

# **OFHEO WORKING PAPERS**

## **WORKING PAPER 07 - 2**

### **Home Improvements and Appreciation Rates Reflected in the OFHEO House Price Index**

by

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## Abstract

The repeat-transactions model that is used in the construction of OFHEO's house price index (HPI) does not perfectly control for changes in the average condition of the housing stock. If the value of home improvements is not exactly offset by the effects of home depreciation, the HPI could reflect more or less appreciation than would be reported in a true "constant quality" index. This paper attempts to measure the annual amount of "quality drift" embedded within the index. The analysis focuses primarily on measuring quality change *gross of the effects of depreciation*. Three approaches are used: one based on macroeconomic measures of remodeling expenditures, another based on data from the American Housing Survey, and a final investigation focused on building permit data obtained from the City of San Francisco. While improvements-related appreciation is not detected in the San Francisco data, the other two approaches suggest that the inflationary impact of home improvements could be between about 0.4 and 1.0 percent per year. Given these estimates, if offsetting home depreciation is around 1.1 percent per year (as some have presumed), the HPI will reflect less appreciation than would be found in a constant-quality index. The net "quality drift" embedded in the HPI would then be in the range of -0.1 to -0.7 percent per year, with a slightly wider range plausible under more extreme assumptions.

## Introduction

OFHEO's House Price Index (HPI) aims to measure house price appreciation over time. The indexing approach, the repeat-transactions model, has a number of desirable characteristics, one of which is that it controls for the quality mix of transacted homes. Because the input data for the index are appreciation rates, as opposed to price levels, changes in average prices for transacted properties do not affect the index. Hence, unlike average or median price measures, if a large number of particularly expensive homes transact in a period, the OFHEO index will not report a spurious uptick in appreciation rates during that period.

Although the HPI is sometimes classified as a "constant quality" index, many researchers have noted that it does not achieve perfect quality constancy.<sup>1</sup> The effects of improvement activities and physical deterioration for a given home will impact its appreciation and thus will be reflected in the HPI. Thus, depending on the net effects of the property improvement and deterioration, the HPI could be "biased" relative to a perfect measure of quality-constant price movements.

The analysis in this paper attempts to quantify the impact of the net change in home quality on the HPI. The effects will be described as "quality drift" because, assuming that effects of improvements and deterioration do not perfectly offset each other, estimated HPI trends will incorporate the impact of net quality changes. If existing houses are, on average, getting bigger and better, then the amount of drift will be positive and some fraction of OFHEO's measured price increases will merely reflect the effect of home improvements. By contrast, if the effects of depreciation are larger than the positive impact of improvements, then the HPI will understate true constant-quality appreciation.

This paper attempts to provide a sense of how large the effect of quality drift could be. Unfortunately, little research exists that attempts to measure home depreciation rates. Without such information, it is difficult to come to a determination as to the overall net effects of quality change. Estimates are presented in this paper using a commonly-referenced depreciation rate, but most attention is paid to measuring the first part of the relevant calculation: the impact of home improvements on measured appreciation. The estimates of improvement-related inflation can then be a basis for future calculations of quality drift (to be made when better depreciation estimates become available). In the meantime, the improvement effects are, in essence, upper bound estimates on how large the effects of quality drift could be. This upper bound is, in itself, of interest because it answers the question: "Could much of the recent boom in home values be attributable to home improvements?"

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<sup>1</sup> See, for example, Egleton, Richard, "U.S. Housing Market Responding to Low Interest Rates—But Is it a Bubble?" *BMO Financial Group Commentary*, January 24, 2006 and Birger, Jon, "The Great Real Estate Debate," *Fortune*, August 8, 2005. For an academic overview, see Li, Wenzheng, March Prud'homme and Kam Yu, "Studies in Hedonic Resale Housing Price Indexes," Paper Presented at OECD-IMF Workshop on Real Estate Price Indexes, November 6, 2006.

## Background

### *OFHEO's Goals and the HPI*

Before an attempt is made to measure quality drift, it should be recognized that, for OFHEO's purposes, a perfect constant quality index (PCQI) is not necessarily the end goal. OFHEO uses the HPI to "...capture changes in the value of single family homes in the U.S." in its risk-based capital stress test.<sup>2</sup> The index is used to estimate the value of the collateral supporting the mortgages purchased or guaranteed by Fannie Mae and Freddie Mac. To the extent that the collateral becomes more valuable by virtue of home improvements, these effects can and should be measured. Indeed, if the net impact of quality improvements on value is consistently positive, the use of a PCQI would tend to undervalue loan collateral and thus exaggerate the credit risk faced by the Enterprises.

Understanding the differences between the measured appreciation and the constant-quality appreciation is nevertheless quite important. A PCQI can provide clearer information concerning price trends and, potentially, future price movements. In doing so, it may be a particularly good gauge of the health of the real estate market.

### *An Ideal "Constant-Quality" Index*

To assess the differences between the HPI and the theoretical PCQI, one should first understand what is meant by perfect quality control. In short, the PCQI ensures that fluctuations in home quality (including house size, physical condition, etc.) do not affect estimates of house price growth from period to period. Such "quality control" is difficult given that the property valuations that are observed come from a different set of homes in each period. Moreover, even if each property transacted in every period, the task would be problematic because property characteristics can change over time for each home. Home values are a function of a vast number of house attributes (e.g., square footage, the number of bathrooms, presence of air conditioning, etc.), and home alterations are sometimes made that change those characteristics.

Under ideal conditions—if all characteristics relevant to value were observable for each house that transacts—a PCQI index would be relatively easy to construct. The attributes data could easily be used to control for changes in the mix of homes that occur from period to period. Unfortunately, such ideal conditions do not exist. Home attributes that affect values are at least partly unobservable to the house price modeler.<sup>3</sup> Even more rarely is a time series of house characteristics available; most data collection agencies are uninterested in tracking

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<sup>2</sup> See 2006Q4 HPI Release available at: <http://www.ofheo.gov/media/pdf/4q06hpi.pdf>.

<sup>3</sup> Given the myriad attributes that can affect value, modelers never have a complete dataset of relevant characteristics.

home characteristics *at different points in time*. Hence, even if the modeler has information on property characteristics, he may not know the precise property characteristics at the time of sale.

The repeat-transactions model that is used in the construction of the OFHEO HPI presents a practical way of measuring average price changes when home attributes data are unavailable. The model uses observed appreciation for properties having multiple valuations, but does not explicitly use property characteristics. By focusing on observed appreciation for the same property over time, the model estimates will not be influenced by short-term fluctuations in the quality mix of homes that transact. Because the model uses appreciation rates, as opposed to price levels, fluctuations in the quality mix of transacting homes do not spuriously affect index estimates. For example, unlike an average or median series, a repeat-transactions model will not produce prices that rise dramatically in a period in which a large number of very expensive homes transact.<sup>4</sup>

Unfortunately, the repeat-transactions model's parsimony comes at a price: its estimates for price appreciation will only match appreciation shown for a PCQI if existing homes, on average, do not experience overall changes in quality. If, for example, remodeling activity is very intense and many homeowners are increasing the size of their homes through additions, the repeat-transactions model will tend to estimate more growth than a PCQI. Improvements in the overall "quality" of the housing stock thus may lead a repeat-transactions models (such as the HPI) to "drift" higher than the theoretical PCQI over time.

