Bubble, Bubble, Where's the Housing Bubble?

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Abstract

Housing-bubble discussions generally rely on indirect barometers such as rapidly increasing prices, unrealistic expectations of future price increases, and rising ratios of housing price indexes to household income indexes. These indirect measures cannot answer the key question of whether housing prices are justified by the anticipated cash flow. We show how to estimate the fundamental value of a house and use unique rent and price data for matched single-family homes in ten metropolitan areas to illustrate this approach. These data indicate that the current housing bubble is not, in fact, a bubble in most of these cities in that, under a variety of plausible assumptions, buying a house at current market prices still appears to be an attractive long-term investment. Our results also demonstrate the flaw in models that gauge bubbles by comparing movements in housing price indexes to movements in other indexes or to values predicted by regression models.

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U. S. housing prices have risen by about 50% in the past five years, and more than 100% in some hot markets. Many knowledgeable observers believe that we are in the midst of a speculative bubble in residential real estate prices, particularly on the coasts, that rivals the dot-com bubble in the 1990s and that will have a similarly unhappy conclusion.

In December 2004, UCLA Anderson Forecast's Economic Outlook described the California housing market as a bubble, repeating their warnings made in previous years. Yale economist Robert Shiller has issued similar housing-bubble alarms for several years and, in June 2005, warned that, "The [housing] market is in the throes of a bubble of unprecedented proportions that probably will end ugly." Shiller suggests that real housing prices might fall by 50% over the next decade. In August 2005, Princeton's Paul Krugman argued that there was definitely a housing bubble on the coasts and that, indeed, the air had already begun leaking out of the bubble.

Evidence of a housing bubble has been suggestive, but indirect, in that it does not address the key question of whether housing prices are justified by the anticipated cash flow. We show how to estimate the fundamental value of a house and use a unique set of rent and price data for matched single-family homes in ten metropolitan areas to illustrate this approach. Our evidence indicates that, even though prices have risen rapidly and some buyers have unrealistic expectations of continuing price increases, the bubble is not, in fact, a bubble in most of these areas in that, under a variety of plausible assumptions, buying a house at current market prices still appears to be an attractive long-term investment.

Our results also demonstrate that models that gauge a housing bubble by comparing movements in housing price indexes to movements in other indexes or to the values predicted by regression models are flawed because they assume that market prices fluctuate randomly around fundamental values. We have to assume that prices were close to fundamentals in the past in order to conclude that the 2001-2005 runup pushed prices above fundamentals; maybe prices were below fundamentals in the past and the 2001-2005 runup pushed prices closer to fundamentals.

Defining a Bubble

Charles Kindleberger (1987) defined a bubble this way:

> a sharp rise in price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers—generally speculators interested in profits from trading rather than in its use or earning capacity. The rise is then followed by a reversal of expectations and a sharp decline in price, often resulting in severe financial crisis—in short, the bubble bursts.

Researchers often focus on specific aspects of this general concept: rapidly rising prices (Baker 2002), unrealistic expectations of future price increases (Case and Shiller 2003); the departure of prices from fundamental value (Garber 2000), or a large drop in prices after the bubble pops (Siegel 2003).

Shiller and Case (2003) wrote that "A tendency to view housing as an investment is a defining characteristic of a 'housing bubble'." To the contrary, we believe that the correct way to gauge a bubble is to view housing as an investment. (And that one of the main sources of mispricing in the housing market is that almost none of the participants estimate the fundamental value of their houses.)

We define a bubble as a situation in which the market prices of a certain class of assets (such as stocks or real estate) rise far above the present value of the anticipated cash flow from the asset (what Kindleberger called the asset's use or earning capacity). This definition suggests many of the features noted above: prices rising rapidly, a speculative focus on future price increases rather than the asset's cash flow, and an eventual drop in market prices. However, these features are only suggestive. Market prices can rise rapidly, and be expected to rise rapidly in the future, if fundamental values are increasing rapidly or if market prices are far below fundamental values. Market prices can drop (for example, in a financial crisis) even when there has been no bubble. What truly defines a bubble is that market prices are not justified by the asset's anticipated cash flow.

Is the Housing Market Efficient?

True believers in efficient markets might deny that there can ever be a bubble. The market price is always the correct price and is therefore justified by the expectations market participants hold. Even Siegel (2003), who believes there can be bubbles, writes that, "We know that the price of any asset is the present value of all future expected cash flows." Contrast this with the opening sentence of John Burr Williams' classic treatise, The Theory of Investment Value (1938): "Separate and distinct things not to be confused, as every thoughtful investor knows, are real worth and market price." In the stock market, these two arguments can perhaps be reconciled by a consideration of whether the anticipated cash flows investors use to calculate present values are reasonable. The residential real estate market is fundamentally different in that homebuyers generally do not calculate present values.

Case and Shiller (2003) report survey evidence of homeowners' naive beliefs about the real estate market. The residential real estate market is populated by amateurs making infrequent transactions on the basis of limited information and with little or no experience in gauging the fundamental value of the houses they are buying and selling. It is highly unlikely that residential real-estate prices are always equal to the present value of the expected cash flow if market participants almost never attempt to estimate the present value of the expected cash flow.

Instead, the nearly universal yardstick in residential real estate is "comps," the recent sale prices of nearby houses with similar characteristics. Comps tell us how much others have paid for houses recently, but not whether these prices are justified by the cash flow. Is a Britannia the British Bear Beanie Baby worth $500 because a Princess Beanie Baby sold for $500? Is this house worth $1 million because a similar house sold for $1 million? The nearly universal use of comps by buyers, sellers, real estate agents, and appraisers is the very mechanism by which market prices can wander far from fundamental values. If no one is estimating fundamental value, why should we assume that market prices will equal fundamental values?

In the stock market, professional investors can, in theory, arbitrage and exploit the mistakes made by noise traders. In the housing market, however, professionals cannot sell houses short and cannot obtain the tax advantages available for owner-occupied housing by physically occupying multiple houses. It is also expensive to manage and monitor rental houses, especially from afar. If a myopic focus on comps causes housing prices to depart from fundamentals, there is no effective self-correcting mechanism.

In an inefficient market, prices can be above or below fundamental value. Housing bubble enthusiasts implicitly assume that market prices were, on average, equal to fundamental values in the past and that recent increases have pushed prices above fundamental values. Perhaps housing prices were too low in the past and recent price increases have brought market prices more in line with fundamentals.

Bubblemetrics

Researchers have used a variety of proxies to gauge whether there is a bubble in the real estate market. One pervasive problem is the reliance on aggregate measures of housing prices that are notoriously imperfect because: houses are so heterogeneous in their characteristics and location; it is difficult to measure the depreciation and remodeling of existing homes; and it is difficult to measure changes in the quality of home construction over time. McCarthy and Peach (2004) show that, between 1977 and 2003, four popular home price indexes showed price appreciation ranging from 199% (constant quality new homes) to 337% (median price of sales of existing homes).

Even if the price indexes were perfect, their application is questionable. For example, Case and Shiller (2003) look at the ratio of housing prices to household income, the idea being that housing prices are a bubble waiting to pop if the median buyer is priced out of the market. But the affordability of a house has little to do with its intrinsic value. Berkshire Hathaway stock currently sells for nearly $100,000 a share. It is not affordable for most investors, but it may be worth the price!

Even on its own terms, the ratio of housing prices to income doesn't really measure affordability. A better measure would be the ratio of mortgage payments to income. Mortgage rates have fallen dramatically and the ratio of mortgage payments on a constant-quality new home to median family income has fallen steadily, from 0.35 in 1981 to 0.13 in 2003 (McCarthy and Peach 2004).

The Local Market Monitor, which is widely cited in the popular press, uses a variation on the Case-Shiller approach to compare cities. They calculate the ratio of a metropolitan area's relative home prices (the ratio of a local home price index to a national home price index) to the area's relative income (the ratio of average local income to average national income). The extent to which the current value of this ratio deviates from the historical average value of the ratio for this metropolitan area is used to measure if homes are overpriced or underpriced.

National City Corporation uses a multiple regression model relating the ratio of housing prices to household income in a metropolitan area to its historical prices, population density, mortgage rate, and the ratio of household income in this area to the national average. The amount by which actual market prices deviate from the prices predicted by the multiple regression model is interpreted as the extent to which homes are overpriced or underpriced.

One problem with regression models is that the equations are likely to be misspecified in that fundamental values are a highly nonlinear function of many variables. For example, Case and Shiller (2003) estimate the relationship between housing prices and per capita personal income between 1985 and 2002, but omit interest rates from their model. If interest rates are included in models, we need both the mortgage rate (which affects the cash flow) and the homebuyers' required return (which is used to discount the cash flow), and the relationship is very nonlinear.

Even more fundamentally, these models assume that past home prices were determined by fundamental factors (with a random error term), so that any systematic deviations of current prices from the values predicted by the model must be because current prices have wandered away from fundamental values. However, if current market prices are higher than the values predicted by multiple regression models using historical prices, it may be because past prices were consistently below fundamental values.

Indianapolis is a great example in that it has had relatively stable housing prices that are easy to "explain" with multiple regression models. In the National City Corporation model, Indianapolis home prices have varied between 11% underpriced and 17% overpriced for the period studied, 1985-2005. Because they "recommend treating valuation metrics between +/- 15 percent as 'fair value,'" they conclude that Indianapolis houses have almost always been fairly valued. In reality, the regression model tells us nothing at all about whether Indianapolis home prices are close to fundamental values. We will see later in this paper that Indianapolis housing prices are almost certainly far below fundamental values.

Some economists (e.g., Leamer 2002, Hatzius 2004) cite the fact that home prices have risen faster than rents as evidence of a bubble. Krainer and Wei (2004) report that there has been a 30% real increase in home prices over the past decade and only a 10% real increase in rents over this same period, suggesting that prices are departing from fundamentals.

Housing prices and rents are tied together by the fact that the fundamental value of a house depends on the anticipated rents, in the same way that the fundamental value of bonds and stocks depends on the present value of the cash flow from these assets. However, just as bond and stock prices are not a constant multiple of coupons and dividends, we should not expect the fundamental value of a house to be a constant multiple of rents. Among the many factors that affect the price-rent ratio are interest rates, risk premiums, growth rates, and tax laws (including property, income, and capital gains taxes). Thus, just as with price-earnings ratios in the stock market, price-rent ratios in the housing market can rise without signaling a bubble if, for example, interest rates fall or there is an increase in the anticipated rate of growth of rents.

In addition, the dwellings included in price indexes do not match the dwellings in rent indexes, giving us a comparison of apples to oranges (McCarthy and Peach 2004). The ratio of a house price index to a rent index can rise because the prices of houses in desirable neighborhoods increased more than did the rents of apartment buildings in less desirable neighborhoods. Or perhaps the quality of the average house in the price index has increased relative to the quality of the average property in the rent index. And, in any case, to gauge fundamental value, we need actual rent and price data, not indexes with arbitrary scales.

