The Stock of Private Real Estate Capital in U.S. Metropolitan Areas

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The Stock of Private Real Estate Capital in U.S. Metropolitan Areas

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Abstract The stock of private real estate capital is estimated for each of 242 MSAs, annually, for 1982 through 1994. Three series are computed: (1) total private real estate capital (residential and nonresidential); (2) private single-family residential capital; and (3) private income property capital (multifamily housing plus nonresidential real estate, or (1) less (2)). The determinants of each series are modeled, and the results are used to predict the value of the capital stock for a larger set of 295 MSAs.

Introduction

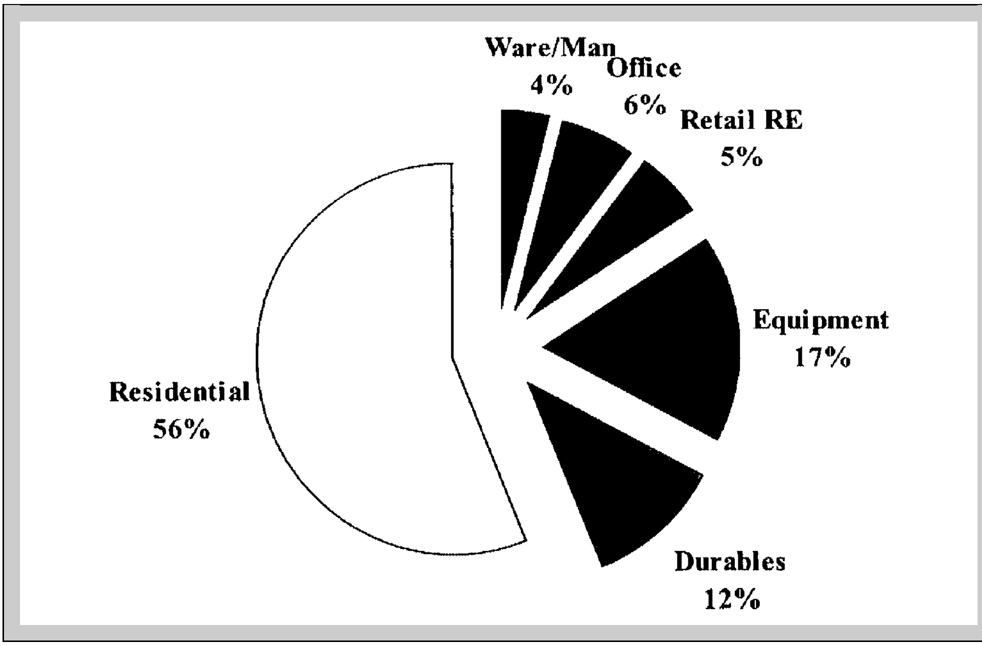
The bulk of the capital stock in the United States, indeed the world, is real estate (see Exhibit 1; and Ibbotson, Siegel and Love, 1985). As a general proposition, the need for careful measurement of such fundamental data needs no elaboration.

Many recent studies of real estate markets adopt the metropolitan area as the unit of observation.[1] Conversations with developers, investors and others confirm that market participants often use the metropolitan area as a decision unit. Commercial data providers such as Torto-Wheaton also focus on the metropolitan area as the unit of observation. This is hardly surprising, given that real estate's locational fixity is in fact its defining characteristic. Despite this, hardly any data exists on the stock of real estate capital by metropolitan area.

Many specific examples can be given of potential uses for such data. For example, studies of portfolio allocation can be much improved with such data. In fact, this study was undertaken in order to construct the data needed for Malpezzi and Shilling (2000), which required estimates of real estate capital stock by metropolitan area (MSA). While flow data on real estate investment are readily available from building permits, stock estimates are not, in general, widely available.

This article describes the construction of estimates of private real estate capital for each of 242 MSAs, annually, for 1982 through 1994. Three series are computed: (1) total private real estate capital (residential and nonresidential);

Exhibit 1 | U. S. Fixed Tangible Wealth



Source: Hartzell, Pittman and Downs 1992.

(2) private single-family residential capital; and (3) private income property capital (multifamily housing plus nonresidential real estate, or (1) less (2). The determinants of each series are then modeled, and the results used to predict the value of the capital stock for a larger set of 295 MSAs.

Previous Literature

Only two previous studies have attempted to measure the real estate capital stock in such a disaggregated fashion. Miles, Pittman, Hoesli, Bhatnager and Guilkey (1991) begin with county level tax assessments, and regress them against a set of demographic variables to construct an instrument for the value of real estate in thirty-six metropolitan areas. The estimates are broken out by retail, office and industrial property types. They do not include multifamily investment property, and are limited to a small subset of metropolitan areas.

Hartzell, Pittman and Downs (1994) apply a similar method to county level data. Sixty-seven counties in thirty-two metropolitan areas are used. The baseline data are also property tax assessments. They then collected a set of exogenous variables related to population, structure of employment, income and employment.

They use these to construct instrumental variables for each property type. Their regression models are then used to estimate the value of real estate by property type for each U.S. county.

Methodology

Conceptually, the most straightforward method of constructing capital stock data is to undertake a census or appropriately designed survey to collect data on the market values of said stock.

Direct measurement is not, in general, used for the official National Income Accounts (NIA) of capital. NIA measures of real estate capital (and most other tangible capital) are constructed by the so-called "perpetual inventory" method (Young and Musgrave, 1980). Given a sufficiently long time series of flow investment data, and knowledge of depreciation, it is possible to solve for an expression representing capital stock at time t, K_t, as a function of previous changes in the stock:

$$K_T = K_0 + \sum_{0}^{T-1} \Delta K_t, \qquad (1)$$

where the initial condition K_0 can be estimated by a variant of this method. Obviously ΔK_T is determined by depreciation, which is denoted below as δ, and by flow investment, I_t. For a sufficiently long time span between 0 and T, errors in K_0 become unimportant for a reliable estimation of K_T.

The official NIA accounts data on the real estate capital stock are based on this method, and can be found in Bureau of Economic Analysis (1993). However, NIA measures, and alternative series such as those constructed by Hulten and Wykoff (1980), are not disaggregated geographically. In this study, such measures are constructed and presented separately by MSA. The basic data source is annual BEA building permit data. However, the long time series is not sufficiently long enough to reliably apply the true perpetual inventory method, *i.e.*, one where K_0 can be in turn be estimated by previous flow data, because the flow data must be long enough that errors in an arbitrarily chosen starting point become unimportant. Given the shorter data span, a benchmark of some kind is needed that is a reasonable estimate of K_0.

Every five years there is a Census of Governments (COG). In several COG, the Census collected data on: (1) the appraised value of private real estate; and (2) recent sales data comprising market values and appraised values. With these data, assessment ratios can be constructed to translate appraised value into an estimate of the value of the private real estate capital stock.[2] If this exercise were done frequently and with sufficient accuracy, the COG data could serve as the basis of a direct estimate of the private real estate capital stock.

Unfortunately, the Census stopped collecting data on assessment ratios in 1982. The general procedure, then, is as follows. The stock of real estate capital in 1982 was estimated in each MSA as:

$$K_{82} = \text{1982 Census Assessed Value of Property} * \text{Assessment Ratio.} \qquad (2)$$

Thus, 1982 is the benchmark year. Starting in 1983, and for successive years until 1994, real estate capital was estimated in each MSA by (1) multiplying the previous year's capital stock by 1 plus an estimate of inflation in real estate prices, dP_t; (2) subtracting depreciation at rate δ; and (3) adding investment I_t:

$$K_t = (1 + dP_t)(K_{t-1} - \delta K_{t-1}) + I_t \quad (t = 1983, \ldots 1994). \qquad (3)$$

The inflation rate is from the NIA GNP price deflators, taken from *Economic Report of the President*. Separate inflation rates are used for residential and nonresidential real estate.