The amount of drift depends not just on the extent of remodeling activity, but also on the offsetting effects of depreciation. Over time, breakage and wear can diminish the value of homes if sufficient maintenance and repairs are not made. Indeed, the overall condition of homes in the housing stock could easily decline if the effects of depreciation are large relative to renovation activity. In such a circumstance, the repeat-transactions model would "drift" lower than a PCQI.

## **Methodologies**

This paper uses three very simple approaches to measuring the effects of quality drift on the HPI. The first approach employs expenditures data from the Census Bureau and the American Housing Survey (AHS). Annual estimates of total expenditures on renovation activity are compared with the total value of the owner-occupied housing stock. Under assumptions concerning the market returns to renovation expenditures, the ratio of annual renovation expenditures to the total value of the housing stock can be thought of as a crude measure of the percentage of house price appreciation that could result from home improvements.

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<sup>4</sup> Of course, the repeat-transactions index would increase if those expensive homes had experienced significant appreciation.

In response to research suggesting that quality drift had caused the HPI to largely overstate appreciation,<sup>5</sup> economist Dean Baker used just this sort of approach.<sup>6</sup> The Baker work constructed this ratio and showed that relative renovation expenditures, as measured with the expenditures-to-house value ratio, actually fell over period between 1994 and 2002. His work cast doubt on the claim that much of the recent price run-up could be attributed to quality improvements.

The first approach presented in this paper is an extension of the Baker methodology. Available measures of total renovation expenditures are reviewed in detail. The analysis employs data from the American Housing Survey as well as information from the Census Bureau's C50 series (the data used in Baker's analysis). The estimates are also updated; expenditures information from more than two additional years is available.

With these measurements of the positive effects of home improvements on home values, the paper then briefly discusses the available evidence on depreciation rates. Macroeconomic measures of maintenance and repair activity are discussed in light of the spotty depreciation rate evidence. The analysis suggests that net depreciation—depreciation after repairs are accounted for—could be large relative to the effects of home improvements on house values.

The second and third approaches for measuring the effects of quality improvements are less crude, but still quite simple. In both cases, a repeat transactions-like index is calculated with two different samples—one that includes properties having significant renovations and one that excludes such properties. The price appreciation rates measured with the two indices are then compared.

The second approach uses longitudinal data from the American Housing Surveys for the years 1995 – 2005. The data sample is national in scope and home values are owner assessments of property values. The questions in the bi-annual surveys allow the identification of homes that experienced significant qualitative change over the prior two-year span.

The third approach supplements OFHEO's usual HPI data with building permit information provided by the City of San Francisco. The historical permit series is merged with OFHEO's HPI data to allow for the identification of renovated properties and to isolate the dates on which the renovations occurred for those properties.

As with the first approach, the second and third approaches subtract depreciation from the estimates of home improvement effects. The difference, which is negative if depreciation exceeds the positive benefits of home improvements, is a measure of overall quality drift.

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<sup>5</sup> See McCarthy and Peach (2004).

<sup>6</sup> See Baker, Dean, "Too Much Bubbly at the Fed?: the New York Federal Reserve Board's Analysis of the Run-up in Home Prices," *Center for Economic Policy Research Briefing Paper*, June 12, 2004 (available at: [http://www.cepr.net/publications/housing\\_bubble\\_2004\\_06.pdf](http://www.cepr.net/publications/housing_bubble_2004_06.pdf)).

It should be recognized that the second and third approaches are mechanically quite convenient, but may overstate estimates of quality drift. If renovation activity is positively correlated with maintenance activity, then the differencing process may overstate the impact of home improvements. If the condition of “renovated” homes is more consistently maintained vis-a-vis that of unrenovated homes, then the appreciation rate difference will include both the effects of renovation activities and the value benefits related to better home repair conditions.

## **Estimates of Quality-Drift**

### *Approach 1: A Broad-Brush Measure using Macroeconomic Data*

Two often-cited measures of total national expenditures on renovations and repairs are available. The “C50” report is based on data from the Census Bureau’s Consumer Expenditures Survey (CES), a monthly survey of approximately 7,500 households that gathers detailed information concerning expenditure behavior. The other measure is derived from the American Housing Survey, a biannual longitudinal survey of roughly 60,000 homeowners across the United States. The survey inquires whether significant expenditures have been made on the home during the prior two years. Homeowners are asked to estimate the cost of the expenditures.

Through the use of appropriate scaling factors, both surveys are used to estimate national home improvement expenditures for owner-occupied properties. These national estimates are frequently referenced in academic research and industry reports, including studies from the National Association of Home Builders<sup>7</sup> and Harvard’s Joint Center for Housing Studies.<sup>8</sup>

The C50 and AHS surveys differ in their sampling methodologies and in their treatment of specific types of remodeling expenditures. As a result, the surveys produce substantially different estimates of U.S. remodeling expenditures. For the 2002-2003 time frame, for example, the AHS survey estimated approximately \$250 billion in total expenditures, while the C50 data reports roughly \$198 billion.<sup>9</sup>

Although a detailed reconciliation of the two surveys indicates that both measurements have flaws, the figures still can be used to produce rough estimates of the relative value of improvements vis-à-vis the value of the housing stock.<sup>10</sup> The necessary element to constructing this sort of estimate is that one must know the impact of expenditures on home values. Remodeling expenditures obviously impact the value of homes, but the “return” on

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<sup>7</sup> See, for example, [www.nahb.org/fileUpload\\_details.aspx?contentID=58231](http://www.nahb.org/fileUpload_details.aspx?contentID=58231)

<sup>8</sup> See [www.jchs.harvard.edu/](http://www.jchs.harvard.edu/)

<sup>9</sup> These numbers were computed by Barry Rappaport and Tamara A. Cole at the Census Bureau and are available in: “Research into the Differences in Home Remodeling Data American Housing Survey and Consumer Expenditure Survey/C50 Report.”

<sup>10</sup> *Id.*

those expenditures is not necessarily 100 percent. Homeowners are motivated to remodel not just for financial reasons, but for “consumption” purposes as well; consumers derive aesthetic and convenience benefits from their expenditures. Estimating the financial returns to remodeling is extremely difficult; the financial payback rate differs across many dimensions, including job type, geographic region, and time. A 2006 survey done by *Remodeling Magazine*, for instance, found average nationwide returns of between 63.4 to 85.2 percent for various job types.<sup>11</sup> The geographic differences in returns for each project were very large. For example, the survey estimated that homeowners in the Pacific states recouped about 97 percent of expenditures on major kitchen remodels, while homeowners in many of the Plains states reaped returns of just 69 percent.