Similarly, Leamer (2002) compares median home prices to the Bureau of Labor Statistics (BLS) owner's equivalent rent index, and Himmelberg, Mayer, and Sinai (2005) compare rents for representative 2-bedroom apartments to the repeat-sales index compiled by Office of Federal Housing Enterprise Oversight (OFHEO). Even if the properties were comparable, they cannot gauge whether prices are high or low relative to rents because each study compares dollars to indexes.

Buying Versus Renting

Thus we are inevitably drawn back to the need to use actual rent data to estimate a house's fundamental value, which can then be compared with actual market prices. Because shelter can be obtained either by renting or buying, the implicit cash flow from an owner-occupied house is the rent that would otherwise be paid to live in the house.

Buying and renting have sometimes been analyzed as demands for different commodities. Rosen (1979) wrote that, "In many cases it is difficult (say) to rent a single unit with a large backyard. Similarly, it may be impractical for a homeowner to contract for the kind of maintenance services available to a renter." A decade later, Goodman (1988) observed that, "Until recently, it was easier to purchase small (large) amounts of housing by renting (owning). As a result, households with tastes for small (large) units would rent (buy)."

Today, it is still true that rental and sale properties differ, on average, in location and attributes. But, on the margin, close substitutes are generally available. It is possible to buy small condominiums and to rent houses with large yards. It is possible to buy or rent small or large houses. Many households have the option of buying houses in communities that provide services very similar to those received by most renters.

We consequently view buying and renting as often being viable alternatives. If a household has the opportunity to buy or rent very similar properties (perhaps even the same property), then the relevant question is whether to pay for these housing services by buying the house or renting it. Admittedly, there are other considerations that make renting and owning a different experience. Renters may have different preferences (in paint colors and furnishings, for example) than do their landlords; renters cannot reap the full benefits of improvements they make to the property inside and out; and renters may have less privacy than owners. These are all arguments for why owning is better than renting and, to the extent they matter, our calculations underestimate the value of homeownership. Both renters and owners also confront uncertainty—renters about future rents and housing prices, too, if they plan to buy a house in the future; owners about future homeownership expenses and future housing prices if they plan to sell their house and either rent or buy a house in a different location with different prices. Both might also consider future transaction costs if they move. These arguments probably favor renting.

Fundamental Value

Rental savings are the central, but not the only, factor in determining the fundamental value of an owner-occupied house. We have to look at everything that affects the cash flow, including transaction costs, the down payment, insurance, maintenance, property taxes, mortgage payments, tax savings, and the proceeds if the house is sold at some point.

Once we have the projected cash flow, we can value houses the same way we value bonds, stocks, and other assets—by discounting the cash flow by the household's required rate of return. Specifically, we can calculate the net present value (NPV) of the entire cash flow, including the initial outlay:

$$NPV = X_0 + \frac{X_1}{(1+R)^1} + \frac{X_2}{(1+R)^2} + \frac{X_3}{(1+R)^3} + \ldots + \frac{X_n}{(1+R)^n} \qquad (1)$$

X_0 is a negative number equal to the downpayment and out-of-pocket closing costs; X_n is the net amount received when the house is sold and the mortgage balance (if any) is paid off. The intervening cash flows are the rent you would otherwise have to pay to live in this house minus the expenses associated with home ownership, plus the value of nonfinancial factors (such as a desire for privacy). The rent and other expenses can be estimated from observed data. The intangibles must be assigned values by the household.

The required return R depends on the rates of return available on other investments. The initial downpayment ties up funds that could otherwise be invested in bonds, stocks, and other assets; as the years pass, the net rental savings free up funds that can be invested elsewhere. The required return depends on current interest rates but, because there is considerable uncertainty about the net cash flow from a house, a homebuyer may use a required return similar to that applied to stocks and comparably risky investments.

A homebuyer can use the projected cash flow and a required rate of return to determine if a house's net present value (NPV) is positive or negative. If the NPV is positive, the house is indeed worth what it costs; if the NPV is negative, renting is more financially attractive. Equation 1 can also be used to determine a prospective buyer's reservation price that would make the NPV equal to zero. (Because mortgage payments and other components of the cash flow depend on the price of the house, the reservation price is not simply equal to the market price plus the NPV.) The reservation price can be interpreted as the fundamental value of the house, and the difference between the market price P and the reservation price P* measures whether the house is overpriced or underpriced, what we will call the *premium*:

$$\text{premium} = 100 \frac{P - P^*}{P^*}$$

We can also calculate the internal rate of return (IRR) that makes the NPV equal to zero. The cash flow from residential real estate is generally negative initially and positive in later years, with just one sign change, so that the NPV is a monotonically decreasing function of the required return. If so, the IRR identifies the breakeven required return for which the investor is indifferent about the investment, and the NPV is positive for any required return less than the IRR.

Some Simple Intuition

Consider a house that is purchased for cash and never sold. The present value of the future net cash flow X_t is

$$V = \sum_{t=1} \frac{X_t}{(1+R)^t} \tag{2}$$

Now suppose that the house is sold at a future date for a price equal to the present value of the cash flow beyond that date

$$V = \sum_{t=1}^{n} \frac{X_t}{\left(1+R\right)^t} + \frac{P_n}{\left(1+R\right)^n} \tag{3}$$

where

$$P_n = \sum_{t=1} \frac{X_{n+t}}{\left(1+R\right)^t} \tag{4}$$

The substitution of Equation (4) into (3) gives Equation (2), so that this present value equation holds if the house is held forever or is sold at some future date for a price equal to the present value of the cash flow.

If the net cash flow is growing at a constant rate g, then Equation (2) simplifies to the standard dividend-discount model for stocks with constantly growing dividends:

$$\begin{aligned} V &= \sum_{t=1} \frac{X_1(1+g)^{t-1}}{\left(1+R\right)^t} \\ &= \frac{X_1}{R-g} \end{aligned} \tag{5}$$

It is worth noting that seemingly small changes in R or g can have a substantial effect on the value of a house. Suppose that the net monthly cash flow is \$1,000 (\$12,000 annually), the required annual after-tax rate of return is 9%, and the annual growth rate of the cash flow is 3%. Working with annual cash flows, the house's value is

$$\begin{aligned} V &= \frac{X_1}{R-g} \\ &= \frac{\$12,000}{0.09-0.03} \\ &= \$200,000 \end{aligned}$$

If the required return falls to 6% the value of the house doubles:

$$
\begin{aligned}
V &= \frac{X_1}{R - g} \\
&= \frac{\$12,000}{0.06 - 0.03} \\
&= \$400,000
\end{aligned}
$$

Richard Peach (2005) has argued that the recent run-up in home prices is, in fact, a one-time adjustment of prices to lower interest rates.

If the homebuyer is able to buy the home for a price P_0 that is equal to the present value of the cash flow, then the return is equal to the current cash flow yield plus the cash flow's growth rate:

$$
\begin{aligned}
R &= \frac{X_1}{P_0} + \frac{P_1 - P_0}{P_0} \\
&= \frac{X_1}{P_0} + g
\end{aligned}
\qquad (6)
$$

Equation 6 has a very natural interpretation. The lefthand side is the homebuyer's required rate of return. The righthand side is the anticipated actual return—the current yield X_1/P_0 plus the anticipated rate of increase in the value of the house. If the buyer's expectations are realized, then the buyer will earn the required rate of return. In this simple case, we could use data on the current yield plus the projected rate of growth of the cash flow to estimate the buyer's anticipated rate of return.

In practice, matters are complicated by the fact that most buyers have mortgages that create leverage. Using an interest-only mortgage for simplicity, with a downpayment $\square P_0$ and after-tax mortgage rate R_m, the leveraged return is

$$
\begin{aligned}
R_L &= \frac{X_1 - R_m(1 - \square)P_0}{\square P_0} + \frac{P_1 - P_0}{\square P_0} \\
&= R_m + \frac{1}{\square}\left[\frac{X_1}{P_0} + \frac{P_1 - P_0}{P_0} - R_m\right]
\end{aligned}
\qquad (8)
$$

The leveraged return is larger than the mortgage rate if and only if the unlevered return is larger than the mortgage rate, with the leverage factor 1/□ multiplying the difference between the unlevered return and the mortgage rate.

These simple models illustrate the general principles that the anticipated unlevered after-tax return is the cash flow yield plus the cash flow's anticipated growth rate; and that the anticipated levered after-tax return is higher or lower than the mortgage rate depending on whether the unlevered return is higher or lower than the after-tax mortgage rate. In practice, the calculations are more complicated because: (a) there are substantial transaction costs; (b) the various elements of the cash flow do not necessarily grow at the same rate; and (c) the amount of leverage changes over time as the value of the house grows and, with conventional amortized loans, the loan balance declines. We consequently need detailed cash flow projections in order to determine the NPV, IRR, and premium.

Data

To illustrate this approach, we gathered data for matched pairs of single-family homes that were purchased or rented in the summer of 2005 in the ten metropolitan areas shown in Table 1. These cities were chosen to include a variety of geographic areas in the United States and also to include various degrees of alleged housing market frothiness.

Los Angeles County has more than 10 million residents living in more than 200 cities and unincorporated areas. San Bernardino County has nearly 2 million residents living in an expanse of deserts and mountains stretching from the eastern edge of Los Angeles County to the Nevada border. Orange County is south of Los Angeles County and although it is geographically small by southern California standards, it is the fifth most populous county in the United States, Because these three counties are each so geographically varied and heavily populated, we limited our study to several cities within each county that contain packets of relatively homogeneous homes: Los Angeles (Azusa, Bellflower, Claremont, Diamond Bar, Glendora, Hacienda Heights, La Puente, La Verne, Pacoima, Phillips Ranch, Pomona, Rosemead, San Dimas, Walnut, and West Covina); San Bernardino (Alta Loma, Chino Hills, Fontana, Montclair, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, and Upland); and Orange County (Buena Park, Fullerton, Huntington Beach, Irvine, La Habra, Laguna Beach, Laguna Hills, Lake Forest, Mission Viejo, Newport Beach, Orange, Rancho San Margarita, Santa Ana, Tustin, and Yorba Linda).

We looked at every city in San Mateo County, which is located just south of San Francisco; in the Dallas area, we only looked at the city of Dallas. For the other five metropolitan areas, we looked at the major cities plus surrounding suburbs.

The areas included in our study, in other studies, and in various government indexes do not match perfectly. For example, the BLS owner's equivalent rent indexes lump together Los Angeles, Riverside, and Orange County while the Office of Federal Housing Enterprise Oversight (OFHEO) housing price indexes put Riverside, San Bernardino, and Ontario together, even though Riverside is in Riverside County and San Bernardino and Ontario are in San Bernardino County. Similarly, the National City Corporation gives separate valuation numbers for Los Angeles, Riverside, and Santa Ana (a large city in Orange County), while the Local Market Monitor gives a valuation for Los Angeles-Anaheim (Anaheim being another large city in Orange County) and for Riverside-San Bernardino.