Two separate depreciation rates are used—one for single family residential and one for income property. Hulten and Wykoff (1980) estimate depreciation rates for sixteen categories of income property (nonresidential real estate and apartments). These rates range from 2.1% for shopping centers to 4.1% for certain factories. In the absence of good data on the relative shares of these 16 categories, the median of the sixteen estimates was taken and applied to income property The median is 3.4% per annum. For comparison, the mean of the sixteen categories is 3.5%.

For single-family housing, an estimate from Malpezzi, Ozanne and Thibodeau (1987) was used. They report that the average depreciation rate for 30-year old owner-occupied units is 0.6% per annum. However, they do not account for units that completely drop out of the stock. Hulten and Wykoff (1980) argue that this selectivity seriously biases depreciation rates. They apply an adjustment based on work by Winfrey (1935) to each of their sixteen categories. The median ratio between adjusted and unadjusted numbers is 2.4, this ratio is used as an ad hoc adjustment to the Malpezzi et al. result, resulting in an estimated depreciation rate of 1.44%.

The permits data are taken from Census CD-ROM database *USA Counties* 1996. Permit data are used because they are available for small areas. Construction put in place and completions data are only available for a small subsample of locations, but on an annual basis, permits data are highly correlated with actual investment.[3] MSAs are comprised of one or more counties so it is straightforward to sum county permits data to the MSA level. Available permits data are broken out by the value of: (1) all nonresidential private construction, excluding alterations and additions; (2) nonresidential additions and alterations; (3) residential housing units; (4) residential non-housekeeping units (*e.g.*, motels and dormitories); (5) residential garages and carports; and (6) residential additions and alterations. The sum of (1) through (6)is the estimate of the total gross private real estate investment in each county in each year.

Several county permit series start in 1985, but data was needed for 1983 and 1984 as well. For data on the value of nonresidential real estate investment, including additions, the following ad hoc procedure was adopted: construct the ratio between national nonresidential investment in 1983 and 1985, then multiply this ratio times each MSA's 1985 figures to estimate each county's investment m 1983. A similar procedure was used for I984.

Several series are sparse, and vary quite a bit, especially for smaller counties. Sparse permits data include residential additions, non-housekeeping residential (*e.g.*, motels), and garages and carports. For imputing these series for 1983 and 1984, a different ad hoc procedure was adopted. The county data from 1985 to 1989 was simply adopted and this average value was imputed to 1983 and 1984.

As noted, county permit data are aggregated into MSAs. The definition of an MSA is one or more central cities of 50,000 each, and surrounding counties with substantial economic links to the cities. Thus, county data can be easily mapped into MSA data. A few caveats are required about this aggregation.

MSA definitions change over time. The current (1993) definitions are used here, but the baseline 1982 Census data match up less than perfectly because the definitions have changed, and because even for 1982 definitions, the baseline 1982 Census valuation data are incomplete for some MSAs. Even more common than incomplete Census data are cases when area definitions are ambiguous.[4] In some cases, data were so incomplete that the MSA was dropped, and in others some reasonable judgement or imputation was made to match 1982 and 1993 definitions.[5] This left 242 MSAs for which count permits were matched with COG baseline data. Generally, by the logic of the model above, errors due to such imputations become less serious the further time is from the baseline year.[6]

New England data are particularly problematic because some data are provided by MSA and/or county, but other data are presented by New England County Metropolitan Areas (NECMAs). Generally, in New England, metropolitan areas are defined by cities and towns rather than by counties. This is New England's little joke on regional economists in the rest of the country. NECMAs are an alternate, county-based definition. The upshot is that matching data from different sources is more difficult in New England than in other regions. In some cases, cross checks with population data, etc. indicated that the data sources for permits and 1982 Census value are consistent, or reasonably so. In some cases, the metro area was simply dropped from the analysis. Regression analyses carried out separately with and without the metro areas in New England showed that the results were robust.

To summarize, the following procedure is used to compute the total stock of real estate capital. The baseline of total value of all property was constructed from the 1982 *Census of Governments*, as described. For each year forward, the value of the capital stock was inflated by the increase in a weighted average of the residential and nonresidential GNP implicit price deflators.[7] Depreciation was then subtracted, and the value of permits was added.

Two sub-categories of real estate capital were also estimated—single family and income property. The value of the stock of single-family housing was constructed as follows. The *Census of Governments 1982* provides a separate baseline estimate of the value of single-family stock in each MSA. Using a procedure analogous to that for total property, estimates of the single-family stock were constructed. Of course, residential inflation and depreciation estimates are used in place of the weighted averages. The permit data that is available on the value of housing is not disaggregated by single family and multifamily. But there are counts of the number of single family and multifamily units built in each location and each period. So, the percentage of single family units for each place and time was constructed, and this fraction was multiplied by the corresponding value of housing and residential additions to estimate the value of single-family construction. All carport and garage investment is allocated to single-family housing.

With these estimates of the total stock of real estate in each MSA from 1982 to 1994, and similar estimates of the single-family stock, estimates of the income property stock were constructed by simple subtraction. Unfortunately there is no consistent COG baseline of value by type of income property, so these data could not be disaggregated further by property type.

Basic Estimates

Exhibits 2, 3 and 4 summarizes the basic results for the capital stock estimates, in levels and per capita, for the beginning and end years of the analysis (1982 and 1994). All units are in millions of current dollars. Exhibit 5 presents the 1994 capital stock data for the top twenty metropolitan areas. Metropolitan areas are ranked by total capital stock, single-family capital stock and income property capital stock. Exhibit 6 presents the analogous information for capital stocks on a per capita basis. Exhibits 7, 8 and 9 present the total single family and income capital stocks graphically. Each circle on the map represents a metropolitan area, and the area of the circle is proportional to the metropolitan area's capital stock. For comparison, Exhibit 10 presents the analogous map of population.

Exhibit 2 | Summary Statistics on Real Estate Capital Stock—Total Real Estate Capital Stock ($Million)

	Total Capital Stock		Total Capital Stock Per Capita	
	1982 Original *KTOT82*	1994 Original *KTOT94*	1982 Original *KTOTPC82*	1994 Original *KTOTP94*
Mean	16,789	25,876	0.023	0.031
Std. Dev.	33,108	47,228	0.014	0.013
Max.	303,751	426,155	0.103	0.107
3rd Quartile	14,989	23,160	0.028	0.036
Median	5,768	10,079	0.020	0.029
1st Quartile	2,815	4,706	0.015	0.023
Min.	679	1,346	0.002	0.006

Note: Number of observations = 247.

Most of the exhibits are self-explanatory, so only a few points are highlighted in this section. A more detailed look at the data is available at the website. The actual data for each year between 1982 and 1994 for each metropolitan area studied can be found at http://www.bus.wisc.edu/realestate.