Deriving a meaningful “average” return from these figures is difficult, if not impossible. Optimally, one would couple these figures with estimates of the number and type of improvements that occur in each geographic region of the country. The weighted average return would reflect the mean return on all renovation activities that occurred in the country for a given time period. Unfortunately, no good regional estimates of renovation activity are readily available, and thus the estimation exercise would be quite involved.<sup>12</sup>

For the purposes of this analysis, an average return of 77.5 percent is used. *Remodeling Magazine’s* 2006 *Remodeling Report* survey summarizes its findings by stating that “75 cents to 80 cents spent on a project goes directly back into the home through increased value...” The midpoint of this range, 77.5 percent, seems reasonable in light of the empirical estimates provided in the survey and estimates from previous *Remodeling Magazine* surveys.<sup>13</sup> To construct an upper bound on the effects of renovation expenditures, a 100 percent return rate is used as well.

Under the assumption that renovation expenditures yield these returns, the relative effect of improvements on home values is simply the ratio of the value created by the expenditures (i.e., the product of expenditures and the assumed return) to the value of the housing stock. Estimates of the total value of the housing stock are obtained from the Federal Reserve Flow of Funds Data. The Fed provides quarterly and annual estimates of the value of owner-occupied housing units.

The total value of housing in the United States is a stock variable reported as of the quarter’s end, while renovation expenditures, a “flow” variable, occur throughout a quarter. Consequently, for the ratio to be meaningful, renovation expenditures must be compared with the value of the housing stock during the expenditure period. In this analysis, the value of the housing stock for a given year is simply assumed to be the average of the value at the end of the previous year and the value at the year-end.

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<sup>11</sup> These figures are the national average returns. The estimates differed substantially by geographic region.

<sup>12</sup> Although the American Housing Survey data might be used to construct these estimates, one would need to reconcile various terminology differences across the two data samples.

<sup>13</sup> Although previous surveys reported “average” returns that were higher, according to *Remodeling Magazine*, the earlier estimates were less accurate.



Table 1 presents annual estimates from the C50 of the relative value added by home renovations. The data presented in Table 1 suggest that that, even without subtracting out the effects of depreciation, the impact of home improvement activity on home values has been relatively limited over the last fifteen years. Under the assumption that expenditures tend to yield an average return of 77.5 percent, the C50 figures suggest that the impact of renovations never exceeded about .7 percent of the value of the overall housing stock. In the latest five year period (2001-2005), the estimated impact of renovations was relatively stable at between .54 and .58 percent. Under the implausible “upper bound” presumption that renovation expenditures yield 100 percent returns, the table indicates that the annual impact of renovation on home values was generally under  $\frac{3}{4}$  of a percentage point.

The modest renovation outlays are notable in light of potential “overcounting” that may plague estimates of “improvement.” Prior to 2004, the C50 expenditures data were reported in a way that highlights the problem. “Improvements” expenditures were broken down into two subcategories: “Additions and Alterations” and “Major Replacements.” As the latter category’s name suggests, a portion of “improvement” expenditures is, in effect, devoted to repairing the home. When major home components (for example, an entire roof or a piping system) are replaced, some proportion of those expenditures represents repairs. The repairs are necessary to maintain a home’s functionality and thus are not true home improvements. Instead, they merely act to offset ongoing home depreciation. Unfortunately, although the C50 data and the AHS estimates are potentially affected by this problem, it is difficult to estimate its magnitude.

Table 2 reveals that the AHS estimates greater remodeling expenditures and, correspondingly, greater value impact than the C50. The annual figures, which have been computed from biannual estimates compiled from the Census Bureau, reflect that the value impact of such expenditures ranged from about .68 to .89 percent between 1996 and 2003.<sup>14</sup> Even if the return on expenditures was 100 percent (as opposed to the presumed 77.5 percent), the annual value creation from remodeling expenditures would have been at most 1.14 percent over that time frame.

Overall, the estimates in Tables 1 and 2 should be relatively generous estimates of the potential impact of home improvements on home values. Nevertheless, one might consider an additional source of potential undercounting: “do it yourself” (DIY) work. When working on their houses, homeowners do not just repair broken items, they also make improvements that positively impact value. The value of their work, unfortunately, is not captured in either the AHS or the C50 surveys.

Data for the relative value contribution of DIY efforts are difficult to obtain. A very rough (and likely generous) estimate of the value of DIY renovator’s time can be constructed, however, by comparing the average reported value of remodeling jobs done by

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<sup>14</sup> To produce the annual figures, the biannual expenditure estimates are apportioned among the years based on the proportion suggested in the C50 data. For example, with \$97.9 billion in improvements in 2002 and \$100.3 billion in 2003, the C50 series suggests that 49.4 percent (\$97.9 billion/\$198.2 billion) of total 2002-2003 expenditures occurred in 2002.

“professionals” with those done by DIY individuals. In 2003, the cost of professional remodeling jobs averaged \$7,155, while DIY jobs averaged \$3,500.<sup>15</sup> If the \$3,655 difference represents the average value of householders’ input, with approximately 10.6 million households reporting DIY activity, the total value of time for the DIY individuals would be approximately \$38.7 billion.<sup>16</sup> In 2003, this would amount to approximately .27 percent of the value of the housing stock.

Aiming to construct a more complete measure of the impact of renovation expenditures, Table 3 adds this figure to the expenditures estimate from previous tables. As with Tables 1 and 2, two estimates of the overall impact of renovation activity are presented: one modest estimate and an “upper bound” figure. The higher, “upper bound,” estimate uses an extraordinarily generous suite of assumptions: the (higher) AHS expenditures data are coupled with the 100 percent return assumption and DIY activities are fully valued as described above.<sup>17</sup> Under the middling estimate: renovation expenditures are assumed to be at the mid-point of the AHS and C50 estimates; a 77.5 percent return to renovation outlays is assumed; and DIY activities are credited at half of the rate described above.

The results in Table 3 generally relay a message similar to that conveyed by Tables 1 and 2. Even under this fuller accounting, the modest estimates suggest that value of home improvements is under one percent. In both 2004 and 2005, the annual impact of home improvements was just under .8 percent. Under the extremely liberal assumptions, the value of home improvements hit a high of 1.27 percent in 1994, but ranged from .95 to 1.09 percent in the most recent five years.

As indicated earlier, it is important to recognize that Tables 1-3 do not account for home depreciation in any way. They do not incorporate the impact of any net change in the average operating condition of homes and thus might be described as estimates of “gross” quality drift.

As discussed in a recent paper by Harding, Rosenthal, and Sirmans (hereafter Harding *et al* 2006), the empirical evidence on depreciation rates is scant. Much of the little work that has been done was performed in the 1970s and involved data from outside the U.S.<sup>18</sup> One estimate that has earned some support is 1.14 percent per year, which is *net of maintenance and repair expenditures*. In other words, the value indicates the extent to which house prices decline given *normal levels of maintenance and repair*. The Bureau of Economic Analysis (BEA), which gleaned this value from work by Charles Hulten and Frank Wykoff in the early

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<sup>15</sup> See research conducted at the Joint Center for Housing Studies of Harvard University: “The Changing Structure of the Home Remodeling Industry: Improving America’s Housing 2005,” Table A-2

<sup>16</sup> The AHS data compilation performed by the Joint Center for Housing Studies of Harvard University is employed here.