Table 2 shows the annual percentage increases in OFHEO housing prices and BLS owner-equivalent rents during the 20 years 1985-2005 and the more recent 10 years 1995-2005. For comparison, the annual percentage increase in the CPI was 3.02% for 1985-2005 and 2.49% for 1995-2005. Housing prices in the four California areas and Boston increased much faster than rents or the CPI, particularly during the period 1995-2005. Figure 1 shows time series data for housing prices back to 1976 for Los Angeles, Chicago, and Dallas. Clearly, part of the reason for the relatively rapid increase in Los Angeles area prices between 1995 and 2005 is that 1995 was near a trough.

In compiling our data, the matched rental and sale properties could differ by no more than 100 square feet in size, no more than 1 bedroom, and no more than half a bath. When the information was available, we also compared the houses' ages, style (for example, ranch), and identified amenities (such as a pool and the size of the garage). Because the three most important factors in real estate are location, location, location, Yahoo maps was used to estimate the driving distance between properties (no more than 1 mile) and to identify golf courses, parks, lakes, major highways, and other physical objects that might add to or detract from a house's value. It was evident from these maps that driving distance often exaggerates the physical distance between houses; for example, two houses might have adjoining back yards but have a driving distance of 0.1 or even 0.2 miles. One problem we encountered is that square footage is traditionally not reported in the Atlanta area; so we restricted our Atlanta matches to houses that have exactly the same number of bedrooms and bathrooms and that are no more than 0.2 miles driving distance from each other.

When there were multiple matches (for example, two sales to one similar rental), and we used the best overall match in terms of square footage, distance, and so on. Occasionally, there was a perfect match in that a house that had been rented was sold, or a house was sold and then rented. Sometimes, we found essentially adjacent tract houses that had been built within a year of each other and had exactly the same number of bedrooms and bathrooms and square feet. Unless there was a perfect match, the sale and rental properties surely differ in unknown ways (carpet versus wood floors, fireplace or no fireplace, paint colors), but we can hope that these differences average out over our sample so that single-family homes that were rented in the summer of 2005 were not systematically better or worse than the matched single-family homes that were sold during the same time period. If the rental properties are, on average, inferior to the sale properties, then our calculations underestimate the returns to purchasing a house. Table 3 shows the mean physical characteristics of the data in our sample; Table 4 shows the average distance between our matched pairs, and the means of the absolute value of the differences between the matched pairs in the number of bedrooms and the number of bathrooms.

Our data were gathered in the fall of 2005 with the objective of gauging the housing market as of July 15, 2005. We consequently tried to find sale and rental transactions that occurred near July 15, extending our search as far as May or September in order to obtain roughly 100 matches for each metropolitan area. The increases in each area's BLS rents and OFHEO housing prices during 2005 were used to adjust all rents and sale prices to July 15 values. All of the data reported here refer to these adjusted prices. Table 5 shows the average of the sale prices, monthly rents, and the ratio of the annual rent to the sale price for the matched properties. Also shown is the first-year cash flow (rent net of all estimated expenses), which will be explained shortly.

Analysis

The following national assumptions were used in estimating the cash flow: 20% downpayment, 30-year mortgage, 5.7% mortgage rate (the average 30-year mortgage rate in mid-July 2005), buyer's closing costs equal to 0.5% of the sale price, maintenance equal to 1% of the price, 28% federal income tax rate, 15% federal capital gains tax (on capital gains in excess of $500,000), 6% seller's transaction cost if the house is sold. State and metropolitan-area data were used for property taxes, state income taxes, and home insurance.

Most states have a fixed property tax rate that is applied to the amount by which the assessed value exceeds a homeowner's exemption. Massachusetts communities set property tax rates annually so that total tax revenue does not exceed the amount allowed by Proposition 2 1/2. We consequently used actual 2004 property taxes for the Massachusetts houses in our data base that have these tax data to estimate the property taxes for those houses with missing data; we then assumed that property taxes will increase by 2.5% annually. Analogous methods were used for Indiana and Illinois properties. California assessed values are initially based on the sale price and then assumed to increase by 2% annually, in accord with Proposition 13. For the other metropolitan areas, we assume that assessed values increase by 3% a year.

The baseline model assumes a 3% annual increase in housing rents and expenses (roughly the recent historical and predicted rate of CPI inflation) and a 6% required after-tax return. One of the authors presented some preliminary calculations at a meeting of 27 Certified Financial Planners (CFPs) and asked them what required after-tax return they would use if they adopted our house-valuation methodology; all answered either 5% or 6%. If we used 5% in place of our 6% assumption, this would increase the estimated fundamental values.

One way to gauge whether market prices can be justified without unrealistic expectations about future prices is, as with dividend-discount models of stock prices, assume that the investment is for keeps—that the buyer never sells and is therefore unconcerned about future prices. Few people literally plan to hold stocks or houses forever, but this assumption allows us to determine whether the cash flow alone is sufficient to justify the current market price. We will use this approach and we will also look at some finite horizons with modest assumptions about future prices.

Some of our reported results are for annual horizons of one to 30 years. When we need to save space by focusing on a single finite horizon, we show a 10-year horizon—a round number that is somewhat longer than U. S. Census survey data showing that the median homeowner has been living in their current residence for 8 years (Hansen 1998) and somewhat shorter than the 13-year expected total residence time for homeowners estimated by Anily, Hornik, and Israeli (1999).

The 8-year number is flawed because we don't know how much longer people will stay in their current residence. The 13-year number is based on a convenient model with simplifying assumptions. Any specific homeowner using our model should look at horizons that are consistent with their own particular circumstances.

Where's the Bubble?

Table 6 shows the median values of the NPVs, IRRs, and premiums (the percentage by which the market price exceeded the reservation price) for each of the ten metropolitan areas. The infinite horizon makes no assumptions about future prices, the 10-year horizon assumes that housing prices rise by 3% a year. Figure 2 shows box plots for each of the 10 metropolitan areas of each matched pair's premium with an infinite horizon.

For our baseline assumptions, only San Mateo seems bubbly, with a median IRR of 4.61% for an infinite horizon and 3.51% for a 10-year horizon. For a homebuyer with a 6% required return, the median San Mateo property is 54% overpriced with an infinite horizon and 42% overpriced with a 10-year horizon. Orange County seems to be fairly valued, while Los Angeles, San Bernardino, Boston, and Chicago are all somewhat underpriced. Home prices in Dallas, New Orleans, Atlanta, and Indianapolis appear to be substantially below fundamental values.

Table 5 shows that in Indianapolis, the average monthly rent is about half what it is in Boston, but market prices are one-fourth Boston levels, and the average initial monthly cash flow is positive in Indianapolis but negative in Boston. The average value of the ratio of the initial annual cash flow to the house's price is 3.32% in Indianapolis and, with a 20% downpayment, the ratio of the cash flow to the downpayment is 5 times the numbers shown in the last column of Table 5. With these favorable fundamentals, Table 6 shows that Indianapolis housing prices are only about a third of fundamental values.

New Orleans is a particularly interesting case, in that it vividly illustrates that we are not attempting to time the market or predict housing prices. When one estimates the fundamental value of a stock, the proper question is not whether the price will be higher tomorrow than it is today, but whether, given currently available information, the projected cash flow is sufficient to justify the market price in the sense that an investor would be happy to pay today's price in order to receive the anticipated cash flow. The same is true here. Our objective is to estimate, based on information available in the summer of 2005, whether the projected cash flow from the houses we looked at is sufficient to justify market prices. Accounting fraud, oil discoveries, hurricanes, and other unexpected events may well lead to substantial revisions in the fundamental values of stocks and houses.

Orange County is also interesting in that Figure 2 shows that there appear to be almost as many houses that sold at a discount from fundamental value as sold at a premium. While it may be hard to find a bargain in San Mateo and easy to find one in Indianapolis, homebuyers in Orange County can find plenty of houses that are priced above and below fundamental values. Of course, in every city, there are different degrees of underpricing and overpricing, and we advise prospective home buyers to make their own estimates of the rental savings and other components of the cash flow and to apply their own personal required return in order to estimate the fundamental value of the houses they are considering purchasing.

Table 7 compares our assessment of housing prices in these 10 metropolitan areas with those of National City Corporation and Local Market Monitor. By our reckoning, San Mateo's bubble ranking should be higher and San Bernardino's much lower. Among the bottom four cities, it is Indianapolis, not Dallas, that is the biggest bargain. More generally, while National City Corporation and Local Market Monitor consider most of these 10 metropolitan areas to be overpriced, based largely on the recent increases in home prices, our comparison of 2005 prices with fundamental values indicates that most are fairly priced or underpriced.

Predicting Future Prices

Our objective here is not to predict future movements in housing prices, but rather to gauge whether plausible projections of the cash flow are sufficient to justify current prices. This is most obvious in the forever calculations, which assume that the homeowner buys for keeps. For the finite-horizon calculations, we assume modest rates of price appreciation that are consistent with predicted rates of inflation and historical increases in house prices.

We might temper these price projections by a comparison of fundamental values with current market prices. If we believe that market prices will equal fundamental values at some point in the future, then we might be more optimistic about the future rate of increase of housing prices in Indianapolis than in San Mateo. Similarly, if one is willing to assume that market prices will converge to fundamental values by the time the homeowner is ready to sell, then one could (and should) project fundamental values at that future date. For instance we could predict rents, mortgage rates, and the model's other parameters 10 years from now; use these parameter values to predict fundamental values 10 years from now; and then predict market prices 10 years from now by assuming that they will equal fundamental values at that time.

We have not done this because of our deep skepticism about whether the residential real estate market has any effective mechanisms for anchoring market prices to fundamental values. We will see evidence later that residential real estate prices can remain far from fundamental values for a substantial period of time.

Show Me the Cash

Our earlier discussion of the intuition underlying valuation calculations pointed out the importance of the initial cash flow relative to the purchase price and the growth rate of the cash flow. Figure 3 confirms this intuition with a scatter diagram of the forever IRR versus the first-year cash flow as a percentage of the purchase price for all 1,044 of our matched pairs. Different assumptions about the various parameters will of course shift this relationship about. For example, the curve would be shifted upward by a more rapid increase in rents and downward by a slower rate of increase.

Figure 4 shows a scatter diagram for all 1,044 matched pairs of the premium versus the first-year cash flow as a percentage of the purchase price. A cash flow that is initially negative does not necessarily make the house financially unattractive, since the rental savings are likely to grow over time while the mortgage payments are constant and then stop. But, ceteris paribus, a substantial positive cash flow makes it more likely that the IRR will be large and the reservation price will be above the market price (making the premium negative).

Stricter Matching Criteria

Table 8 shows the median values of the premium in each metropolitan area for more stringent matching criteria. The same-house data are the smallest samples, but the purest matches in that these houses could literally have been purchased or rented in the summer of 2005. The only weakness in these data is if there were any special circumstances, such as a below-market rent for someone who agreed to repaint the house or perhaps the house was purchased and major renovations made before it was rented. The perfect-match data include the same-house data and also houses that are quantitatively identical (same number of bedrooms, bathrooms, and square footage) and virtually adjacent. The close-match data expand the sample to include houses with up to 50-foot difference in square footage that are less than 0.50 miles from each other.