Exhibit 3 | Summary Statistics on Real Estate Capital Stock for Single Family ($Million)

	Capital Stock		Capital Stock Per Capita	
	1982 Original *KSF82*	1994 Original *KSF94*	1982 Original *KSFC82*	1994 Original *KSFPC94*
Mean	8,669	13,411	0.011	0.016
Std. Dev.	16,477	23,561	0.006	0.006
Max.	158,928	208,497	0.041	0.046
3rd Quartile	7,684	12,554	0.014	0.019
Median	3,132	5,176	0.011	0.015
1st Quartile	1,535	2,283	0.008	0.012
Min.	227	436	0.001	0.001

Note: Number of observations = 242.

Exhibit 4 | Summary Statistics on Real Estate Income Property ($Million)

	Income Property		Income Property Per Capita	
	1982 Original *KIP82*	1994 Original *KIP94*	1982 Original *KIPP82*	1994 Original *KIPPC94*
Mean	8,326	12,766	0.012	0.015
Std. Dev.	18,533	25,723	0.010	0.009
Max.	153,939	217,658	0.091	0.086
3rd Quartile	7,054	11,208	0.014	0.017
Median	2,921	4,625	0.009	0.013
1st Quartile	1,356	2,322	0.006	0.010
Min.	157	355	0.001	0.004

Note: Number of observations = 242.

In 1982, the mean total real estate capital stock for the 247 metropolitan areas with the required data was approximately $16.8 billion; the median was significantly less at $5.8 billion. The very large difference between the mean and the median is expected, since the distribution of capital stock across metropolitan areas is highly skewed, with a long tail to the right. In 1982, Los Angeles had an estimated $304 billion in total private real estate capital (1982 data for individual MSAs not shown in tables). The second largest metropolitan area was Chicago with $201 billion, followed by New York ($190 billion), Houston ($164 billion) and Boston ($140 billion).

The median total real estate capital stock for the 247 metropolitan areas rose to $10.1 billion in 1994. Once again the distribution is quite skewed with a mean of $26.9 billion. The ranking of metropolitan areas is, unsurprisingly, fairly stable. In 1994, the total value of Los Angeles' real estate capital stock was estimated at $426 billion (Exhibit 5). Chicago's stock is estimated to be worth $293 billion followed by New York ($238 billion), Houston ($208 billion) and Boston ($200 billion).

The ranking of cities by the single-family capital stock is somewhat different. Los Angeles has both the largest population in the country, and some of the highest housing prices, so it is not surprising that the 1994 value of the single-family housing stock weighs in at $208 billion, followed by Chicago at $138 billion. Boston's stock is estimated to be worth $121 billion, followed by Washington ($110 billion) and San Francisco ($768 million). New York drops out of the top league, which is unsurprising given their low rate of home ownership.

Exhibit 5 | Top 20 Metro Areas—By Stock Variables

	Total Real Estate Stock		Single Family Stock		Income Property Stock
Los Angeles-Long Beach, CA	426,154	Los Angeles-Long Beach, CA	208,497	Los Angeles-Long Beach, CA	217,658
Chicago, IL	292,555	Chicago, IL	137,892	New York, NY	190,031
New York, NY	237,578	Boston, MA	120,751	Chicago, IL	154,663
Houston, TX	207,639	Washington, DC	110,369	Houston, TX	136,833
Boston, MA	200,477	San Francisco, CA	76,787	Dallas, TX	88,836
Washington, DC	184,892	Philadelphia, PA	73,813	Boston, MA	79,726
Dallas, TX	145,041	Houston, TX	70,806	Washington, DC	74,523
San Diego, CA	138,592	Minneapolis-St. Paul, MN	65,849	San Diego, CA	73,915
Phoenix, AZ	126,156	Riverside-San Bernadino, CA	65,762	Oakland, CA	63,817
Philadelphia, PA	119,470	Nassau-Suffolk, NY	64,977	Phoenix, AZ	63,444
Riverside-San Bernadino, CA	115,269	San Diego, CA	64,676	Riverside-San Bernadino, CA	49,507
Minneapolis-St. Paul, MN	108,695	Phoenix, AZ	62,712	Atlanta, GA	48,508
San Francisco, CA	106,399	Seattle, WA	56,962	Philadelphia, PA	45,657
Atlanta, GA	105,312	Atlanta, GA	56,804	Miami-Hialeah, FL	43,543
Oakland, CA	104,479	Dallas, TX	56,204	Minneapolis-St. Paul, MN	42,846
Seattle, WA	99,435	San Jose, CA	50,895	Seattle, WA	42,473
Nassau-Suffolk, NY	90,624	Baltimore, MD	49,126	San Jose, CA	37,679
San Jose, CA	88,573	Denver, CO	47,696	Denver, CO	35,893
Miami-Hialeah, FL	86,656	New York, NY	47,547	Detroit, MI	35,518
Denver, CO	83,589	St. Louis, MO	43,286	Sacramento, CA	35,380

Notes: Information is from 1994. Data is in $million.

Exhibit 6 | Top 20 Metro Areas—By Stock Per Capita

	Total Real Estate Stock		Single Family Stock		Income Property Stock
Brazoria, TX	0.107	San Francisco, CA	0.047	Brazoria, TX	0.086
Longview-Marshall, TX	0.089	Santa Cruz, CA	0.038	Longview-Marshall, TX	0.074
Bakersfield, CA	0.071	Honolulu, HI	0.035	Bakersfield, CA	0.055
San Francisco, CA	0.064	San Jose, CA	0.032	Grand Forks, ND	0.047
Odessa, TX	0.061	Boulder-Longmont, CO	0.032	Houston, TX	0.038
West Palm Beach-Boca Raton, FL	0.060	Santa Barbara-Santa Monica, CA	0.031	Fort Myers-Cape Coral, FL	0.036
Santa Cruz, CA	0.060	West Palm Beach-Boca Raton, FL	0.030	Reno, NV	0.032
Grand Forks, ND	0.059	Santa Rosa-Petaluma, CA	0.029	West Palm Beach-Boca Raton, FL	0.032
Honolulu, HI	0.058	Fort Lauderdale-Hollywood, FL	0.028	Greeley, CO	0.031
Houston, TX	0.058	Denver, CO	0.028	Dallas, TX	0.031
Reno, NV	0.057	Wilmington, NC	0.027	Oakland, CA	0.029
San Jose, CA	0.056	Seattle, WA	0.026	Beaumont-Port Arthur, TX	0.029
Greeley, CO	0.056	Reno, NV	0.025	San Diego, CA	0.028
Santa Barbara-Santa Monica, CA	0.054	Nassau-Suffolk, NY	0.025	Corpus Christi, TX	0.028
Santa Rosa-Petaluma, CA	0.054	Phoenix, AZ	0.025	Santa Rosa-Petaluma, CA	0.027
Boulder-Longmont, CO	0.050	Minneapolis-St. Paul, MN	0.024	Salinas-Seaside-Monterey, CA	0.026
Fort Myers-Cape Coral, FL	0.050	Fort Collins-Loveland, CO	0.024	Fargo-Moorhead, ND	0.026
San Diego, CA	0.049	Washington, DC	0.024	Phoenix, AZ	0.026
Phoenix, AZ	0.049	Sacramento, CA	0.024	Bloomington-Normal, IL	0.026
Denver, CO	0.049	Melbourne-Titusville-Palm Beach, FL	0.024	Anchorage, AK	0.025

Notes: Information is from 1994. Data is in $Million.