<sup>17</sup> The 2003 estimate for the relative value of DIY labor, .27 percent of home values, is used for all other dates as well.

<sup>18</sup> See, for example, Chinloy, P., “The Estimation of Net Depreciation Rates on Housing,” *Journal of Urban Economics* (1979), pp. 432-443.

1980s, uses this estimate to calculate the value of fixed housing assets on an annual basis.<sup>19</sup> The Federal Reserve Board and the Department of Housing and Urban Development also use the estimate in various capacities.

The 1.14 percent annual estimate is for housing *structures* only. It does not apply to land values which, in some locales, may comprise a significant proportion of the total value of properties. Because land does not depreciate in most settings, the 1.14 percent figure could be considered an upper-bound estimate for overall property depreciation.

Harding *et al* produce estimates of depreciation rates that, by contrast, are for the combined value of the structure and the land. Such estimates are provided for depreciation gross and net of maintenance expenditures. Unfortunately, the authors classify “maintenance” expenditures differently than they are classified in this paper. “Maintenance” includes maintenance, repairs *and home improvements* in their analysis. Hence, their estimates of “net depreciation” are, in effect, estimates of overall quality drift.<sup>20</sup> The approach, although reasonable, does not provide the direct estimate of net depreciation that is required here.

The authors fortunately do estimate gross depreciation. They calculate national gross depreciation of between 2.5 and 3.0 percent per year. National estimates of “maintenance and repairs” outlays can then be subtracted from these measures to arrive at implied “net depreciation” estimates. Expenditures on maintenance and repairs are measured in the C50 data series and are reported in Table 4 as a proportion of the total value of the housing stock. Unfortunately, as discussed earlier, some expenditures on “repairs” are included in estimated home improvements and thus the Table 4 figures likely understate outlays on home upkeep.

With maintenance and repairs ranging from .19 to .40 percent of home values, the implied net depreciation estimate from Harding *et al* is, in effect, between 2.1 and 2.8 percent per year. This range far exceeds the well-used 1.14 percent figure produced by the BEA and seems extraordinarily high given that it covers the housing structure *and land*, which generally does not depreciate. Given the preliminary nature of the Harding *et al* paper and the relatively small sample size employed, the lower 1.14 percent figure will be used for illustrative purposes in this analysis. More research is clearly needed on the topic.

Given the more than one percent rate of net depreciation, this first approach suggests that overall quality drift may be negative. The amount of understatement appears to be small under reasonable assumptions, with the calculations indicating in the HPI net drift of between -0.2 and -0.5 percent per year. More extraordinary assumptions put the range at between +0.1 and -0.5 percent per year.

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<sup>19</sup> See U.S. Department of Commerce. Bureau of Economic Analysis. *Fixed Assets and Consumer Durable Goods: 1925-1999*. Washington, DC: U.S. Government Printing office, September 2003. See also, “The User Cost of Homeownership,” *U.S. Housing Market Conditions Summary*, Summer 2000, and Kiel, Katherine A. and Jeffrey E. Zabel, “Evaluating the Usefulness of the American Housing Survey for Creating House Price Indices,” *Journal of Real Estate Finance and Economics* (1997), 14: 189-202.

<sup>20</sup> Those estimates will be discussed in the next section.

*Approach 2: Estimates based on Repeat Valuations Data from the American Housing Survey*

Research performed in the mid-1990s by Katherine Kiel and Jeffrey Zabel suggest that a repeat transactions-like house price index could be formed using the American Housing Survey data.<sup>21</sup> The researchers noted that indexing is possible because multiple valuations are provided for the same property over time.

To be sure, the AHS data are not perfectly suited for constructing house price indices. The sample size is not especially large, owner assessments of home values may not be accurate, and the AHS data are not released in a particularly timely fashion.<sup>22</sup> Ultimately, the flaws are not fatal, however, particularly in light of the type of analysis that is performed in this paper.

In fact, as discussed earlier, the recent paper by Harding *et al* used the AHS survey to directly measure quality drift. The authors augment the basic repeat-transactions estimation model with estimates of maintenance and home improvement expenditures and with a variable designed to measure the effects of home depreciation. These variables, which are included in the basic indexing regression model as independent variables, remove the effects of quality change from the index-related regression coefficients. The resulting empirical estimates suggest that the effects of quality change ultimately depress measured appreciation rates. The authors find that, on average, the net annual quality drift was about -2 percent between 1983 and 2001.

The Harding paper employs older data than are used here; neither the 2003 nor the 2005 AHS samples are included in their work. It also uses a more involved methodology that may be very sensitive to assumptions concerning the evolution of depreciation over time.

This paper uses a much simpler technique. To determine the effect of home improvements on estimated appreciation rates, the AHS data are used to construct two repeat-transactions price indices: one that includes valuation pairs where interim remodeling occurred and the other excluding such observations. The difference between the appreciation rates for the two indices should reveal the extent of the “bias” resulting from home improvements.<sup>23</sup> To derive an estimate of net quality drift, one can then subtract net depreciation from the estimated effects of home improvements.

“Transaction pairs” are constructed using owner-assessments of home values in the AHS.<sup>24</sup> Because valuations are observed every two years, each observation—a pair of valuations—

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<sup>21</sup> See Kiel and Zabel (1997) and Zabel (1999).

<sup>22</sup> See Kiel and Zabel (1997) for a detailed cataloging of the various problems.

<sup>23</sup> That the *difference* between the two rates is the focus of this analysis should mitigate concerns about AHS data biases.

<sup>24</sup> All valuations are included, not just those that are made immediately after a transaction occurred. Harding *et al* exclusively used valuations occurring right after transactions.

has an interim period of exactly two years.<sup>25</sup> Homes are flagged as having been remodeled if the owner reported that “improvements” expenditures were made during the two-year span.

Using the AHS data, Figure 1 and Figure 2 compare indices based on the full-sample of valuation pairs against indices constructed using only valuation pairs for which no interim renovation activity occurred. The “unrenovated” series contains approximately 60 percent fewer valuation pairs than the full sample.

While Figure 1 and Figure 2 both report national indices, they use slightly different methods for constructing the index. Figure 1 merely aggregates all available valuation data and directly estimates the index regression models. Figure 2 reports a national index that is a weighted-average of four regional indices, which are estimated separately. Because OFHEO’s national HPI is a weighted-average index of smaller geographic regions, the results reflected in the latter figure may more closely resemble results that might obtain from an analysis using OFHEO’s data.<sup>26</sup>

On balance, Figure 1 and Figure 2 present very similar results: the effect of removing the renovation effect is evident, but not particularly large in magnitude. As measured with the compound annual growth rate (CAGR), the annual appreciation rates without renovation effects lagged the full-sample estimates by just under .5 percentage points. Although the estimates varied significantly across years, the largest estimates were not substantial. The greatest differences occurred in the 1997-2001 period, when appreciation for the full sample exceeded appreciation for the unrenovated properties by about .6-.7 percent per year. By contrast, in the latest period (2003-2005), the full sample appreciation rates were only 0.1 to 0.2 percent higher than for unrenovated properties.