The results are generally consistent across matching criteria, with a tendency (except for the very small Boston and New Orleans samples) for the stricter criteria to reduce the premium. In Indianapolis, for example, with an infinite horizon, the median house in the full sample of 103 matched pairs sold for 65% below its reservation price, while the median house among the 23 houses that were both sold and rented had a market price 75% below its reservation price.

Sensitivity Analysis

We can gauge the robustness of our results by varying our key assumptions. Table 9 shows the median values of the premium for different growth rates of rents and prices. Annual rent growth rates of 2%, 3%, and 4% are roughly the historical range shown in Table 2 across these 10 metropolitan areas. For each of these rent growth rates, we report results for an infinite horizon with no assumptions about future housing prices and for 10-year horizons with annual price increases of 0%, 3%, and 6%.

As expected, the faster the growth of rent, the more financially attractive are houses in all of these areas. Boston, Chicago, and the four California areas all experienced annual rent increases of approximately 4% over the 20-year period 1985-2005. The last column shows that if this were to continue indefinitely, house prices in the summer of 2005 would be fully justified in all of these areas, even San Mateo. For 10-year horizons with 4% annual rent growth, housing prices would have to increase by more than 3% a year to justify San Mateo prices. At the other end of the spectrum, housing prices in Dallas, Indianapolis, Atlanta, and New Orleans were financially justified even with 2% rent growth and 0% price growth. Even if Indianapolis rents and prices were not to grow at all, the IRR would be 15.58% with a 10-year horizon and 13.17% with an infinite horizon.

Although our objective is not to forecast housing prices, we can assess the extent to which changes in mortgage rates and required returns would affect reservation prices. Table 10 compares the hypothetical premiums for mortgage rates of 4.7%, 5.7% (the actual value), and 6.7%. Since required returns are on an after-tax basis, as the before-tax mortgage rate goes up or down by one percentage point, we change the after-tax required return by 0.7 percentage points (based on our 28% marginal federal income tax rate). San Mateo looks pricey even with 4.7% mortgage rate and 5.3% after-tax required return. Dallas, Indianapolis, Atlanta, and New Orleans look cheap even with 6.7% mortgage rate and 6.7% after-tax required return.

For another kind of sensitivity analysis, we can incorporate stochastic changes in rent and prices into the model and use Monte Carlo simulations to estimate probability distributions for the NPVs. We will illustrate this approach here with a matched-pair of southern California houses that are directly across the street from each other. Both are 2,200 square-foot, 4-bedroom, 3-bath 2-story houses built in 1981 on 5,600 square-foot lots. From the outside, the main difference appears to be that one is painted a lighter color than the other. One was leased for $2,116 a month; the other sold for $571,098. The NPVs using a 6% required return are $25,539 with a 10-year horizon and $57,989 with an infinite horizon.

Because our matched rent/price data are unique, there are no directly comparable historical data that can be used to estimate the means, variances, and covariances of rent and prices that we need for our simulations. Instead, we use Los Angeles-area BLS and OFHEO indexes to give ballpark estimates. Over the years 1983-2004, the annual growth rates of the Los Angeles-area rent and price indexes were 3.9% and 6.3% respectively. We will work with monthly cash flows, but assume that rent increases occur every 12-months. We simplify our Monte Carlo simulations by assuming that price increases also occur at 12-month intervals.

We use the following simple mean-reversion model to allow random variation in the growth of rent and prices around a long-run annual growth rate

$$y - y_{-1} = \lambda\left(\ln\left[1+g\right] - y_{-1}\right) + \varepsilon$$

where y is the natural log of the ratio of the current price (or rent) to the value a year earlier, g is the long-run growth rate, λ is the pull-back coefficient, and ε is a normally distributed error term. This model can also be written as

$$y = \lambda \ln\left[1+g\right] + (1-\lambda)y_{-1} + \varepsilon$$

Least squares regressions using annual data for the years 1983 – 2005 yielded these estimates:

Rent: $y = 0.003 + 0.823y(-1)$, $t = 6.66$, $SEE = 0.005$, $R^2 = 0.70$

Price: $y = 0.007 + 0.866y(-1)$, $t = 6.19$, $SEE = 0.023$, $R^2 = 0.67$

The implied pull-back factors are 0.177 for rents and 0.134 for prices; the implied long run annual growth rates are 1.59% for rents and 5.59% for prices. A least squares regression of the price residuals on the rent residuals gave a t-value of 1.21 and an $R^2 = 0.07$, indicating that they are essentially uncorrelated.

We should not assume that the future will replicate the past and, indeed, our objective here is to see if the purchase of a house can be justified financially even with conservative assumptions about future increases in rents and prices. Our illustrative calculations consequently assume 3% annual long-run growth rates and 0.2 pull-back factors for both rents and prices, an 0.005 standard deviation of the rent error term, an 0.020 standard deviation of the price error term, and zero correlation between the two error terms.

For n independent simulations, each with a probability p of the NPV falling within a prespecified interval, the simulation standard error for the Monte Carlo estimate of p is approximately

$$\sqrt{\frac{p(1-p)}{n}}$$

One million simulations were used with a maximum standard error equal to 0.0005.

The fixed-rate columns in Table 11 shows the median NPVs (using a 6% after-tax required rate of return), and the probability that the NPV will be less than -\$50,000 and less than -\$100,000. (An NPV of -\$50,000 reflects an after-tax IRR of approximately 1.8% over a 10-year horizon and 5.5% over an infinite horizon; an NPV of -\$100,000 reflects an after-tax IRR of approximately -5.2% over a 10-year horizon and 5.0% over an infinite horizon.) Figure 5 shows the complete estimated probability distribution (labeled *fixed-rate mortgage*) for the NPV with a

10-year horizon and an infinite horizon. With a 10-year horizon, there is an estimated 37.8% chance that the NPV will be negative (an IRR below 6%) and a 11.1% chance that the IRR will be negative. With an infinite horizon, there is an estimated 16.7% chance that the NPV will be negative and a 0.0% chance that the IRR will be negative.

These calculations assume that the homebuyer chooses a 30-year mortgage with a fixed mortgage rate. Many homebuyers instead choose variable-rate mortgages, perhaps because the initial interest rate is less than that on a longer-term fixed rate mortgage. There are, of course, a plethora of fixed-rate and variable-rate options. For example, interest-only mortgages maintain more leverage than do amortized mortgages—which is good if the unlevered return exceeds the after-tax mortgage rate but bad otherwise. We will focus on the cash-flow risk inherent in a variable-rate mortgage by assuming that the initial mortgage rate is 5.7%, the same as with our 30-year fixed-rate mortgage, and that the mortgage rate is adjusted every 12 months based on the average interest rate on 1-year Treasury securities during the most recent month, with a 2 percentage-point cap on the annual change in interest rates and a 10% maximum for the interest rate. Every time the mortgage rate is changed, the loan is amortized over the remaining years—30 years minus the years already elapsed.

For modeling monthly changes in the Treasury rate we use the discrete version of the well-known Cox, Ingersoll, and Ross (CIR) mean-reverting model: (1985):

$$R_t - R_{t-1} = a(b - R_{t-1}) + \sqrt{R_{t-1}}\,\sigma\varepsilon$$

where the long run equilibrium interest rate is b = 0.057, the pull-back factor is a = 0.20, the instantaneous standard deviation is σ = 0.02, and the stochastic term ε is normally distributed with mean 0 and standard deviation 1.

The Federal Reserve has monthly interest data on 1-year constant maturity Treasury securities back to April 1954. Since we assume that the adjustments in the mortgage rate are based on the monthly average interest rate at 12-month intervals, we use the changes in monthly average Treasury rates at 12-month intervals for guidance. During the years 1983-2004, the correlation between the annual percentage-point changes in the 1-year Treasury rate and Los Angeles-area housing prices was 0.11 ($p = .61$) and the correlation between annual percentage-point changes in the 1-year Treasury rate and Los Angeles-area rents was -0.16 ($p = 0.47$). We can also look at the historical correlations for more frequent data—quarterly for the price index and monthly for the rent index. The correlation between quarterly percentage-point changes in the 1-year Treasury rate and Los Angeles-area prices was 0.12 ($p = 0.20$) and the correlation between monthly percentage-point changes in the 1-year Treasury rate and Los Angeles-area rents was -0.01 ($p = 0.89$). Our Monte Carlo simulations consequently assume that percentage changes in 1-year Treasury rates are uncorrelated with rents and prices.

The variable-rate column in Table 11 shows the median NPVs over various horizons for 1 million simulations. With a 10-year horizon, there is an estimated 37.8% chance that the NPV will be negative (an IRR below 6%) and a 12.4% chance that the IRR will be negative. With an infinite horizon, there is an estimated 20.7% chance that the NPV will be negative and a 0.0% chance that the IRR will be negative.

Figure 5 shows the complete estimated probability distribution (labeled *variable-rate mortgag*e). Table 11 and Figure 5 show that: (a) the probability distribution for a variable-rate mortgage is somewhat more dispersed than for a fixed-rate mortgage, because of the increased cash flow risk; and (b) the probability distribution for a 10-year horizon is more dispersed than for an infinite horizon, because of uncertainty regarding the sale price.

Predicting Policy Effects

Our model can also be used to predict the effects of various policy actions on fundamental values. For example, Table 10 shows the predicted effects of changes in mortgage rates and required return, due perhaps to inflation or monetary policies.

This past November, the President's Advisory Panel on Federal Tax Reform (2005) noted that many countries, including Australia, Canada, and the United Kingdom, do not allow a home mortgage interest deduction in the calculation of taxable income. In order to make their recommendation somewhat more politically palatable, they instead recommended replacing the deductibility of mortgage interest from federal income taxes with a tax credit equal to 15% of the mortgage interest paid that year, subject to some maximum limit. Because the details of this proposal are unclear, we analyze the effects on fundamental values of two policies: (a) the complete elimination of the interest deduction; and (b) its replacement with a 15% tax credit without a cap.

Table 12 shows the implied median fundamental values by city for a 10-year horizon and an infinite horizon. Relative to the current deductibility of mortgage interest, the 15% credit would reduce our median estimates of fundamental value across cities by 11-17 percent for a 10-year horizon and by 4-6 percent for an infinite horizon, and the elimination of the tax benefit completely would reduce our median estimates of fundamental values by 20-30 percent for a 10-year horizon and by 9-13 percent for an infinite horizon.

Looked at the other way around and using a 10-year horizon, the current deductibility of mortgage interest increases our median estimates of fundamental values across cities by 12-20% relative to a 15% tax credit and by 26-43 percent relative to no tax benefits.

Survey Data

We also conducted a small mail survey to gauge how home purchases might be influenced by financial considerations. Surveys were mailed to 1,000 randomly selected households (100 in each metropolitan area) who had purchased houses in July, 2005. The key question was:

If you hadn't bought this house, but were renting it instead, how much would you be willing to pay for rent each month?

From our sale data, we already knew the sale price and the number of bedrooms, baths, and square footage of these houses. Our survey was intended to gauge preferences by putting a dollar figure on how much they value living on their house, what we will call “rental value.” Responses were received from 94 out of 1,000 households.