Exhibit 7 | Total Real Estate Capital Stock: 1994

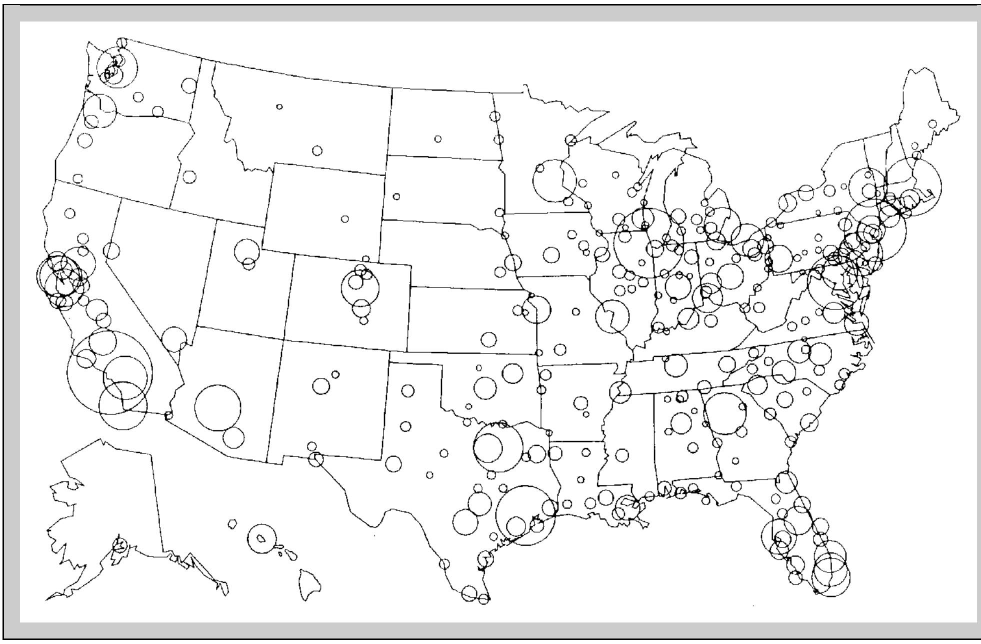


Exhibit 8 | Single Family Capital Stock: 1994

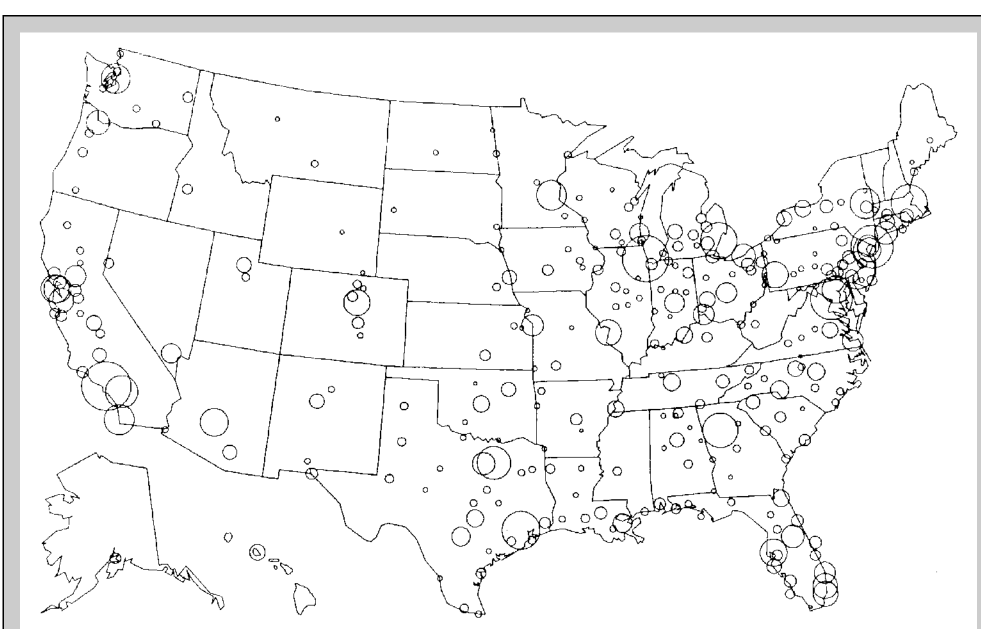
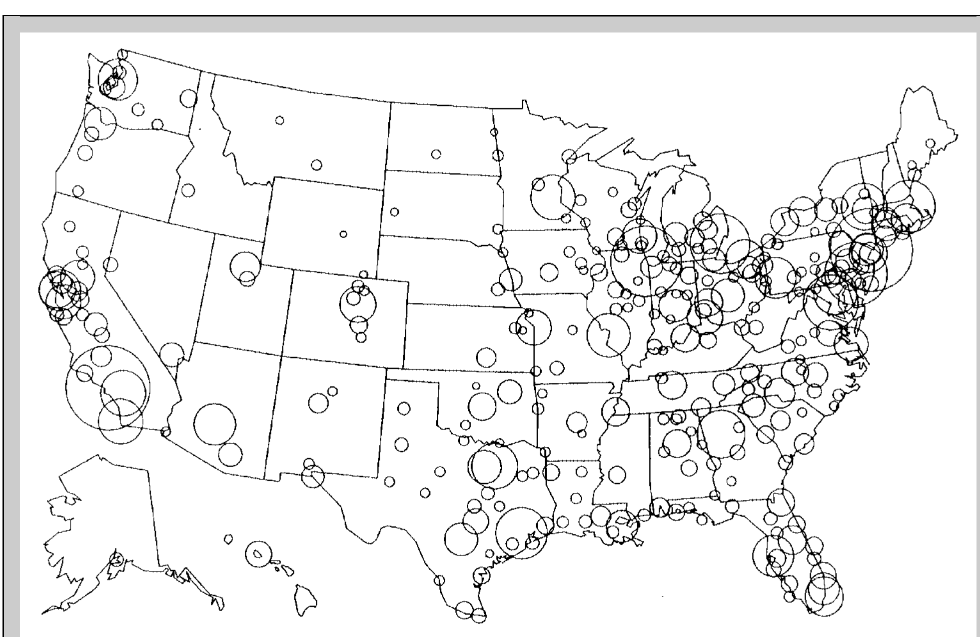


Exhibit 9 | Income Property Capital Stock: 1994

Exhibit 10 | 1990 Population for U.S. Metro Areas



Of course, large metropolitan areas will have large real estate capital stocks. The capital stock -per capita adjusts roughly for size, which is presented in Exhibits 2, 3 and 4. These figures are also in millions of dollars, so the median per capita capital stock in 1994 is $29,000. The mean is $31,000. This data is also somewhat skewed, though less so than the total capital stock data. The metropolitan areas with the highest stock per capita (Exhibit 6) include Brazoria Texas, with $107,000 in 1994; Longview with $89,000, Bakersfield ($70,000), San Francisco ($64,000) and Odessa ($61,000). The Texas capital stocks are high because these metropolitan areas have fairly small populations and large petrochemical industries. San Francisco and Bakersfield are high largely because of the extraordinary housing prices in California in recent years.

The maps presented in Exhibits 5 through 8 highlight the fact that the stock of real estate, like the U.S. population, is not geographically uniform. The stock of capital is highest in the eastern half of the country, especially the Northeast, Great Lakes, Florida and Texas; and a crescent of investment centering on California but also including Washington, Oregon and Arizona. West of Minneapolis, and east of that crescent, there's comparatively little stock, except for a cluster of investment centering on Denver, and some near Salt Lake City. Mahoney, Malpezzi and Shilling (2000) discuss these regional patterns in greater detail.