Various sensitivities have been calculated for this measurement and the general result is quite robust. Various thresholds for renovation significance were used as were different sampling universes. For example, indices were calculated using only homes that had recently sold. Ultimately, these perturbations do not provide radically different estimates of the effects of improvements.<sup>27</sup>

If one subtracts the 1.14 percent estimate of annual home depreciation from these estimates of home improvement effects, the implied annual estimate for overall “quality drift” is about -0.7 percent annually. Thus, as was the case in the first approach, these figures suggest that the

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<sup>25</sup> The repeat-transactions model that OFHEO uses in constructing its usual house price index involves three steps. The last two adjust the index coefficients from the first stage to account for the differences in the time between valuations for different transaction pairs. Because the time between valuations is identical in each of the AHS pairings, the index model used here only requires a one-stage estimation.

<sup>26</sup> The OFHEO HPI is a weighted-average of indices for nine different census divisions. Due to data limitations, the national AHS index is constructed using regional indices for the four regions in the U.S.

<sup>27</sup> Note that AHS valuation data are, in some cases, quite noisy over time and that some outlier properties were removed from the sample prior to estimation. For example, data screens were implemented to remove homes that experienced a 40 percent drop in valuation over any two-year period. Although these screens had a nontrivial impact on the regression estimates, the reliability of the filtered observations was sufficiently dubious to warrant their removal.

OFHEO index may understate home price inflation relative to a perfect constant quality index.

*Approach 3: Estimates using the Enterprise Data and Building Permit Data from San Francisco*

Given that significant home renovations often require building permits, permit data can be used to flag renovated properties and the effects of quality improvements can be measured in the same fashion as was done for the second approach. A full-sample repeat-valuation index can be compared against an index constructed with valuation pairs having no interim renovations. In this case, properties are assumed to have been renovated if a building permit were issued at some point between the valuation dates. As before, the difference in the measured appreciation rates is presumed to reflect quality drift gross of depreciation.

The City of San Francisco's Department of Building Inspection has provided OFHEO with an electronic dataset of all approved building permits issued in that city extending back to the 1970s. Ideally, an empirical investigation would employ permit data for a larger geographic area. Although the analysis proceeds with a relatively narrow geographic scope, it should be noted that remodeling activity in San Francisco has reportedly been very intense and thus renovation-related appreciation in that city should be substantial.<sup>28</sup> The high level of renovation activity in San Francisco suggests that the effects of quality improvements on home values should be quite apparent in these data.

Using the HPI data available to OFHEO from the Enterprises, Table 5 reports baseline appreciation rates for San Francisco over the last fifteen years. As these index figures are calculated using only properties with San Francisco addresses (and not properties in other parts of the San Francisco-San Mateo-Redwood City Metropolitan Division), this index differs from that provided with OFHEO's Quarterly HPI Release. Because the Department of Building Inspection's jurisdiction only covers the city proper, as opposed to the entire Metropolitan Division, the most meaningful geographic region for this analysis is the city itself.

Appreciation rates for three alternative indices are reported in Table 5. These indices have been calculated using the San Francisco data, but transaction pairs have been removed when intermediate "renovation" activity occurred between the valuation dates.<sup>29</sup> Three different

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<sup>28</sup> See, for example, Roth, Rachel, "Using Additions and Alterations Permits to Estimate Remodeling Activity in Metropolitan Areas," Joint Center for Housing Studies Harvard University, N04-3, October 2004.

<sup>29</sup> To determine whether permits were issued for a particular property in the OFHEO data, it is necessary to use "address scrubbing" software on the San Francisco permits data. Such software ensures that address formats are uniform and uses both street addresses as well as zip codes. Unfortunately, zip code information is missing for many records in the building permits database, particularly for periods prior to the early 1990s. To partially rectify this problem, for each permit that has a street address but no zip code, a search is conducted for permits having the same address but with a zip code. If a clear match is found, the available zip code is used to fill in the missing value.

methodologies are used for flagging renovation activity. These alternative filtering rules remove between 3 and 14 percent of the transaction pairs used in index estimation.

The first and most restrictive approach is simple: if a building permit was issued at any time between the valuation dates for a transaction pair, the pair is eliminated. The second approach excludes properties and transaction pairs by referencing the work “description” field in the permit application. Transaction pairs are eliminated when a permit was issued between the two transactions and the work description suggested that improvements were made.<sup>30</sup> The third and final approach introduces a materiality threshold for permitted activity: transaction pairs are only eliminated if the total reported cost of renovations occurring between the valuation dates amounted to (on average) at least one percent of the home value per year.<sup>31</sup>

As is evident in the table, the three alternative indices report appreciation rates that are nearly identical to those calculated in the full-sample index. The overall price growth between the first quarter of 1991 and the third quarter of 2006 was approximately 178.0 percent for the full-sample index and between 176.3 and 178.0 percent for these alternative metrics. These data suggest that the annual effect of quality drift is trivial; the average annual growth rate for the usual HPI was about 6.82 percent and between 6.78 and 6.82 percent for the filtered indices.

That these results show a smaller effect than the estimates from the second approach is, in part, a result of the much more limited filtering that occurs. As indicated previously, when removing “renovated” properties, the second approach screened out roughly 60 percent of valuation pairs. The permit-based analysis extracts only about 5 to 25 percent of that proportion.

The near absence of a measurable effect is still surprising, however, given that permits are likely to be filed where the largest improvements occur. Given the extremely limited effect and the richness of the data series available for San Francisco, it is reasonable to search for confounding factors that may be obscuring the measurement of renovation activities’ impact. For instance, if renovated homes tend to be properties with otherwise higher appreciation rates, then removing such observations could have offsetting effects. Screening out the pairings with interim property improvements will minimize the effect of improvements on appreciation, but, at the same time, will skew the data sample toward homes with less impressive appreciation rates.

The relevant issue is: Are renovated properties materially different from other properties in ways that are related to appreciation? A number of different comparisons are performed that ultimately suggest minor differences, but none of the differences is large enough to indicate that sample-selection issues are materially clouding the measurement of improvement effects.

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<sup>30</sup> Due to the number of properties involved, the review of the description field is automated. An improvement is assumed to have been made if one of the following keywords appears in the work description: “Add”, “Install”, “Erect”, “Improve”, “Renovate”, and “Remodel.”

<sup>31</sup> For example, if the interval between the two valuation dates was two years, then the home was flagged as “renovated” if the reported cost of all interim renovations exceeded about two percent of the home value.