One potentially appealing feature of these data is that each response yields price and rent data for a single house. If the respondents’ rental estimates are reliable, then surveys might be a feasible way of gathering data for gauging the fundamental value of houses in different housing markets. To assess the reliability of the survey responses, we compared the implied fundamental values to those derived from the perfect matches we observed.

Table 13 shows the average number of bedrooms, bathrooms, and square footage of the observed and surveyed houses. The samples seem generally comparable with respect to these three characteristics, the exceptions being the very small samples for Boston, Chicago, and New Orleans. Table 14 shows several financial characteristics (we should not take the results for Boston, Chicago, and New Orleans too seriously). It is particularly striking that the sale prices were usually higher for the survey houses than for the observed houses, yet the estimated rental values were lower. These low rental values imply low fundamental values for the houses they bought, in that the median premium was typically higher with the survey data than with the observed data.

Indianapolis is a strong example of this in that the average sale price for the surveyed houses is nearly twice the average sale price for the observed houses, yet the average estimated rental value is 25% lower. Looking at the individual responses, it seems as if homebuyer rental values are quite different from rents. What are we to make of the household that purchased a 4 bedroom, 3-bath, 2,430-square foot house in Indianapolis for $259,000 and estimated the rental value to be

$650/month? For the Indianapolis houses in our sample with sale prices between $200,000 and $300,000, the average sale price was $236,000 and the average monthly rent was $1,740, with no house renting for less than $1,200 a month. Overall, 8 of the 9 survey responses are below a least squares line relating rent to price for our observed Indianapolis data.

We also asked those surveyed to estimate the "Predicted annual rate of increase of this house's price over the next 10 years." The median answer was 5%. For the 45 respondents in Boston and the four California areas, the median answer was 7%; for the 39 respondents in the other five markets, the median answer was 5% (Mann-Whitney-Wilcoxon two-sided $p = 0.003$.) These answers seem a bit optimistic, but certainly not delirious. (Case and Shiller (2003) asked a similar question in a survey of persons who bought homes between March and August 2002 and found the average answers to be 13.1% in Orange County, 15.7% in San Francisco, 14.6% in Boston, and 11.7% in Milwaukee; we do not know why our survey obtained much lower numbers.) It is also interesting that 10 of our 94 respondents did not answer this question, instead putting a question mark, writing "not sure," or simply leaving it blank.

To be sure, there were some aggressive answers: 16 of 84 (19 percent) gave numbers larger than 10%, ranging all the way up to 50% for one cheerful or confused San Mateo household. (Did they mean 50% over 10 years, or 50% a year for 10 years?) On the other hand, 26 (31%) gave answers below 5%. In Boston and the four California areas, 8 gave numbers below 5% and 13 gave numbers above 10%. Overall, these homebuyers do not seem as out of touch with reality as were the stock buyers surveyed during the dot-com bubble whose median expectation was 15% annual returns over the next 10 years.

Overall, the homebuyers who responded to our survey seem somewhat optimistic about future housing prices, but inclined to give rental values substantially below market rents. Perhaps this is why they bought instead of rented.

So, Why Have Housing Prices Increased?

If our conclusion—that houses in these metropolitan areas are not out of line with fundamentals—is correct, then how do we explain the recent run up in housing prices? There are two possible explanations: fundamentals have increased rapidly, too, or prices were substantially below fundamental values in the past and this discount has been shrinking as prices have been moving closer to fundamental values. We can't say how much of the increase in housing prices is due to the first factor and how much to the second without expanding our present study to include historical estimates of the valuation premium in each of these ten metropolitan areas.

That task is far beyond the scope of this paper. But our anecdotal evidence is that, at least in that part of Los Angeles County where we live, home prices three-to-five years ago were much farther below fundamental values than they are today. One of the authors of this paper is not only an economics professor, but is also a Certified Financial Planner (CFP) and has been advising prospective homebuyers for several years now. Up until very recently, it was very clear that it was more financially advantageous to buy a house than to rent one; the decision now is much less obvious than it was in the past.

For a modest test of this anecdotal evidence, we collected matched rental and sale data for Los Angeles County, where we live, for the years 2001 through 2004, to supplement our 2005 data. This is a particularly interesting period since the OFHEO index of housing prices for the Los Angeles metropolitan area doubled during these five years.

We followed exactly the same procedure used for our 2005 study. We were able to obtain between 84 and 121 matched pairs for each year and, as before, adjusted all rents and sale prices to July 15 of each year. After determining historical values for the model's parameters (mortgage rates, tax rates, homeowner's insurance, and so on), we calculated the after-tax IRRs and valuation premiums for each matched pair.

The median values for each year are shown in Table 15. Consistent with our anecdotal evidence, home prices were substantially below fundamental values three-to-five years ago. After 2003, the after-tax IRR dropped sharply and the discount of prices to fundamental values narrowed dramatically.

We do not have matched-pair data for earlier years, but perhaps we can assume that historical movements in matched-pair prices and rents are reasonably well approximated by the OFHEO house-price index and the BLS owner's equivalent rent index. In our 2001 matched-pair data, the average house price was $320,714 and the average value of the ratio of monthly rent to price was 0.00598, implying a monthly rent of 0.00598($320,714) = $1,920. We used the Los Angeles OFHEO house-price index and BLS rent index to extrapolate the $320,714 house price and $1920 forward to 2005 and backward to 1983 (the earliest year with both OFHEO and BLS data). This yielded an annual set of hypothetical matched rents and prices. For simplicity, we assumed a 3% anticipated growth in rents and prices throughout this period—surely a conservative estimate in the early 1980s! Historical values for mortgage rates, tax rates, and the model's other parameters were then used to estimate after-tax IRRs and valuation premiums for each year from 1983 through 2005.

Figure 6 shows these price and value estimates for a 10-year horizon. In 1983 and 1984, even with a 13% 30-year mortgage rate and assuming only a 3% increase in house rents and prices, prices were nearly 20% below fundamental values. In 1984, the 30-year mortgage rate rose to 14.7% and fundamental values dipped, reducing the valuation discount from 20% to 7%. Then mortgage rates started falling and fundamental values temporarily raced ahead of market prices. Between 1985 and 1990, market prices nearly doubled and the discount disappeared. Mortgage rates kept falling—from 10.0% in 1990 to 7.0 in 1998—but house prices declined, opening up a huge gap between fundamental values and market prices. After 1996, market prices began rising again but mortgage rates kept falling—from 8.2% in 2000 to 5.6% in 2003—and market prices were still well below fundamental values. Mortgage rates stabilized in 2004 and 2005 and rapidly rising market prices reduced the discount to less than 20%.

Figure 7 shows the estimated valuation premiums: the percentage by which market price was above or below fundamental value. The similar movements of the premium estimates based on the matched-pair data and the extrapolated data during the years 2001-2005 are reassuring. It is striking that the premium was negative (with price below fundamental value—often far below) for all but one of these 23 years. The calculations for an infinite horizon are very similar, with the premium 3% in 1990 and negative in all other years.

These calculations reveal a fundamental problem with regression models of housing prices that assume that market prices have historically fluctuated around fundamental values, being above fundamental values about as often as below. Such models assume that because current LA market prices are well above the values predicted by these regression models, they must also be well above fundamental values. If, in fact, the historical market prices used to estimate these models have consistently been well below fundamental values, then current market prices need not be above fundamental values.

So, why did housing prices in LA County double between 2001 and 2005? By our reckoning, fundamental values increased by about 40% during this period and the discount of prices from fundamental values, which had been nearly 40% in 2001, shrank to less than 20% in 2005.

Conclusion

Measures of housing bubbles generally compare movements in home price indexes to the consumer price index, household income, rent indexes, or the values predicted by multiple regression models of housing prices. None of these measures can gauge whether housing prices are above or below fundamental values—the projected net rental savings, discounted by a required rate of return. Homebuyers do not seem to be a reliable source of information about rental savings; instead, it seems safer to gather such data from market rents and prices of matched pairs of houses.

To gauge whether the projected cash flow from a house justifies the current price, with no assumptions about future prices, we look at an infinite horizon. In our data, the median after-tax IRRs with an infinite horizon ranged from 4.6% in San Mateo to 21.2% in Indianapolis. With a 10-year horizon, and assuming that prices increase by 3% a year, the after-tax IRRs range from 3.5% in San Mateo to 23.6% in Indianapolis. For a homebuyer with a 6% after-tax required return, our baseline assumptions imply that the median San Mateo house sold for 54% above fundamental value with an infinite horizon and 42% above fundamental value with a 10-year horizon and home prices rising by 3% a year. In contrast, the median Indianapolis house sold for 65% below fundamental value with an infinite horizon and 68% below fundamental value with a 10-year horizon.

Housing prices in all of these areas can be justified by plausible, if perhaps somewhat optimistic, assumptions about the future growth or rent and prices. Even in San Mateo, the bubbliest city, homebuyers with a 6% after-tax required return would be better off buying than renting if rents and prices increase by 4% a year for the next 10 years. In Atlanta, Dallas, New Orleans, and especially Indianapolis, houses were cheap in the summer of 2005. Even with 2% rent growth and no price growth for 10 years, the median Indianapolis homebuyer with a 6% after-tax required return bought a house for a price 37% below the house’s fundamental value. All of these calculations underestimate the fundamental value of houses to the extent that homebuyers value privacy and other nonfinancial factors that we did not consider in our calculations. In addition, homebuyers who only plan to live in a house for ten years can usually reduce their mortgage rate by taking out a 15-year mortgage, rather than a 30-year mortgage.

Housing prices have increased rapidly in many areas in recent years and some homebuyers have unrealistic expectations about future prices. The relevant question, however, is not how much prices have increased in the past or how fast people expect them to increase in the future, but whether, at current prices, a house is still a fundamentally sound investment. Our answer is generally yes, if the owner either buys for keeps (with no assumptions about future house prices) or makes conservative assumptions about future housing prices.

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Table 1 Percent Overpriced or Underpriced, Summer 2005

	National City Corp	Local Market Monitor
San Bernardino County	65	56
Los Angeles County	54	61
Orange County	44	61
San Mateo County	35	35
Boston	18	29
Chicago	21	9
New Orleans	12	-9
Atlanta	2	-4
Indianapolis	-5	-19
Dallas	-16	-14

sources:

National City Corporation: Richard DeKaser, House Prices in America, December 2005, Global Insight/National City Corporation

Local Market Monitor; Ingo Winzer, Home Value Ratings, Retrieved December 21, 2005, from http://www.localmarketmonitor.com/

Table 2 Annual Percentage Price and Rent Increases, 1985-2005 and 1995-2005

	1985-2005			1995-2005		
	Price	Rent	Price/Rent	Price	Rent	Price/Rent
San Bernardino County	6.65	3.81	3.51	10.43	2.73	6.47
Los Angeles County	7.45	3.81	3.51	10.42	3.72	6.45
Orange County	7.53	3.81	3.51	11.04	3.58	7.05
San Mateo County	8.25	4.02	4.06	10.39	4.12	6.03
Boston	6.58	4.14	2.34	10.02	4.49	5.30
Chicago	6.11	3.97	2.06	6.11	3.26	2.76
New Orleans	3.47	NA	NA	5.51	NA	NA
Atlanta	4.21	2.44	1.73	5.34	2.31	2.96
Indianapolis	4.03	NA	NA	3.60	NA	NA
Dallas	1.88	2.48	-0.58	4.20	2.92	1.24

source: Office of Federal Housing Enterprise Oversight (OFHEO) house price indexes and Bureau of Labor Statistics (BLS) owner-equivalent rent indexes. The index values are for July of the respective years.