Comparison to Other Estimates

Estimating the capital stock is difficult and fraught with error. For example, Hulten and Wykoff (1980) calculate an alternative capital stock measure for nonresidential manufacturing structures for a number of years in the 1960s and 1970s, and compare them to official BEA numbers. Their estimates were generally over 50% higher than BEA estimates, although both sets of estimates were carefully and defensibly done.[8]

The most commonly cited statistics on the value of real estate capital are the Bureau of Economic Analysis estimates of fixed reproducible tangible wealth. The BEA produces data on residential and nonresidential structures. However, these data suffer from several shortcomings. First of all, they are only generally available for the U.S. as a whole. No geographic disaggregation is found in publicly available data. Secondly, they do not include the value of land. For residential real estate, the Federal Reserve does publish separate estimates of land in their balance sheets for the U.S. economy, but once again, these are only available in the aggregate.

One study that breaks out estimates of nonresidential real estate by property type and location is Miles, Pittman, Hoesli, Bhatnager and Guilkey (1991). They start with county level tax assessments and use an instrumental variables approach to estimate the value of real estate in thirty-six metropolitan areas. The values of retail, office and industrial property are estimated. They estimate the total value of this commercial real estate to be $1.7 trillion in 1989. The authors do not include multifamily investment property. And, of course, they do not include locations outside the thirty-six large metropolitan areas.

Hartzell, Pittman and Downs (1994) apply a similar method to county level data. As noted, sixty-seven counties in thirty-two metropolitan areas were used. The baseline data were from property tax assessments. A number of large metropolitan areas were dropped from analysis including Chicago, New York and Washington D.C., as well as all California counties because of distortions in the assessment process (*e.g.*, by Proposition 13). Hartzell et al. then collected a set of exogenous variables related to population, structure of employment, income and employment. They used these to construct instrumental variables for each property type. Their regression models were then used to estimate the value of real estate by property type in each of the 3,141 counties in the U.S. However, their article only reported results aggregated by region, and their original county estimates are, unfortunately, no longer readily available.

An obvious comparison would be to compare the estimates to the Hartzell, Pittman and Downs (1994) estimates. Unfortunately, such a comparison is not possible. Several comparability issues would arise, but the dominant problem is that unfortunately, their disaggregated data was lost during the conversion of computer systems. Still, a comparison of the aggregate results (available in their published paper) is instructive.

The income property measure in this study and the data presented in Hartzell, Pittman and Downs (1994) do not match perfectly, but an approximate comparison can be made. Hartzell et al. estimates the 1989 value of retail, office and warehouse space at $2,429 billion. Their estimate of the residential capital stock was $8,703 billion. Unfortunately, they do not break out their residential stock into single family and multifamily, and the latter is an important component of the total stock of income property.

The total single-family stock is estimated as follows. In 1989, there were 69,290,000 single-family units in the U.S., according the American Housing Survey. The median value of these units was $75,201. In order to estimate the total value of these units, the average price was used, which is generally higher than the median for data distribution log normally as are housing prices. Based on the ratio of the average to median house prices from several alternative sources, a rough rule of thumb was adopted that the average house price will be about 20% higher than the median house price. Multiplying out, and adding the value of the 6,908,000 mobile homes (at $14,877 per unit), an estimated total single-family stock is worth $6,355 billion.

Subtracting this from the Hartzell, Pittman and Downs (199$) estimate of total residential stock, leaves a rough estimate of $2,347 billion for multifamily housing in 1989. Thus, the estimated 1989 value of all income property, based on Hartzell et al. and the AHS, is the sum of $2,429 billion and $2,347 billion, or $4,776 billion. In 1994 dollars, that would be equivalent to $5,550 billion. The estimates of the income property capital stock for 242 metropolitan areas are about 55% of this separate estimate for the entire country. Errors are inevitable in any such calculation of the capital stock—including in any ‘‘official’’ source, or prior estimate, or other potential baseline calculations used for comparison. In any event, the estimates in this study seem broadly in line with other data.

A Simple Model of Determinants

In this section, simple models of the determinants of the investment series are presented for 1982 and 1984. There are at least three reasons to undertake such an exercise. First, and most importantly, some insight is gained into market behavior. Second, the value of the stock for missing locations can be forecasted. Third, an alternative series can be constructed for the original 242 locations that may ‘‘smooth’’ possible errors.

Six dependent variables: total capital stock per capita in 1982 and 1994 (*KTOTPC82* and *KTOTPC94*); single family capital stock per capita for in 1982 and 1994 (*KSFPC82* and *KSFPC94*); and the values of income property per capita in 1982 and 1994 (*KIPPC82* and *KIPPC94*). In preliminary regressions, models linear in per capita stocks worked best for total and single family property; and models logarithmic in per capita stocks worked best for income property. ‘‘Worked best’’ means that there were few outliers and generally homoskedastic residuals.

What are the possible determinants of a metropolitan area’s capital stock? Real estate is required for virtually any economic activity, albeit in different forms for different activities. In brief, the supply and demand for such capital will be affected by more or less any variable that affects the time path of the local economy. Kusmin (1994) provides one nice summary of a wide range of such determinants. Studies such as Corgel and Gay (1987), Hartzell, Pittman and Downs (1994) and Malizia (1991) focus particularly on the local economic determinants of real estate activity. Variables commonly used include income, employment, demographics, the structure of local production, and the tax and regulatory climate, among others. Of course, many such local economic variables will be correlated. Since the object in this article is prediction, not estimation of a structural model a fairly parsimonious reduced form specification is used.

The independent variables are listed in Exhibit 11. They are divided into three categories: economic structure, employment classification and other. After an initial specification search, the six models presented in Exhibit 12 were selected. The number in the parentheses below each parameter estimate is the corresponding *p*-value. Careful analysis of residuals found no evidence of major specification errors.

Several interesting patterns emerge from Models (1)–(6). A higher growth rate in employment leads to more total capital stock per capita. Its impact on the capital stock per capita for single family is quite significant in 1982, but not for 1994. Higher real incomes (Y82 and Y94) drive investment in all six models. The growth

Exhibit 11 | Independent Variables

	Variable Name	Content
Basic Variables	*P82, P94*	Population: 1982 and 1994
	DP6982, DP8194	Growth rate of employment, 1969–82 and 1981–94
	SEMSGP82, SEMGP94	Semi-standard deviation of growth rate of population 1969–82 and 1981–94
	E82, E94	Employment: 1982 and 1994
	DE6982, DE8194	Growth rate of employment: 1969–82 and 1981–94
	SEMSGE82, SEMSGE94	Semi-standard deviation of growth rate of employment: 1969–82 and 1981–94
	Y82, Y94	Real income per capita: 1982 and 1994
	DY6982, DY8194	Growth rate of real income per capita: 1969–82 and 1981–94
	SEMSGY82, SEMSGY94	Semi-standard deviation of growth rate of real income per capita: 1969–82 and 1981–94
Economic Structure Variables	*PBUS80, PBUS90*	Percentage of employment in business services: 1980 and 1990
	PCON80, PCON90	Percentage of employment in construction: 1980 and 1990
	PFIRE80, PFIRE90	Percentage of employment in FIRE: 1980 and 1990
	PMAN80, PMAN90	Percentage of employment in manufacturing: 1980 and 1990
	PMIN80, PMIN90	Percentage of employment in mining: 1980 and 1990
	PPERS80, PPERS90	Percentage of employment in personal services: 1980 and 1990
	PPROF80, PPROF90	Percentage of employment in professional services: 1980 and 1990
	PPUB80, PPUB90	Percentage of employment in public administration: 1980 and 1990
	PTRANS80, PTRANS90	Percentage of employment in transportation: 1980 and 1990
Other Variables	*PCTGE65*	Metro percentage of people 65 or older: 1990
	PCT18_64	Metro percentage of people 18 to 64: 1990
	PCTCOUPL	Percentage of married couples: 1990
	POO80, POO90	Percentage of owner-occupied units: 1980 and 1990
	PTYDIR90	Percentage of real transfer income, dividends and interest: 1990
	RCDUM	Rent control dummy: 0 = w/o rent control, 1 = with rent control