Figure 3 is, in effect, a general test of whether the “renovated” properties are different in ways that are material to appreciation rates. The graph plots two different house price indices: one constructed using transaction pairs for unrenovated properties and the other constructed using transaction pairs for renovated properties. To isolate the sample selection issue, the renovated property index is constructed using only transaction pairs where no interim renovation took place.<sup>32</sup> As is evident in the graph, over the last ten years, the samples look quite similar. Appreciation rates for renovated properties are nearly identical to appreciation rates for properties that had no such renovations.

Table 6 more directly compares renovated and unrenovated properties. Comparisons are made across two dimensions that may be correlated with appreciation rates: price level and the proportion of valuations derived from refinance appraisals.<sup>33</sup> For the properties that are renovated, average price levels are computed using valuations occurring before the first permit date for the property.<sup>34</sup>

The proportion of valuations derived from refinance appraisals is nearly identical across the two samples, with the largest difference being only two percentage points in 2000. By contrast, the average prices for the two samples are, in fact, materially different. Average prices for renovated homes (before renovations) were 5-10 percent higher than for unrenovated properties. This difference raises the possibility that renovated properties are in a different market segment and thus may be prone to substantively different appreciation patterns vis-à-vis unrenovated homes.

Table 7 attempts to control for the price difference by limiting the indexing sample to only homes in the lowest price tier.<sup>35</sup> The analysis examines properties whose values were in the lowest price *quartile*—the bottom one-fourth of home values.<sup>36</sup> Values in the bottom quartile of the unrenovated sample are very similar to values in the bottom quartile of the renovated sample.<sup>37</sup>

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<sup>32</sup> Mechanically, homes that were renovated at any point in time are first identified. Then, transaction pairs are formed for each of these homes. Transaction pairs having no interim permits are then selected to construct this index.

<sup>33</sup> Appreciation rates will be correlated with price level if relative demand and supply conditions differ in different price segments. Measured appreciation rates may be influenced by the prevalence of refinance appraisal if such appraisals systematically differ from valuations from home purchases. See, for example, Leventis, Andrew, “Removing Appraisal Bias from a Repeat-Transactions Index: A Basic Approach,” OFHEO Working Paper 06-1.

<sup>34</sup> The removal of post-renovation observations is important because the two properties could have similar average prices only because renovation expenditures increased the value of the renovated properties. The goal is to compare covariates that are related to appreciation, but unrelated to renovation activity, and thus it is important to look at pre-renovation valuations.

<sup>35</sup> The home value at the time of the first (of the two) transactions is compared against the distribution of San Francisco home values for the transaction year.

<sup>36</sup> For example, OFHEO’s sample of San Francisco home values in the 2004 indicates that one quarter of all homes had values less than \$500,000. In 2005, the bottom quartile included homes with values up to \$598,333.

<sup>37</sup> The average value of first-quartile *unrenovated* homes was within one percent of the average value of first-quartile *renovated* properties.



For homes in the lowest price tier, the table indicates that the appreciation rate for renovated properties was higher than for unrenovated homes; the average appreciation rate of renovated homes was approximately 11.8 percent over the 1996-2006 time period, nearly one percentage point higher than the rate for unrenovated homes. Because this analysis focuses on transaction pairs for which no interim renovations occurred, the direct effects of renovation expenditures on appreciation rates are not incorporated in the growth estimates for renovated properties. Accordingly, the difference between the renovated and unrenovated property growth rate is a pure measure of sample selection effects and does not simply reflect the impact of renovation expenditures. The implication of the difference is that sample selection effects apparently may be obscuring the quality-drift measurement.<sup>38</sup>

Fortunately, one can make a minor adjustment to the analysis reflected in Table 7 to arrive at an estimate of quality-improvement effects that are not confounded with the sample selection problem. Recognizing that the appreciation rate for renovated properties shown in Table 7 only includes transaction pairs for which no interim permits were issued, one simply needs to calculate an alternative index for renovated properties using all transaction pairs (i.e., including those with interim permits). The differences between the two appreciation measures for the renovated properties then reflects the impact of renovation activity on measured appreciation rates.

The average annual appreciation rates for the “full sample” of renovated property transaction pairs was approximately 11.6 percent between the first quarter of 1996 and the third quarter of 2006. This estimate is nearly identical to the rate calculated using valuation pairs without interim renovations—11.7 percent. Hence, after controlling for sample-selection effects, the empirical evidence produces the same finding as was initially reported in this section: the effects of quality improvement appear to be trivial.

If these estimates are accurate, then the overall effects of “quality drift” on the HPI are effectively just the estimates of net depreciation. If net depreciation is around 1.1 percent per year, then the absence of measurable effects of “improvements” means that the HPI will understate true constant-quality appreciation by about 1.1 percent.

## **Discussion and Conclusion**

The impact of quality improvements on house price indexes has been a topic of some debate for quite some time amongst housing economics. Unfortunately, the absence of empirical

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<sup>38</sup> An underlying assumption here is that the effects of depreciation on home values are the same for renovated and unrenovated homes. If depreciation effects are more extensive for one of the groups, then this quality-drift measurement will also incorporate differences in the impact of depreciation. Depreciation rates could differ across the two samples, for example, if renovated and unrenovated homes are of significantly different ages. If one presumes that depreciation occurs nonlinearly over time, then any age difference for renovated and unrenovated properties will have the confounding effect.

work on the subject has made much of the discussion largely theoretical in nature. A strong demand exists for empirical estimates.

Such demand was fueled by a 2004 paper by Federal Reserve economists Jonathan McCarthy and Richard Peach. In weighing evidence concerning the most recent house price run-up, the authors suggested that quality drift embedded in OFHEO's HPI and the NAR price medians, had led to a significant overstatement of underlying house appreciation rates. Without the benefit of direct measures of quality drift, the authors came to their conclusion by comparing the OFHEO and NAR indexes with the Census Bureau's Constant Quality House Price Index (CQHPI), a hedonic model of price changes for new homes that uses property attribute information. They recognized that the comparison provided an imperfect measure of quality drift because that the OFHEO and NAR series cover *existing* homes. Alternative empirical estimates were unavailable, however, so they proceeded with the comparisons and were forced to address the extent to which sample differences may have impacted their results.

That the authors had to resort to such measures highlights the need for research into the effects of quality drift. This work provides a series of broad-brush estimates derived from a small array of data sources. The techniques used have been rather rudimentary and the range of annual quality drift is quite large. Nevertheless, after factoring in a one-percent estimate for annual depreciation, the calculations suggest that the annual amount of quality drift is in the range of -.1 to -.7 percent per year. The range could be even wider under rather extraordinary assumptions--perhaps between +0.1 and -1.1 percent.

The breadth of these estimates is great and is, in part, a likely consequence of the simplicity of the approach. Better methods and data in the future will hopefully improve such estimates. The formal model presented in the Harding *et al* paper is a step in the right direction, but the AHS data have significant limitations, not the least of which is its very small sample size. The estimate of -2 percent per year seems extraordinary given the amount of aggregate expenditures on maintenance and improvements.