Table 3 Mean Physical Characteristics of Sold and Rented Houses

	Sold Houses			Rented Houses		
	Bedrooms	Baths	Square Feet	Bedrooms	Baths	Square Feet
San Mateo County	3.18	2.19	1,858	3.14	2.23	1,866
Orange County	3.56	2.48	2,006	3.53	2.51	1,994
Los Angeles County	3.46	2.12	1,754	3.45	2.08	1,753
Boston	3.34	1.99	1,803	3.18	1.87	1,801
Chicago	3.22	2.12	1,951	2.92	2.04	1,934
San Bernardino County	3.50	2.36	1,830	3.49	2.38	1,827
Dallas	2.83	1.68	1,484	2.87	1.72	1,470
New Orleans	3.02	1.88	1,681	3.01	1.86	1,683
Atlanta	3.42	2.32	NA	3.42	2.32	NA
Indianapolis	3.26	2.41	1,758	3.28	2.42	1,756

Table 4 Mean Absolute Values of Differences in Physical Characteristics of Sold and Rented Houses

	Observations	Bedrooms	Baths	Square Feet	Distance
San Mateo County	90	0.21	0.17	42.0	0.40
Orange County	116	0.16	0.08	32.8	0.31
Los Angeles County	103	0.20	0.08	34.2	0.41
Boston	85	0.42	0.28	61.6	0.61
Chicago	85	0.49	0.50	64.6	0.75
San Bernardino County	133	0.12	0.07	12.7	0.33
Dallas	121	0.17	0.13	40.0	0.38
New Orleans	125	0.16	0.10	45.7	0.42
Atlanta	83	0.00	0.00	NA	0.04
Indianapolis	103	0.12	0.03	29.3	0.20

Table 5 Mean Initial Financial Characteristics of Sold and Rented Houses, July 2005

	Sale Price ($)	Monthly Rent ($)	Annual Rent/Price (%)	Monthly Cash Flow ($)	Annual Cash Flow/Price(%)
San Mateo	1,200,020	2,987	3.05	-2,698	-2.64
Orange County	801,210	2,670	4.09	-1,266	-1.81
Los Angeles	572,408	2,128	4.55	-632	-1.24
Boston	570,342	2,216	4.89	-634	-1.13
Chicago	467,422	2,135	6.09	-248	-0.11
San Bernardino	463,795	1,899	5.01	-343	-0.79
Dallas	166,940	1,157	9.30	92	1.43
New Orleans	204,814	1,207	7.57	141	1.31
Atlanta	170,146	1,280	9.46	367	3.03
Indianapolis	145,924	1,172	10.39	347	3.32

note: The monthly rent and monthly cash flow are for the first year. Annual rent/Price is the first year's rent as a percentage of the purchase price. Annual Cash Flow/Price is the first year's net cash flow as a percentage of the purchase price.

Table 6 Mean Sale Price P; Median NPV, IRR, and Premium

Infinite Horizon

	P ($)	NPV ($)	IRR (%)	Premium (%)
San Mateo	1,200,020	-328,298	4.61	54
Orange County	801,210	-14,787	5.90	2
Los Angeles	572,408	62,299	6.62	-11
Boston	570,342	62,269	6.66	-12
Chicago	467,422	86,498	7.18	-17
San Bernardino	463,795	106,323	7.33	-20
Dallas	166,940	127,660	13.04	-40
New Orleans	204,814	165,917	13.01	-46
Atlanta	170,146	215,929	18.42	-53
Indianapolis	145,924	223,216	21.21	-65

10-Year Horizon

	P ($)	NPV ($)	IRR (%)	Premium (%)
San Mateo	1,200,020	-65,915	3.51	42
Orange County	801,210	6,440	6.37	-4
Los Angeles	572,408	28,089	7.86	-17
Boston	570,342	25,617	7.66	-15
Chicago	467,422	30,907	8.76	-23
San Bernardino	463,795	35,632	9.10	-26
Dallas	166,940	35,516	16.23	-43
New Orleans	204,814	45,693	16.18	-49
Atlanta	170,146	61,441	21.46	-56
Indianapolis	145,924	56,400	23.56	-68

Table 7 Percent Overpriced or Underpriced, Summer 2005

			Smith & Smith	
	National City Corp	Local Market Monitor	forever	10-year
San Mateo County	35	35	54	42
Orange County	44	61	2	-4
Los Angeles County	54	61	-11	-17
Boston	18	29	-12	-15
Chicago	21	9	-17	-23
San Bernardino County	65	56	-20	-26
Dallas	-16	-14	-40	-43
New Orleans	12	-9	-46	-49
Atlanta	2	-4	-53	-56
Indianapolis	-5	-19	-65	-68

Table 8 Median Premium for different matching criteria

Forever

	same house		perfect match		close match		all matches	
	Obs.	Premium	Obs.	Premium	Obs.	Premium	Obs.	Premium
San Mateo	4	40	7	38	27	54	90	54
Orange County	10	-3	16	-3	46	0	116	2
Los Angeles	10	-22	12	-21	37	-23	103	-11
Boston	3	-6	5	-28	9	-24	85	-12
Chicago	1	-58	1	-58	4	-59	85	-17
San Bernardino	27	-26	33	-21	67	-20	133	-20
Dallas	7	-53	7	-53	42	-41	121	-40
New Orleans	1	-19	2	-35	33	-47	125	-46
Atlanta	24	-53	57	-54	83	-53	83	-53
Indianapolis	15	-75	18	-73	62	-68	103	-65

10-Year Horizon

	same house		perfect match		close match		all matches	
	Obs.	Premium	Obs.	Premium	Obs.	Premium	Obs.	Premium
San Mateo	4	30	7	28	27	43	90	42
Orange County	10	-8	16	-8	46	-5	116	-4
Los Angeles	10	-28	12	-27	37	-19	103	-17
Boston	3	-10	5	-31	9	-27	85	-15
Chicago	1	-61	1	-61	4	-62	85	-23
San Bernardino	27	-31	33	-26	67	-26	133	-26
Dallas	7	-55	7	-55	42	-44	121	-43
New Orleans	1	-23	2	-38	33	-50	125	-49
Atlanta	24	-57	57	-57	83	-56	83	-56
Indianapolis	15	-76	18	-75	62	-70	103	-68

same house: houses that were both rented and sold in the summer of 2005

perfect match: houses that have the same number of bedrooms, bathrooms, and square footage, and are less than 0.05 miles from each other.

close match: the same number of bedrooms, the same number of bathrooms, a square-footage difference less than 50, and are less than 0.50 miles from each other.

Table 9 Median Premium for different growth rates of rents and prices

	rent growth = 2%				rent growth = 3%				rent growth = 4%			
price growth	0%	3%	6%	forever	0%	3%	6%	forever	0%	3%	6%	forever
San Mateo	169	50	-62	142	152	**42**	-63	**54**	137	33	-65	-10
Orange County	74	1	-70	50	65	**-4**	-71	**2**	56	-9	-72	-37
Los Angeles	52	-13	-77	29	44	**-17**	-78	**-11**	36	-22	-79	-44
Boston	54	-11	-77	29	45	**-15**	-78	**-12**	38	-20	-79	-45
Chicago	36	-18	-78	19	29	**-23**	-79	**-17**	23	-27	-80	-48
San Bernardino	36	-22	-80	15	29	**-26**	-81	**-20**	23	-24	-81	-50
Dallas	-13	-40	-76	-15	-17	**-43**	-77	**-40**	-21	-46	-78	-62
New Orleans	-13	-46	-84	-25	-17	**-49**	-85	**-46**	-21	-51	-85	-65
Atlanta	-29	-54	-84	-35	-32	**-56**	-85	**-53**	-35	-58	-85	-69
Indianapolis	-37	-66	-93	-52	-41	**-68**	-93	**-65**	-44	-69	-94	-77

Note: Price growth rates of 0%, 3%, and 6% are over 10-year horizons; “forever” is an infinite horizon with no assumptions regarding future housing prices. The results for the baseline case of 3% rent growth and 3% price growth are boldfaced.

Table 10 Median Premium for Different Mortgage Rates R_M and Required Returns R

	R_M = 4.7%, R = 5.3%		R_M = 5.7%, R = 6%		R_M = 6.7%, R = 6.7%	
horizon	10 years	forever	10 years	forever	10 years	forever
San Mateo	4	22	42	54	70	86
Orange County	-23	-18	-4	2	14	22
Los Angeles	-35	-30	-17	-11	0	6
Boston	-34	-31	-15	-12	3	6
Chicago	-39	-33	-23	-17	-3	-1
San Bernardino	-42	-37	-26	-20	-7	-4
Dallas	-52	-49	-43	-40	-33	-32
New Orleans	-60	-56	-49	-46	-37	-36
Atlanta	-64	-60	-56	-53	-47	-45
Indianapolis	-76	-73	-68	-65	-59	-58

note: Premium is the percentage by which the market price exceeds the reservation price. Forever is for an infinite horizon with no assumptions regarding price growth.