Exhibit 12 | Determinants of Real Estate Capital Per Capita: 1982 and 1994

Dependent Variable		Total Capital Stock Per Capita[a]	Total Capital Stock Per Capita	Capital Stock Per Capita Single Family[a]	Capital Stock Per Capita Single Family[a]	Income Property Per Capita[b]	Income Property Per Capita[b]
		1982	1994	1982	1994	1982	1994
E82, E94	Coef.	2.180E−09	4.460E−11	5.210E−10	−6.170E−10	1.750E−07	3.729E−08
	S.E.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.000E−08	5.000E−08
	t-Stat	1.52	0.03	0.79	−0.98	2.05	0.73
	Prob > |t|	0.129	0.973	0.430	0.329	0.042	0.465
	Tolerance	0.558	0.517	0.554	0.515	0.554	0.515
DE6982, DE8194	Coef.	0.249	0.170	0.109	0.044	10.50	9.92
	S.E.	0.071	0.092	0.033	0.046	4.24	3.68
	t-Stat	3.52	1.85	3.33	0.97	2.48	2.69
	Prob > |t|	0.001	0.066	0.001	0.331	0.014	0.008
	Tolerance	0.293	0.389	0.293	0.399	0.293	0.399
SEMSGE82, SEMSGE94	Coef.	−0.189	−0.001	0.063	0.076	−9.78	−3.46
	S.E.	0.137	0.182	0.063	0.091	8.14	7.32
	t-Stat	−1.38	0.00	1.00	0.84	−1.20	−0.47
	Prob > |t|	0.168	0.998	0.317	0.400	0.231	0.638
	Tolerance	0.453	0.460	0.453	0.533	0.453	0.533
PTYDIR90	Coef.	0.065	−0.216	0.168	0.018	−10.12	−12.79
	S.E.	0.188	−0.211	0.086	0.102	11.18	8.26
	t-Stat	0.34	−1.03	1.95	0.18	−0.91	−1.55
	Prob > |t|	0.732	0.306	0.053	0.858	0.366	0.123
	Tolerance	0.472	0.406	0.477	0.402	0.477	0.402
Y82, Y94	Coef.	2.170E−06	1.990E−06	1.180E−06	1.140E−06	6.652E−05	5.885E−05
	S.E.	4.400E−07	3.900E−07	2.000E−07	1.900E−07	2.644E−05	1.544E−05
	t-Stat	4.99	5.12	5.77	5.96	2.52	3.81
	Prob > |t|	0.000	0.000	0.000	0.000	0.013	0.000
	Tolerance	0.431	0.354	0.445	0.368	0.445	0.368

Exhibit 12 | (continued)

Determinants of Real Estate Capital Per Capita: 1982 and 1994

Dependent Variable		Total Capital Stock Per Capita[a]	Total Capital Stock Per Capita	Capital Stock Per Capita Single Family[a]	Capital Stock Per Capita Single Family[a]	Income Property Per Capita[b]	Income Property Per Capita[b]
		1982	1994	1982	1994	1982	1994
DY6982, DY8194	Coef.	−0.143	−0.597	−0.045	−0.212	−1.43	−25.18
	S.E.	0.146	0.136	0.068	0.067	8.77	5.40
	t-Stat	−0.98	−4.38	−0.67	−3.18	−0.16	−4.66
	Prob > |t|	0.328	0.000	0.506	0.002	0.871	0.000
	Tolerance	0.359	0.445	0.386	0.479	0.386	0.479
SEMSGY82, SEMSGY94	Coef.	0.359	0.199	−0.043	−0.014	19.53	12.87
	S.E.	0.124	0.183	0.057	0.089	7.37	7.20
	t-Stat	2.89	1.08	−0.76	−0.16	2.65	1.79
	Prob > |t|	0.004	0.279	0.450	0.875	0.009	0.075
	Tolerance	0.461	0.400	0.467	0.495	0.467	0.495
PBUS80, PBUS90	Coef.	−0.142	0.033	−0.033	0.167	−8.25	−4.36
	S.E.	0.062	0.123	0.029	0.060	3.69	4.81
	t-Stat	−2.28	0.27	−1.17	2.80	−2.23	−0.91
	Prob > |t|	0.024	0.791	0.242	0.056	0.027	0.366
	Tolerance	0.488	0.359	0.489	0.357	0.489	0.357
PCON80, PCON90	Coef.	0.170	0.199	0.015	0.039	6.54	5.28
	S.E.	0.058	0.064	0.027	0.032	3.48	2.51
	t-Stat	2.94	3.10	0.54	1.27	1.88	2.10
	Prob > |t|	0.004	0.002	0.587	0.206	0.062	0.037
	Tolerance	0.291	0.580	0.287	0.575	0.287	0.575

Exhibit 12 | (continued)

Determinants of Real Estate Capital Per Capita: 1982 and 1994

Dependent Variable		Total Capital Stock Per Capita[a]	Total Capital Stock Per Capita	Capital Stock Per Capita Single Family[a]	Capital Stock Per Capita Single Family[a]	Income Property Per Capita[b]	Income Property Per Capita[b]
		1982	1994	1982	1994	1982	1994
PFIRE80, PFIRE90	Coef.	−0.094	−0.122	−0.022	−0.777	−4.31	−1.93
	S.E.	0.062	0.054	0.029	0.264	3.70	2.13
	t-Stat	−1.52	−2.24	−0.78	−2.93	−1.16	−0.90
	Prob > |t|	0.131	0.026	0.434	0.004	0.246	0.367
	Tolerance	0.352	0.355	0.351	0.352	0.351	0.352
PMAN80, PMAN90	Coef.	−0.063	−0.084	−0.024	−0.038	−4.83	−3.50
	S.E.	0.024	0.030	0.011	0.015	1.40	1.17
	t-Stat	−2.67	−2.79	−2.26	−2.59	−3.45	−2.98
	Prob > |t|	0.008	0.006	0.025	0.010	0.001	0.003
	Tolerance	0.083	0.094	0.084	0.095	0.084	0.095
PMIN80, PMIN90	Coef.	−0.009	0.014	−0.026	−0.074	−5.22	−0.91
	S.E.	0.046	0.073	0.024	0.042	3.13	3.43
	t-Stat	−0.20	0.19	−1.09	−1.74	−1.67	−0.27
	Prob > |t|	0.844	0.852	0.277	0.083	0.087	0.791
	Tolerance	0.474	0.452	0.542	0.554	0.542	0.554
PPERS80, PPERS90	Coef.	−0.083	−0.090	−0.028	−0.030	−4.36	−3.35
	S.E.	0.041	0.048	0.019	0.023	2.45	1.86
	t-Stat	−2.01	−1.88	−1.48	−1.33	−1.70	−1.81
	Prob > |t|	0.046	0.062	0.141	0.186	0.091	0.073
	Tolerance	0.450	0.434	0.448	0.432	0.448	0.432