The failure of the permits-based approach to detect any significant improvement-related inflation in this paper is particularly disappointing. Although permits are not filed for many remodeling activities,<sup>39</sup> permitting data should provide a convenient way of flagging the largest jobs—those with the most significant impact on the repeat-transaction indices.

San Francisco may not have been an ideal location for such an analysis. OFHEO's data are drawn from conforming loans and house prices in San Francisco are so high that mortgages for many homes are near or above the conforming loan limit. Renovations will sometimes raise values to such an extent that a home that once required a conforming-sized loan may require a jumbo mortgage. Because the HPI is constructed using data for homes that have two or more *conforming* mortgages in OFHEO's dataset, the effect of renovations on home values for these houses thus may not be measured. Accordingly, because the renovation effect is not measured in the first place, the permit-filtering approach has no effect to remove.

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<sup>39</sup> Researchers at UCLA have suggested that building permits are filed for less than half of all renovation activity in California.

The analysis of homes in the lowest price quartile (which should be less prone to “disappearing” from OFHEO’s sample) suggests that this problem is not large. Nevertheless, as a theoretical matter, the problem still remains. Data from a broader geographic region could shed some light on the magnitude of the problem and, at the same time, would facilitate the measurement of variations in quality drift across regions.

As a general matter, it appears clear that net quality drift is most likely negative. Thus, the hypothesis that the recent home improvements are behind recent home price gains is not supported in these data. Indeed, the largest estimate of net quality drift calculated in this paper is a scant +.13 percent. Even if the effects of depreciation are assumed to be negligible, the inflationary impact of home improvements apparently would still be relatively small—most likely less than  $\frac{3}{4}$  of a percentage point annually.

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**Table 1: Value of Improvements as Percentage of Housing Stock**  
(Census Bureau's C50 Data)

<b>Year</b>	<b>77.5% Return on Improvements</b>	<b>100% Return on Improvements</b>
1991	0.46%	0.59%
1992	0.54%	0.70%
1993	0.61%	0.79%
1994	0.67%	0.87%
1995	0.57%	0.73%
1996	0.63%	0.81%
1997	0.60%	0.78%
1998	0.61%	0.79%
1999	0.58%	0.75%
2000	0.58%	0.74%
2001	0.55%	0.71%
2002	0.58%	0.75%
2003	0.54%	0.70%
2004	0.55%	0.71%
2005	0.55%	0.71%

**Table 2: Value of Improvements as Percentage of Housing Stock**  
(Aggregated AHS Data)

<b>Year</b>	<b>77.5% Return on Improvements</b>	<b>100% Return on Improvements</b>
1996	0.89%	1.14%
1997	0.85%	1.10%
1998	0.88%	1.13%
1999	0.83%	1.08%
2000	0.85%	1.10%
2001	0.82%	1.05%
2002	0.73%	0.94%
2003	0.68%	0.88%



**Table 3: Quality Improvements as a Percentage of the Housing Stock Value**  
(C50 and AHS Data Sources)

<b>Year</b>	<b>Modest Estimate</b>	<b>Upper Bound Estimate</b>
1991	0.65%	0.95%
1992	0.75%	1.07%
1993	0.84%	1.18%
1994	0.91%	1.27%
1995	0.78%	1.11%
1996	0.99%	1.16%
1997	0.95%	1.12%
1998	0.98%	1.14%
1999	0.93%	1.10%
2000	0.94%	1.12%
2001	0.91%	1.09%
2002	0.87%	1.00%
2003	0.82%	0.95%
2004	0.77%	1.09%
2005	0.77%	1.09%

"Upper Bound" estimate assumes: AHS expenditures estimates if available, otherwise scaled-up C50 estimates; 100 percent return on renovation outlays; and DIY labor valued at professional labor rates.

"Modest" estimate assumes: Midpoint of AHS and C50 expenditures estimates; 77.5 percent return on renovation outlays, and DIY labor valued at half of professional rates.

**Table 4: Maintenance and Repair Expenditures as a Percentage of the Housing Stock Value**  
(Census Bureau's C50 Data)

<b>Year</b>	<b>Maintenance + Repair</b>
1991	0.40%
1992	0.39%
1993	0.31%
1994	0.35%
1995	0.35%
1996	0.27%
1997	0.32%
1998	0.30%
1999	0.24%
2000	0.22%
2001	0.21%
2002	0.18%
2003	0.14%
2004	0.17%
2005	0.19%

**Table 5: Effects of Removing Renovated San Francisco Properties from Indexing Data**

	Appreciation 1991Q1 - 2006Q3	Appreciation 1999Q1 - 2006Q3	CAGR 1999Q1-2006Q3
Usual HPI Estimates	178.03%	149.61%	6.82%
Remove Transaction Pairs with Permits Issued between Dates	176.34%	149.57%	6.78%
Remove Transaction Pairs with Interim Permits Referencing Improvements	177.61%	150.33%	6.81%
Remove Transaction Pairs with Interim Permits whose Cost Estimates Exceed Maintenance Threshold	177.95%	149.55%	6.82%

