Revisiting the Differences between the OFHEO and S&P/Case-Shiller House Price Indexes:

New Explanations

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Preface

This Office of Federal Housing Enterprise Oversight (OFHEO) research paper analyzes the potential causes of the differences between the OFHEO House Price Indexes (the "HPI") and home price indexes produced by S&P/Case-Shiller. The paper updates a research note published by OFHEO in July 2007. This paper is part of OFHEO's ongoing effort to enhance public understanding of the nation's housing finance system. The paper was prepared by Andrew Leventis of the Office of Policy Analysis and Research. Patrick J. Lawler, Robert S. Seiler Jr., Austin Kelly, Robert Dunsky, Art Hogan, Forrest Pafenberg, and Bob Collender provided helpful comments.

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Background

In July 2007, OFHEO published a short research note that discussed differences between the OFHEO House Price Indexes (the "HPI") and home price indexes produced by S&P/Case-Shiller.[1] The report provided a crude attribution analysis, attempting to quantify the extent to which various data filters and methodological differences explained divergences in measured price changes in recent periods.

Subsequent index estimates for each of the two house price measures evidence sharply weakening market conditions, but the S&P/Case-Shiller numbers continue to reflect much softer prices than the OFHEO HPI. Since the summer, OFHEO has continued to monitor the divergence between the indexes and has conducted additional research to reconcile the estimates. This new work has analyzed a greater number of potential causes and has employed supplemental house price information provided by a private data vendor. The empirical estimates suggest that, while the causes of divergence may have differed in previous periods, most of the current gap is generally attributable to three factors: OFHEO's use of home price appraisals, differences in how much weight is given to homes that have lengthy intervals between valuations, and variations in price patterns for inexpensive homes with alternative financing. The role of home appraisals in explaining differences was cited in OFHEO's summer note, but the latter two factors were not analyzed. The extent to which the three factors explain the results divergence is shown to be largely city-specific.

Incremental Effects of Making Changes to the OFHEO HPI

Detailed geographic coverage information is still unavailable for the S&P/Case-Shiller US House Price Index.[2] Accordingly, efforts to reconcile price trends in the two national indexes have limited potential. By contrast, geographic coverage areas are well-defined for the inaugural ten city indexes that were first published by S&P/Case-Shiller. Thus, as was done in the prior reconciliation publication, efforts to disentangle the causal factors are restricted to these ten metropolitan areas.

Table 1 is an updated and expanded version of the results table presented in the prior reconciliation note. The table reports four-quarter price change estimates by city for the period between the third quarters of 2006 and 2007. Column A reflects the estimates of OFHEO's basic HPI model, except the counties covered in each metropolitan area are aligned with those included in the S&P/Case-Shiller index.[3] As one moves toward the right in the table, each

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[1] See Leventis, Andrew, "A Note on the Differences between the OFHEO and S&P House Price Indexes" available at: http://www.fhfa.gov/PolicyProgramsResearch/Research/Pages/A-Note-on-the-Differences-between-the-OFHEO-and-SPCase-Shiller-House-Price-Indexes.aspx.

[2] The S&P/Case-Shiller methodology primer, titled "S&P/Case-Shiller Home Price Indices Index Methodology: November 2007" and available at http://www2.standardandpoors.com/spf/pdf/index/SP_Case_Shiller_Home_Price_Indices_Methodology_Web.pdf, provides estimates of the "percentage coverage" for each state, but does not identify the exact counties included in the sample.

[3] For coverage information, see S&P/Case-Shiller Home Price Indices Index Methodology: November 2007, page 8. Note that OFHEO's standard index reports estimates for Metropolitan Statistical Areas or, where available, the

additional column reflects the impact of altering the OFHEO methodology or the estimation dataset in a way that makes it more similar to the S&P/Case-Shiller approach. Changes are made cumulatively so that each new column reflects the impact of making all the previous alterations plus one additional change. Column I reflects four-quarter price change estimates after all changes have been made. The adjacent column, column J, reports the respective estimates for the S&P/Case-Shiller Index.

It should be recognized that this harmonization effort remains somewhat crude and that material differences in methodology and data will remain, even after all of the denoted changes have been made. For example, although OFHEO's HPI filters out extreme values, none of OFHEO's adjusted estimates explicitly employs a robust-weighting algorithm to constrain the impact of highly-influential observations. Also, the value weighting that is performed in the harmonization does not precisely mimic the implementation of the S&P/Case-Shiller value-weighting.[4]

To help summarize the extent to which changes to OFHEO's model explain differences between the OFHEO and S&P/Case-Shiller estimates, the bottom rows in Table 1 report the average and average absolute differences between the altered OFHEO series and the S&P/Case-Shiller estimates across the ten cities. In the first column, the table indicates that the average difference between the four-quarter price changes estimated in the basic OFHEO model and those estimated by S&P/Case-Shiller was approximately 4.3 percent. The average absolute difference, which is reported in the next row, is identical because for all ten cities the basic OFHEO model estimated less severe price declines[5] than did the S&P/Case-Shiller model.