Table 11 IRRs and NPVs for Stochastic Simulations with Fixed and Variable Mortgage Rates

	Fixed Rate			Variable Rate		
Horizon (years)	median NPV ($)	P[NPV < -50,000]	P[NPV < -100,000]	median NPV ($)	P[NPV < -50,000]	P[NPV < -100,000]
1	-28,423	0.02	0.00	-28,423	0.02	0.00
2	-20,338	0.07	0.00	-20,544	0.08	0.00
3	-12,837	0.11	0.00	-13,094	0.12	0.00
4	-5,888	0.13	0.01	-6,033	0.15	0.01
5	532	0.15	0.01	656	0.17	0.02
10	25,740	0.16	0.04	27,556	0.18	0.06
15	41,926	0.15	0.04	45,219	0.17	0.06
20	51,670	0.13	0.03	54,217	0.15	0.05
25	53,407	0.11	0.02	56,062	0.13	0.04
30	50,174	0.10	0.01	54,199	0.12	0.04
forever	58,255	0.03	0.00	61,204	0.07	0.01

Table 12 Median Fundamental Values for Different Tax Treatment of Home Mortgage Interest

	Current Deductibility		15% Credit		No Tax Benefit	
horizon	10 years	forever	10 years	forever	10 years	forever
San Mateo	675,709	630,800	575,050	591,519	490,436	552,905
Orange County	627,472	582,711	534,138	546,831	456,263	510,503
Los Angeles	755,551	711,891	650,016	670,071	558,648	627,988
Boston	715,600	661,475	606,172	620,813	515,864	579,376
Chicago	591,930	565,315	506,110	530,983	434,074	496,402
San Bernardino	505,874	470,725	434,816	443,831	374,413	416,423
Dallas	260,088	248,019	232,696	237,355	207,017	225,944
New Orleans	402,451	372,609	336,039	349,052	280,465	325,223
Atlanta	349,732	325,730	307,673	309,731	269,918	293,245
Indianapolis	353,051	333,353	311,246	317,326	274,087	300,421

Table 13 Mean Physical Characteristics of Observed and Surveyed Houses

	Observed Houses				Survey Houses			
	Obs.	Bedrooms	Baths	Square Feet	Obs.	Bedrooms	Baths	Square Feet
San Mateo	4	3.00	2.00	1,775	12	3.33	2.12	1,802
Orange County	10	3.90	2.60	2,166	11	3.55	2.57	2,034
Los Angeles	10	3.50	2.17	1,790	7	3.71	2.25	1,858
Boston	3	3.33	2.67	2,352	8	3.25	1.94	1,756
Chicago	1	3.00	4.00	4,934	5	3.60	1.66	2,021
San Bernardino	27	3.59	2.37	1,824	10	3.70	2.45	1,934
Dallas	7	3.00	1.79	1,447	15	2.80	1.89	1,655
New Orleans	1	4.00	3.00	2,900	8	3.00	2.00	1,892
Atlanta	24	3.71	2.58	NA	9	3.22	2.06	NA
Indianapolis	15	3.07	2.13	1,659	9	3.33	2.33	1,924

Table 14 Financial Characteristics of Observed Perfect Matches and Surveyed Houses

	Observed Perfect Matches				Survey Houses			
	Obs.	Mean Sale Price	Mean Rent	Median Premium	Obs.	Mean Sale Price	Mean Rent	Median Premium
San Mateo	4	1,050,993	2,858	40	12	1,109,883	2,690	41
Orange County	10	806,584	2,845	-3	11	785,557	2,211	40
Los Angeles	10	544,225	2,194	-22	7	627,526	1,985	34
Boston	3	992,587	2,833	-6	8	514,881	1,838	-20
Chicago	1	525,861	3,892	-58	5	461,202	1,660	-1
San Bernardino	27	459,227	1,971	-26	10	473,783	1,746	2
Dallas	7	141,204	1,241	-53	15	246,970	1,020	-2
New Orleans	1	443,693	1,961	-19	8	221,686	1,119	-30
Atlanta	24	204,884	1,508	-53	9	291,081	1,333	-10
Indianapolis	15	97,744	1,034	-75	9	187,114	767	-37

note: Premium is the percentage by which the market price exceeds the reservation price for an infinite horizon with no assumptions regarding price growth.

Table 15 Median IRR and Premium for Matches in Los Angeles County

		After-Tax IRR (%)		Premium (%)	
	Obs.	10-year horizon	forever	10-year horizon	forever
2001	84	15.06	12.28	-40	-36
2002	97	14.18	11.29	-42	-37
2003	121	12.29	9.49	-42	-37
2004	89	8.59	7.17	-19	-14
2005	103	7.86	6.62	-17	-11

note: Premium is the percentage by which the market price exceeds the reservation price. Forever is for an infinite horizon with no assumptions regarding price growth.

