived from the 1975-2005 quarterly data.

Table 14: Decade-on-Decade Growth of Real House Prices

	Real Growth Average Value, Owner-Occupied Homes (ann pct.)	Real Growth, Constant-Quality House Prices, Our Calculations (ann pct.)	Real Growth Constant-Quality House Prices, Shiller Data (ann pct.)
1930-1950	0.78	1.73	1.84
1950-1960	0.29	0.10	0.23
1960-1970	1.49	0.62	0.11
1970-1980	4.66	4.35	1.79
1980-1990*	2.14	1.32	0.63
1990-2000**	1.23	1.01	0.81

* Real Growth in OFHEO is 0.35 percent per year from 1980-1990.

** Real Growth in OFHEO is 1.14 percent per year from 1990-2000.

Table 15: Market Value and Land Data, Existing and New Homes, FHA Estimates, 1935-1954

	Existing SF Homes			New SF Homes		
Year	Avg. House Value	Avg. Land Value	Land Share	Avg. House Value	Avg. Land Value	Land Share
1935	5290	ND	ND	6450	1129	0.175
1936	5244	ND	ND	6255	1026	0.164
1937	5170	ND	ND	5978	913	0.153
1938	5069	1010	0.199	5530	785	0.142
1939	5030	956	0.190	5352	724	0.135
1940	5170	954	0.185	5177	658	0.127
1941	5004	981	0.196	5045	649	0.129
1942	5272	935	0.177	5368	635	0.118
1943	5535	956	0.173	ND	ND	ND
1944	5484	924	0.168	ND	ND	ND
1945	5511	857	0.156	ND	ND	ND
1946	5934	761	0.128	6558	761	0.116
1947	6769	915	0.135	7574	893	0.118
1948	7579	970	0.128	8721	1049	0.120
1949	8700	1098	0.126	8502	1018	0.120
1950	9298	1150	0.124	8594	1035	0.120
1951	10147	1222	0.120	9307	1092	0.117
1952	10424	1296	0.124	10184	1227	0.120
1953	10022	1461	0.146	10140	1291	0.127
1954	11919	1591	0.133	10847	1456	0.134

Table 16: Market Value and Land Data, Existing and New Homes, FHA Estimates, 1955-1979

	Existing SF Homes			New SF Homes		
Year	Avg. House Value	Avg. Land Value	Land Share	Avg. House Value	Avg. Land Value	Land Share
1955	11949	1707	0.143	12008	1626	0.135
1956	12684	1931	0.152	13334	1887	0.142
1957	12962	2041	0.157	14402	2148	0.149
1958	13023	2150	0.165	14326	2223	0.155
1959	13180	2357	0.179	14605	2372	0.162
1960	13268	2354	0.177	14855	2477	0.167
1961	13661	2503	0.183	15125	2599	0.172
1962	14270	2721	0.191	15460	2725	0.176
1963	14490	2850	0.197	16189	2978	0.184
1964	14782	2981	0.202	16522	3130	0.189
1965	15390	3218	0.209	17176	3442	0.200
1966	15479	3254	0.210	17984	3627	0.202
1967	16247	3475	0.214	18964	3777	0.199
1968	16426	3597	0.219	19974	4154	0.208
1969	17123	3696	0.216	21030	4300	0.204
1970	18260	3949	0.216	23547	4982	0.212
1971	19382	4013	0.207	24369	5176	0.212
1972	20246	4306	0.213	25324	5420	0.214
1973	19483	3982	0.204	25159	5341	0.212
1974	22148	4519	0.204	27538	5482	0.199
1975	27029	5468	0.202	32172	6382	0.198
1976	27517	5632	0.205	35512	6954	0.196
1977	29402	5828	0.198	37615	7335	0.195
1978	34323	6985	0.204	42091	7764	0.184
1979	39915	8145	0.204	50787	9816	0.193