Exhibit 12 | (continued)

Determinants of Real Estate Capital Per Capita: 1982 and 1994

Dependent Variable		Total Capital Stock Per Capita[a]	Total Capital Stock Per Capita	Capital Stock Per Capita Single Family[a]	Capital Stock Per Capita Single Family[a]	Income Property Per Capita[b]	Income Property Per Capita[b]
		1982	1994	1982	1994	1982	1994
PPROF80, PPROF90	Coef.	−0.089	−0.075	−0.030	−0.027	−5.44	−3.12
	S.E.	0.032	0.037	0.015	0.177	1.88	1.43
	t-Stat	−2.82	−2.04	−2.05	−1.55	−2.89	−2.19
	Prob > |t|	0.005	0.043	0.041	0.124	0.004	0.030
	Tolerance	0.202	0.166	0.204	0.166	0.204	0.166
PPUB80, PPUB90	Coef.	−0.084	−0.105	−0.025	−0.036	−5.52	−4.43
	S.E.	0.032	0.036	0.015	0.017	1.90	1.40
	t-Stat	−2.63	−2.92	−1.70	−2.10	−2.90	−3.16
	Prob > |t|	0.009	0.004	0.090	0.037	0.004	0.002
	Tolerance	0.365	0.397	0.367	0.396	0.367	0.396
PTRANS80, PTRANS90	Coef.	−0.079	−0.074	−0.018	−0.025	−4.34	−3.74
	S.E.	0.051	0.061	0.024	0.031	3.07	2.47
	t-Stat	−1.56	−1.21	−0.76	−0.83	−1.41	−1.52
	Prob > |t|	0.121	0.227	0.450	0.405	0.159	0.131
	Tolerance	0.452	0.448	0.445	0.437	0.445	0.437
POO80, POO90	Coef.	−0.035	−0.031	0.001	0.007	−1.99	−1.99
	S.E.	0.014	0.016	0.006	0.008	0.81	0.63
	t-Stat	−2.59	−1.95	0.15	0.85	−2.47	−3.14
	Prob > |t|	0.010	0.053	0.880	0.395	0.014	0.002
	Tolerance	0.423	0.352	0.42	0.349	0.420	0.349
PCTCOUPL	Coef.	2.000E−04	2.000E−04	1.570E−05	−3.820E−06	1.333E−03	1.068E-03
	S.E.	2.000E−04	3.000E−04	1.000E−04	1.000E−04	1.461E−02	1.005E−02
	t-Stat	0.86	0.67	0.14	−0.03	0.09	0.11
	Prob > |t|	0.389	0.501	0.890	0.976	0.927	0.916
	Tolerance	0.367	0.363	0.368	0.360	0.368	0.360

Exhibit 12 | (continued)

Determinants of Real Estate Capital Per Capita: 1982 and 1994

Dependent Variable		Total Capital Stock Per Capita[a]	Total Capital Stock Per Capita	Capital Stock Per Capita Single Family[a]	Capital Stock Per Capita Single Family[a]	Income Property Per Capita[b]	Income Property Per Capita[b]
		1982	1994	1982	1994	1982	1994
PCT18_64	Coef.	2.000E−04	1.000E−04	3.000E−04	3.000E−04	−1.461E−02	−1.887E−02
	S.E.	3.000E−04	4.000E−04	2.000E−04	2.000E−04	2.079E−02	1.530E−02
	t-Stat	0.44	0.26	1.87	1.70	−0.70	−1.23
	Prob > |t|	0.659	0.794	0.064	0.091	0.483	0.219
	Tolerance	0.317	0.272	0.322	0.275	0.322	0.275
RCDUM	Coef.	−0.001	−0.002	−0.001	−0.002	−0.033	−0.007
	S.E.	0.003	0.004	0.002	0.002	0.206	0.144
	t-Stat	−0.25	−0.54	−0.69	−1.16	−0.16	−0.05
	Prob > |t|	0.804	0.591	0.493	0.248	0.872	0.963
	Tolerance	0.585	0.543	0.594	0.560	0.594	0.560
Intercept	Coef.	0.033	0.054	−0.014	−0.012	−0.490	−0.457
	S.E.	0.038	0.043	0.018	0.021	2.283	1.703
	t-Stat	0.86	1.24	−0.82	−0.59	−0.22	−0.27
	Prob > |t|	0.389	0.216	0.416	0.559	0.830	0.789
F-value		13.73	9.22	9.18	7.86	9.72	9.28
Prob > *F*		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
R^2		0.55	0.45	0.45	0.42	0.47	0.46
Adj. R^2		0.51	0.40	0.40	0.36	0.42	0.41
Model SS		0.026	0.019	0.004	0.004	64.593	28.553
Mean S.E.		0.010	0.010	0.004	0.005	0.332	0.154

Note: For total capital stock per capital, $N = 247$; $N = 242$ for capital stock per capita and income property per capita.

[a] Linear

[b] Logarithmic

rate of real income per capita has a significant effect in 1994, but the coefficient has the wrong sign. Again, this may be due to collinearity among the variables.

The economic structure of each metropolitan area is proxied by a set of employment classification variables. Employment in trade and agriculture are omitted categories. The percentage of owner occupied units (*POO80* and *POO90*) are significant predictors of the total capital stock and of income property, with a negative sign.

A better fit (higher R^2) for the same sets of independent variables could be engineered by using the original capital stock data, instead of capital stock per capita. However, Models (1)–(6) readily predict the original capital stock data, by multiplying the predicted capital stock per capita times MSA population. Of course, for the income property stock, since semi-logarithmic regressions were estimated, the predicted value of the dependent variable can be exponentiated to obtain estimates of the per capita stock, and then multiplied by population.

Exhibit 13 shows the correlation coefficients between the predicted capital stock per capita and the actual capital stock per capita, as well as the correlation between the predicted capital stock and the actual capital stock. The latter correlations are

Exhibit 13 | Correlation Coefficients Between the Predicted and the Actual Values

	Total Capital Stock	Capital Stock for Single Family	Income Property
Between the predicted capital stock per capita and the actual capital stock per capita: 1982	.72	.67	.69
Between the predicted capital stock per capita and the actual capital stock per capita: 1994	.67	.64	.62
Between the predicted capital stock and the actual capital stock: 1982	.97	.92	.96
Between the predicted capital stock and the actual capital stock: 1994	.98	.94	.98

Note: Predicted capital stock = predicted capital stock per capita from Models (1)–(6) × population of the corresponding year.

all larger than .9; the models perform extremely well in predicting actual capital stock.

Predictions

Exhibits 14, 15 and 16 present the basic results for the predicted values of the capital stock. This exhibit parallel Exhibit 2, 3 and 4. The first thing to notice is that the set of metropolitan areas is expanded from 247 to 295. There are forty-eight metropolitan areas for which there are no dependent variables, but which have all the independent variables required for prediction.

Direct comparison of Exhibits 2, 3 and 4 with Exhibits 14, 15 and 16 is made difficult by the fact that they do not cover the same set of metropolitan areas. But given that forty-eight additional metropolitan areas are fairly small, it is not surprising that the results are generally similar between Exhibits 2, 3 and 4 and Exhibits 14, 15 and 16. The ranking of metropolitan areas is also fairly consistent, which is unsurprising given the high correlation coefficients reported. Predictions for each individual MSA are available on the website.