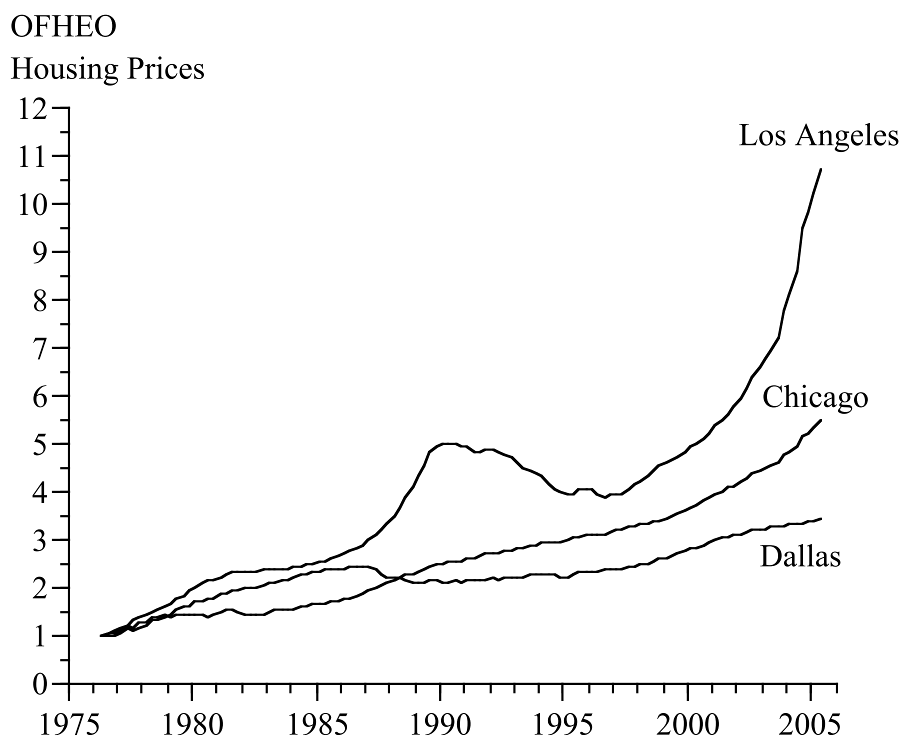


Figure 1 Housing Prices, 1976-2005

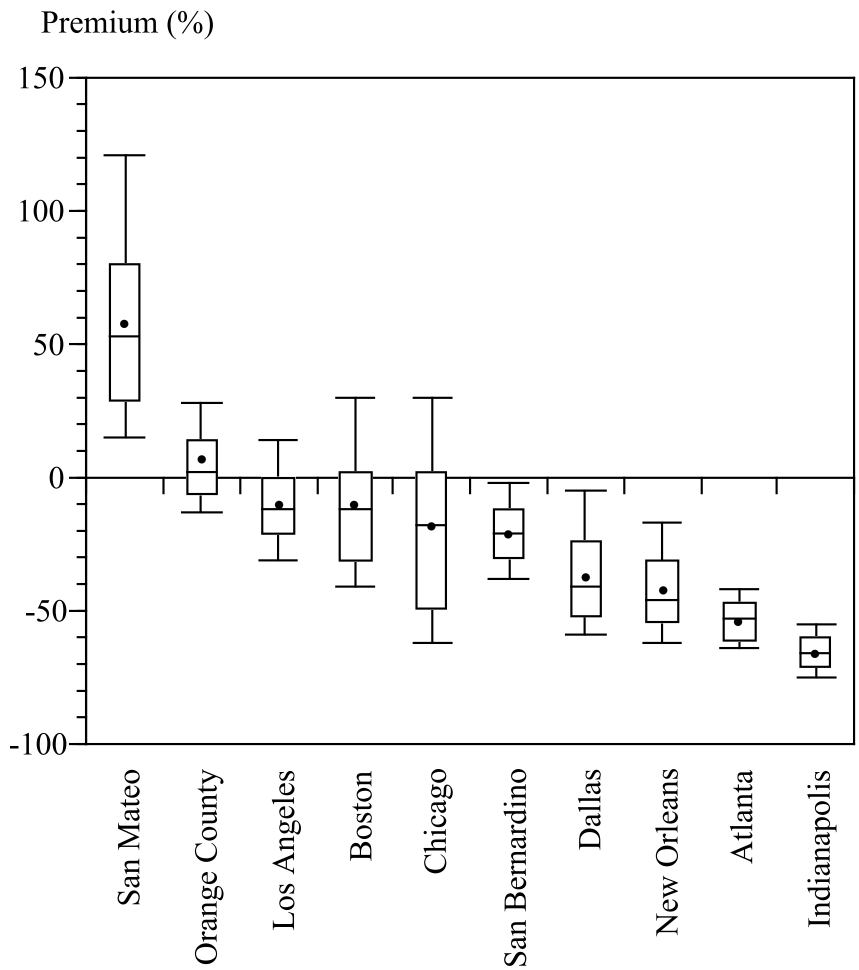


Figure 2 Premium for Full Sample by Metropolitan Area, infinite horizon

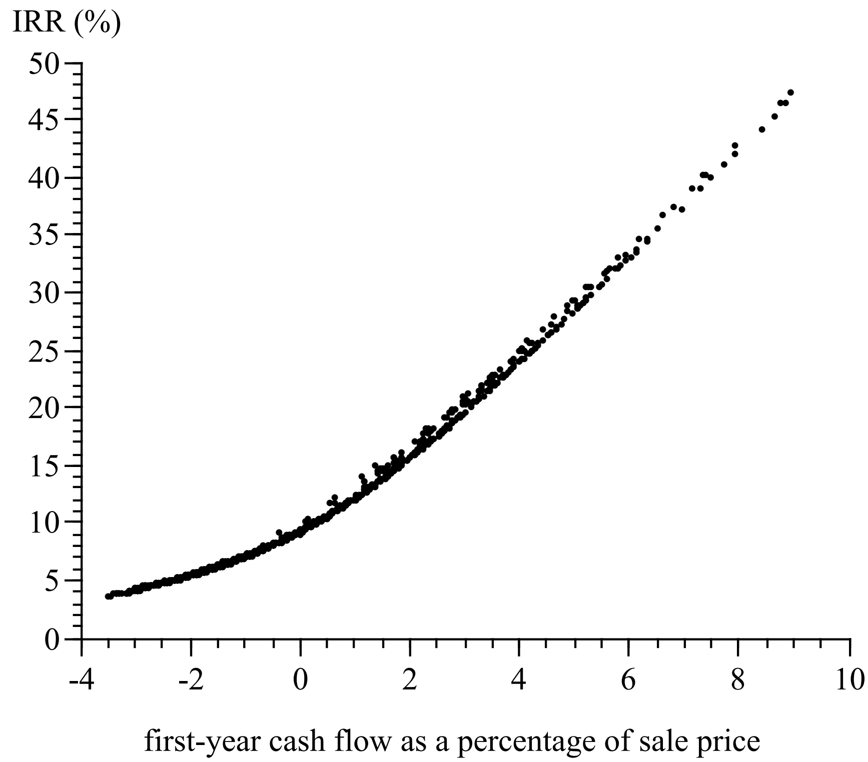


Figure 3 IRR with an Infinite Horizon Versus the First-Year Cash Flow, all homes

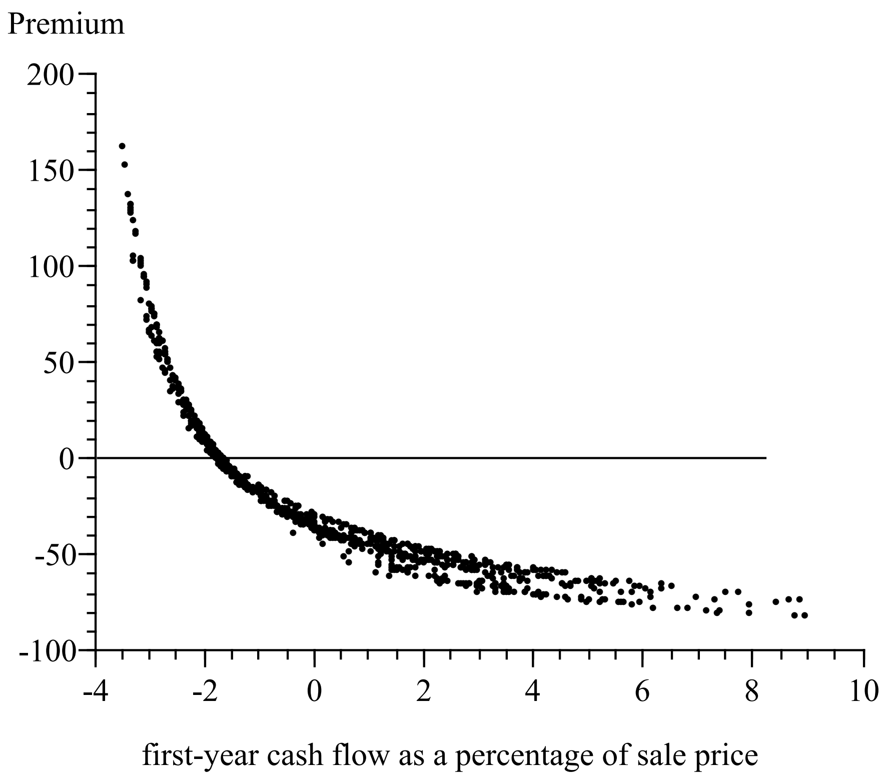
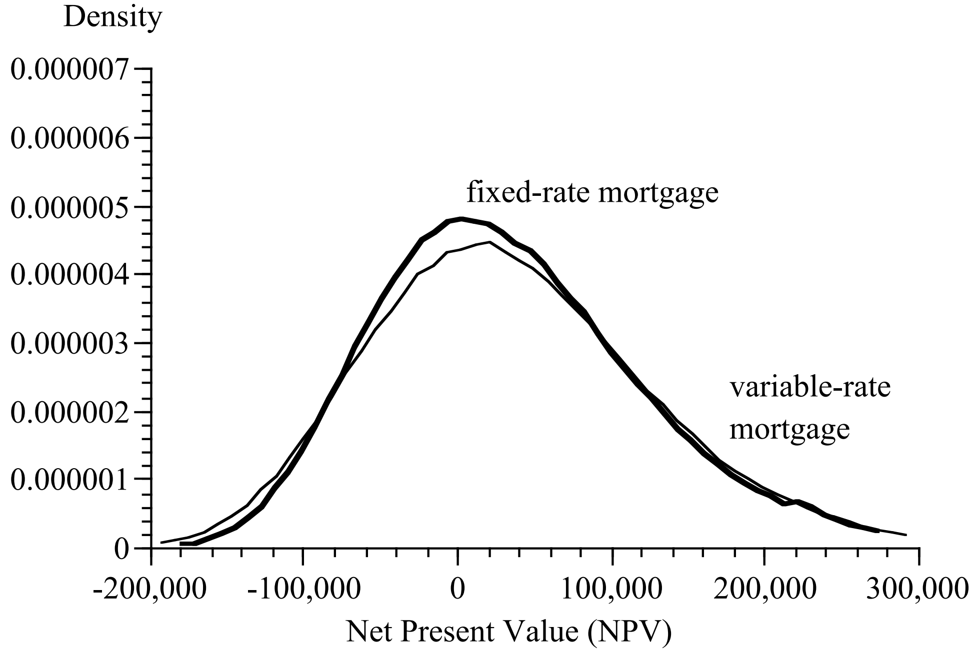


Figure 4 Premium Versus the First-Year Cash Flow, all homes

note: Premium is the percentage by which the market price exceeds the reservation price for an infinite horizon with no assumptions regarding price growth

10-Year Horizon



Forever

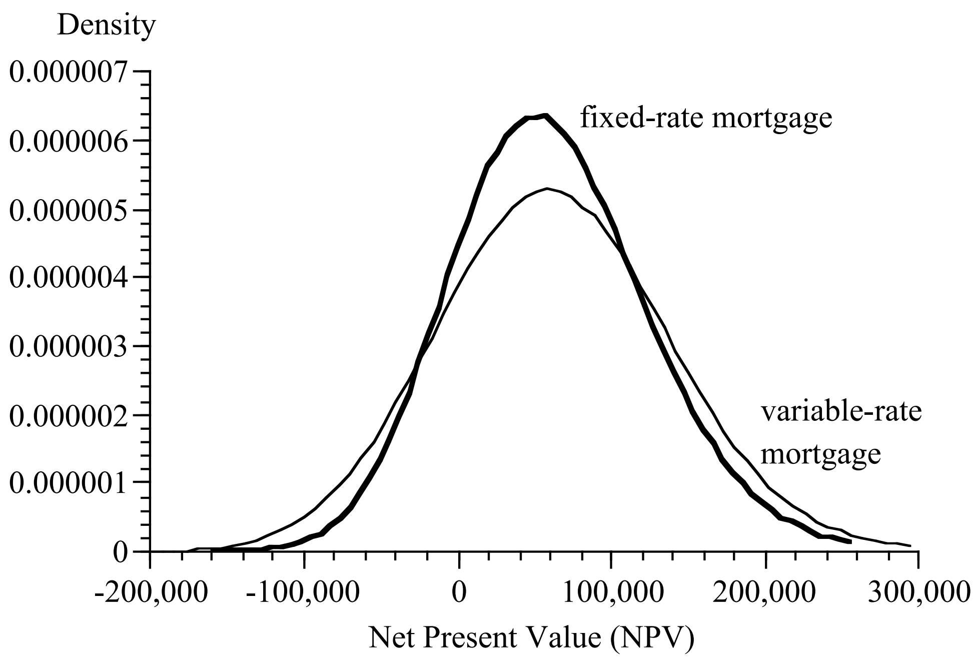


Figure 5 Estimated Probability Distribution of Net Present Value
with Fixed-Rate or Variable-Rate Mortgage

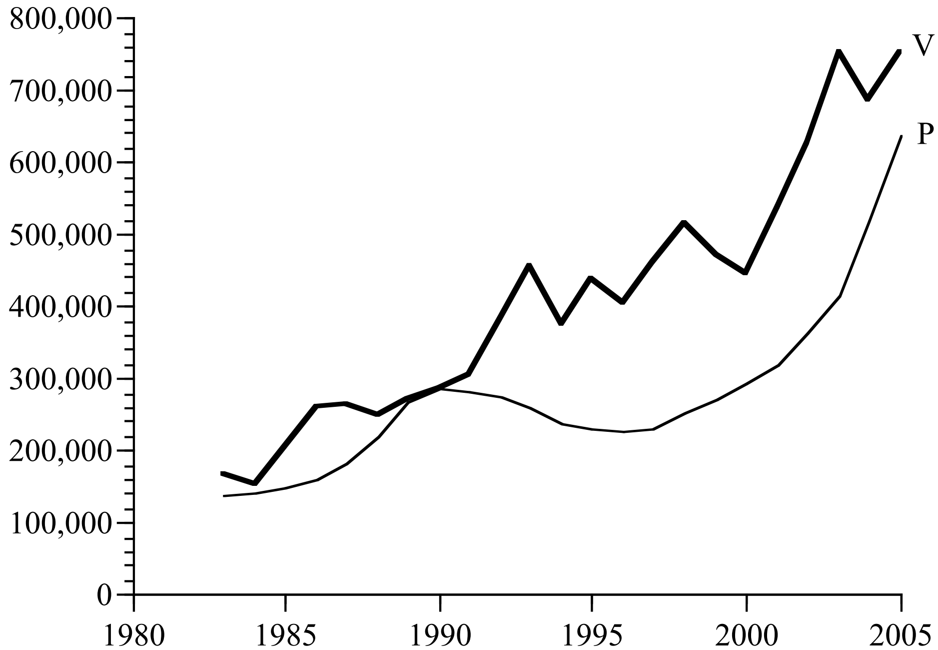


Figure 6 Annual Housing Price P and Fundamental Value V for LA County, 10-year horizon

note: The annual prices were estimated by using the OFHEO house-price index to extrapolate the $320,714 average LA County house price in our 2001 matched-pair data. The annual fundamental values (or reservation prices) were estimated by using the OFHEO house-price index and the BLS owner's equivalent rent index to extrapolate the 2001 matched-pair price and rent data.

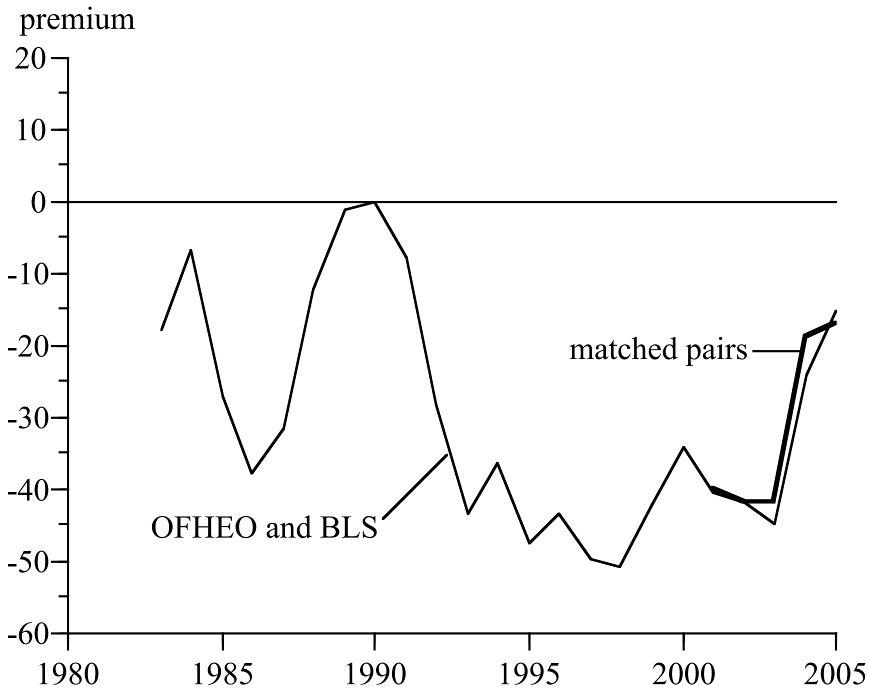


Figure 7 Annual Premium for LA County, 10-year horizon

note: The premium is the percentage by which the market price exceeds the reservation price. The annual premiums shown by the dark line for 2001-2005 were estimated from matched-pair data. The annual premiums shown by the lighter line for 1983-2005 were estimated by using the OFHEO house-price index and the BLS owner's equivalent rent index to extrapolate the 2001 matched-pair price and rent data.