**Table 6: Attributes of Renovated vs. Unrenovated Properties**

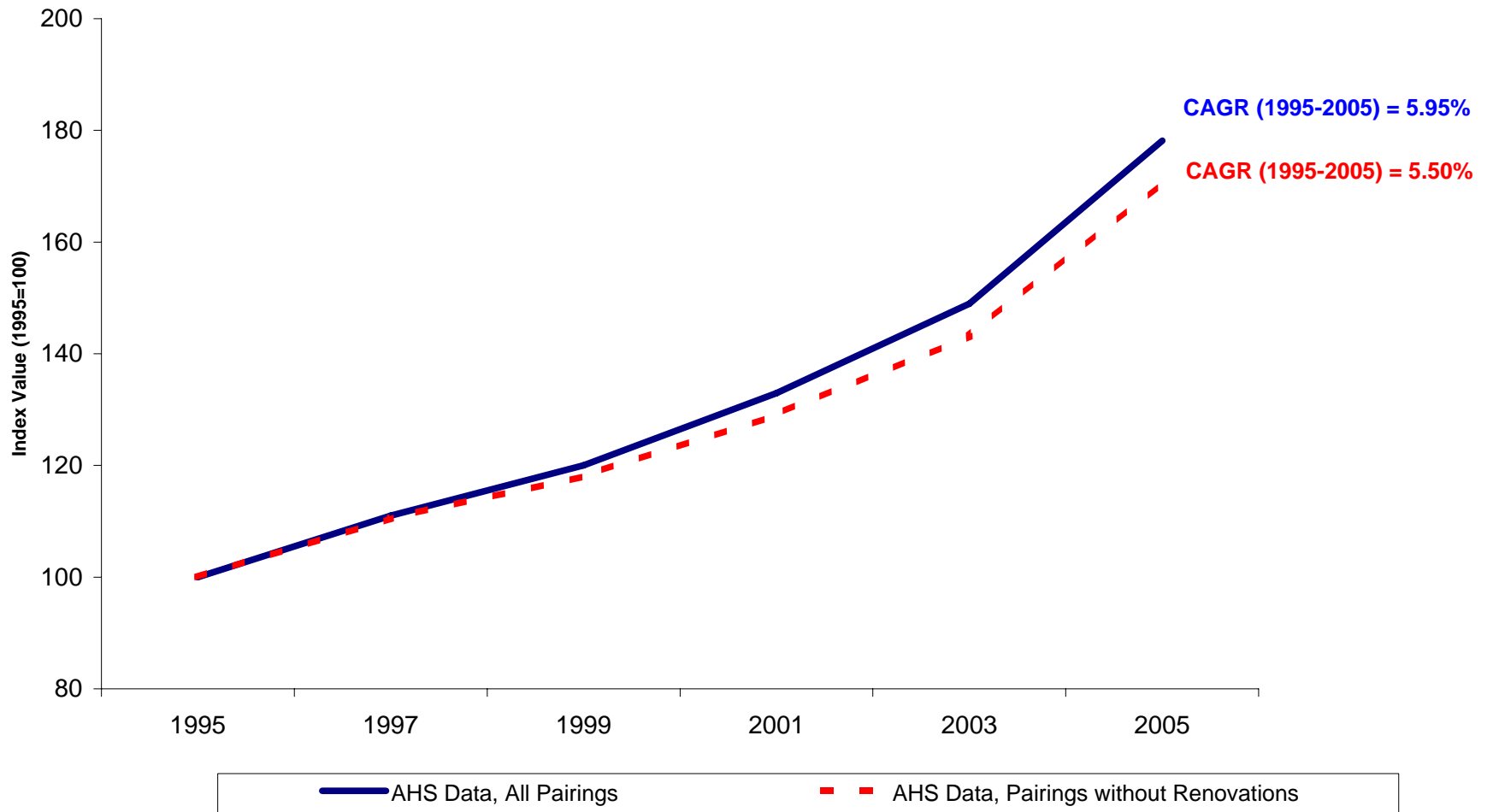
	<u>Renovated (Renovated at Any Time)</u>	<u>Unrenovated</u>
Average Prices		
1995	\$254,621	\$230,558
2000	\$405,581	\$384,358
2005	\$733,038	\$699,198
Fraction of Valuations from Refinances		
1995	50%	54%
2000	57%	66%
2005	95%	97%

**Table 7: Appreciation in First House Price Quartile**  
 Properties without Building Permits vs. Properties with Permits

	Appreciation 1996Q1 - 2006Q3	CAGR 1996Q1-2006Q3
Price Index for Homes in First Quartile Having No Filed Permits	281%	10.88%
Price Index for Homes in First Quartile Having Filed Permits*	303%	11.72%

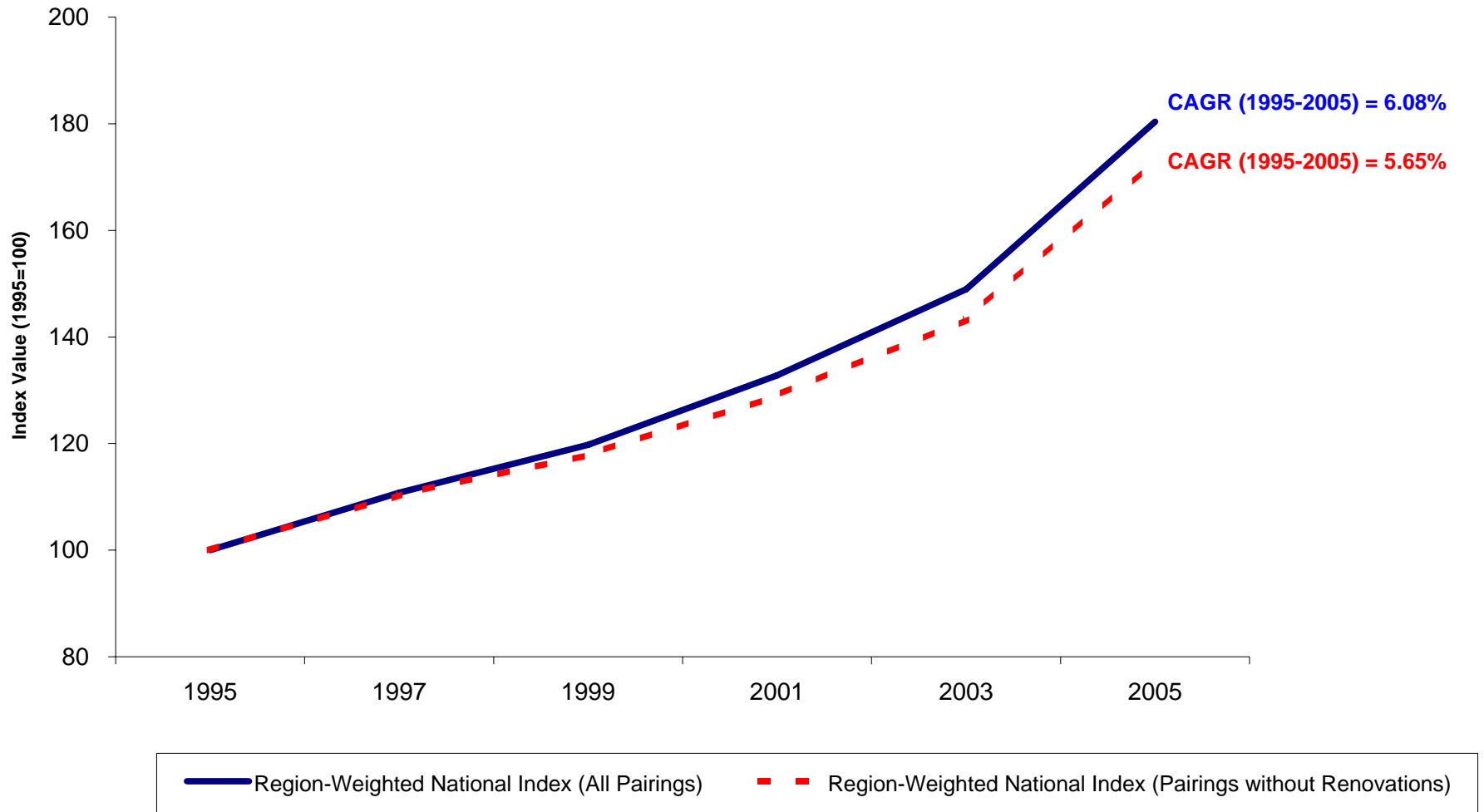
\* Note: Price Index for permitted homes is constructed using only valuation pairs without interim permits

**Figure 1: Simple National AHS Repeat Valuation Index  
With and Without Valuation Pairs having Interim Renovation Activity**



Source: American Housing Survey 1995-2005

**Figure 2: Region Weighted AHS Repeat Valuation Index  
With and Without Valuation Pairs having Interim Renovation Activity**



Source: American Housing Survey 1995-2005

**Figure 3: House Price Appreciation in San Francisco**

Homes Having No Filed Permits vs. Homes with Permits (Pairs without Interim Permits)