Sensitivity Analysis

First, the sensitivity of results to the choice of metropolitan areas is examined. Not all MSAs are included, because of data availability; and it is well known that the definitions of many MSAs change over time. An attempt was made to use

Exhibit 14 | Summary Statistics on Predicted Real Estate Capital Stock—Total Real Estate Capital Stock ($Million)

	Total Capital Stock		Total Capital Stock Per Capita	
	1982 Predicted *KTHAT82*	1994 Predicted *KTHAT94*	1982 Predicted *KTHPC82*	1994 Predicted *KTHTC94*
Mean	14,995	22,776	0.024	0.031
Std. Dev.	29,013	40,882	0.011	0.009
Max.	264,012	343,878	0.070	0.064
3rd Quartile	12,469	21,573	0.030	0.036
Median	5,888	8,851	0.021	0.029
1st Quartile	2,779	4,141	0.016	0.024
Min.	504	1,102	0.005	0.009

Note: Number of observations = 295.

Exhibit 15 | Summary Statistics on Real Estate Capital Stock for Single Family ($Million)

	SF Capital Stock		SF Capital Stock Per Capita	
	1982 Predicted *KSFHAT82*	1994 Predicted *KSFHAT94*	1982 Predicted *KSFHPC82*	1994 Predicted *KSFHPC94*
Mean	7,685	11,710	0.012	0.015
Std. Dev.	144,231	19,675	0.004	0.004
Max.	116,261	142,525	0.032	0.030
3rd Quartile	6,669	10,754	0.014	0.018
Median	2,928	4,275	0.011	0.015
1st Quartile	1,330	2,083	0.009	0.013
Min.	431	677	0.004	0.006

Note: Number of observations = 295.

consistent metropolitan area definitions over time, but error could creep in. In order to test whether results were sensitive to choice of metropolitan areas, and especially whether the matching of disparate datasets used consistent definitions, the regression models of determinants was re-estimated using only MSAs whose definitions did not change between 1982 and 1994, according to the Bureau of the Census. The capital stock was predicted using these revised estimates, and the

Exhibit 16 | Summary Statistics on Real Estate Income Property ($Million)

	Income Property		Income Property Per Capita	
	1982 Predicted *KIPHAT82*	1994 Predicted *KIPHAT94*	1982 Predicted *KIPHPC82*	1994 Predicted *KIPHPC94*
Mean	6,674	10,639	0.011	0.014
Std. Dev.	15,049	21,167	0.008	0.006
Max.	144,434	198,712	0.069	0.039
3rd Quartile	5,785	9,430	0.012	0.016
Median	2,488	3,773	0.008	0.013
1st Quartile	1,071	1,803	0.006	0.010
Min.	335	622	0.003	0.005

Note: Number of observations = 295.

revised estimates were compared to the preferred benchmarks. This was done for the beginning and ending years (1982 and 1994), and for all three categories: total, single family and income property. The correlation between original and revised estimates was always above 0.95 and sometimes approached 0.99. Thus, the results are not sensitive to selection of MSAs.

Next, the estimates were examined to see if the true depreciation rates varied from the best estimates. One percentage point was added to each depreciation estimate (single family and income property), and the stock measures were recalculated. By construction, this simulation leaves the 1982 estimates unaffected; and the effect of a change in depreciation will be stronger the further forward it moves. By 1994, the average capital stock estimate was about 10% lower if depreciation is one point faster. More precisely, the average decline is .096 for total capital, .098 for single family, and .093 for income property. Examining each MSA's estimates, the range is fairly narrow: 95% of estimates in all three categories range between about 8% and about 11%.

Finally, if the original capital stock benchmark is increased by 10%, the 1982 benchmark changes by exactly l0%, but the effect will tend to decline as it moves forward. Ceteris paribus, such an increase in the 1982 benchmark increases the total 1994 stock by .070; the single-family stock by .075 and income property by .063. Across all MSAs, 95% of the 1994 estimates change from about 3%, to about 9%.

To summarize, the results do not seem to be very sensitive to the sampling choice of MSAs. They are somewhat sensitive to assumptions about depreciation, or to errors in the original capital stock benchmark. The former errors loom larger over time; the latter loom less. Of course, the fact that capital stock estimates are somewhat sensitive to especially depreciation is not news to readers of the literature on national income accounting. Better estimates of depreciation are high on any future research agenda in this subject.

Conclusion

In this article, a variant of the perpetual inventory method was applied to calculate the value of the stock of private real estate capital for individual U.S. metropolitan areas. The estimates were broken out by single-family property, and a residual category of income property. The results are broadly consistent with other estimates of the real estate capital stock, however they have the advantage of being disaggregated by location. These estimates have already been used to analyze the location investment decisions of real estate investment trusts and private institutional real estate investors in Mahoney, Malpezzi and Shilling (2000) and Malpezzi and Shilling (2000). The individual MSA estimates are available on the website in order to facilitate their use by other researchers.

Straightforward regression models for the beginning and ending years (1982 and 1994) were also estimated. These yield insights into the determinants of the real estate capital stock, and to permit the forecasting of capital stock for metropolitan areas with insufficient data. Per capita capital stock can be well-modeled using basic demographic and income variables, and variables representing the structure of a local area economy. Using these regression results, the estimates of the capital stock were extended by an additional forty-eight metropolitan areas. These predicted values are also available for individual metropolitan areas at the website.

Additional research in this area could have a high payoff. For example, further disaggregation by property type would be of interest. Previous work by Hartzell, Pittman and Downs (1994) and others suggests that locational differences among property types would be significant. Further research could also refine some of the assumptions, and hence refine the estimates. For example, the best available depreciation estimates for different capital stock types were used, but only one depreciation rate was used for each property type for all locations. Malpezzi, Ozanne and Thibodeau (1987) showed that residential depreciation rates vary significantly by metropolitan area. Further work on location-specific non-residential depreciation would yield more precise estimates of the capital stock. A better understanding of the selectivity problem in depreciation estimates caused by demolitions and removals would also be useful.

The results could also be improved with additional research on nonresidential real estate price changes by location. Many articles have been written on metropolitan housing prices, but much additional work would be needed to have viable metropolitan level price estimates for the income property stock.

Endnotes

[1] See, for example, Malizia (1991), Pollakowski, Wachter and Lynford (1992), Eppli, Shilling and Vandell (1998) and Goodman (1999), among others.

[2] Assessment ratios are constructed in a straightforward manner. Data on recent sales are collected, including sales price and the assessed value at time of sale. Transactions that are apparently not arms-length are dropped. The average ratio of sales price to assessed value is computed. Separate ratios are constructed for each MSA.

[3] The correlation is lower with monthly data, for example, since there are lags between permit issuance and actual construction.

[4] The 1982 data were made available in printed form, laid out generally by (Standard) MSA. But the format varied somewhat from MSA to MSA, and can be best described as ‘‘semi-standardized.’’

[5] For example, if a subarea of an MSA existed, an average of other subareas was inputted. Since the definitions of and available data for subareas were themselves highly variable, these imputations are subject to error.

[6] But any possible *systematic* errors in permit data, and/or errors in the measurement of depreciation, loom larger as time moves forward.

[7] Conceptually a price index that varies by metro area is preferred, but no reliable indexes exist for such a wide variety of property types over so many locations.

[8] Hulton and Wykoff (1980) attribute the majority of the difference to different assumptions about depreciation rates.

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