Removing Appraisals, Changing Interval Weights, and Adding Inexpensive Homes without Enterprise-Financed Mortgages

As indicated in columns B to D, the initial three adjustments to the OFHEO model explain a substantial share of the overall gap between the indexes' estimates. Implementation of the three changes shrinks the average absolute difference between the indexes' price change estimates from 4.3 percent to 1.7 percent. The modifications also produce adjusted estimates that are neither systematically above nor below the S&P/Case-Shiller numbers. For five of the ten cities, the adjusted price change estimates are above the S&P/Case-Shiller estimates and the average difference is less than one-half of a percent.

The first modeling adjustment entails removing refinance appraisal valuations from OFHEO's estimation sample. Consistent with the results presented in the prior reconciliation analysis, removing these valuations has a considerable impact. In every city but San Diego, removing these appraisals increases the magnitude of estimated price declines or shrinks the size of

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component Metropolitan Divisions. Except for the Chicago and New York indexes, the S&P/Case-Shiller coverage areas include the whole of the Metropolitan Statistical Areas.

[4] As discussed in a later section, the so-called "Goetzman correction" is used in this analysis to approximate the value-weighted estimates. With its "Interval Weighted, Arithmetic Repeat Sales" (IV-ARS) methodology, the S&P/Case-Shiller model employs a more involved estimation procedure. For a basic description of the Goetzman correction, see Calhoun, Charles A. "OFHEO House Price Indexes: HPI Technical Description" available at: j wr<lly y y 0hj hc0 qx lRqrke{Rtqi tco uT gugctej lT gugctej lRci gulJ RKVgej plecn/F guetlr vlqp0curz0

[5] In some cases, the basic OFHEO model actually estimated small price increases.

measured price increases. After making this change, the average difference between the OFHEO and S&P/Case-Shiller four-quarter price change estimates shrinks from 4.3 percent to 2.7 percent.

The next modeling adjustment involves changing the extent to which the model downweights valuation information from homes that have lengthy periods between valuations. The downweighting is performed by both OFHEO and S&P/Case-Shiller to increase the precision of index estimates.[6] The S&P/Case-Shiller methodology materials suggest that its downweighting is far more modest, however. The S&P/Case-Shiller methodology primer notes that valuation pairs, which reflect the extent to which homes have appreciated or depreciated over a known time period, are given 20-45 percent less weight when the valuations occur ten years apart vis-à-vis when they are only six months apart.[7] By contrast, OFHEO's downweighting tends to give ten-year pairs about 75 percent less weight than valuation pairs with a two-quarter interval.

The source of the divergence between the OFHEO and S&P/Case-Shiller weights is not known. The manner in which the weights are constructed is slightly different,[8] but the differences do not immediately suggest why the gap would be so large. Whatever the cause, the impact of the differing weights is significant. If OFHEO changes its weights to mimic the S&P/Case-Shiller scheme, the resulting price change estimates are closer to the S&P/Case-Shiller estimates.[9] The adjusted OFHEO estimates generally show weaker housing market conditions than they did without the change and the average difference relative to the S&P/Case-Shiller figures shrinks to 1.6 percent.

The third of the three large-impact model adjustments entails incorporating additional data into the OFHEO estimation dataset. OFHEO's standard estimation dataset includes only valuation data for homes that have secondary market financing from the Enterprises. Data from DataQuick Information Systems reflecting sales prices for homes with all types of financing are used to supplement the Enterprise data. These new data, like the S&P/Case-Shiller data, reflect selling prices recorded at county assessor and recorder offices. The underlying homes will include those with subprime loans, jumbo mortgages, VA, FHA and other types of financing arrangements. Depending on the county, the DataQuick price data typically extend back to the

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[6] Over longer time periods, evidence suggests that there is greater dispersion in appreciation rates across homes. This variability causes heteroskedasticity, which increases estimation imprecision. The downweighting mitigates the effect of the heteroskedasticity.

[7] See S&P/Case-Shiller Home Price Indices Index Methodology, November 2007, p. 20.

[8] OFHEO estimates the weights in the "second-stage" of the repeat-transactions methodology. In that stage, squared errors from an initial stage (where preliminary estimates of index values are derived) are regressed on the time interval and the squared interval. The S&P/Case-Shiller model is estimated in a more complex way, omitting the squared term and allowing for correlations between errors. Unfortunately, neither the methodology primer nor the paper that forms the basis for the basic methodology detail the approach. See S&P/Case-Shiller Home Price Indices Index Methodology: November 2007, page 25: "…the residuals from this model [the first stage] are used to estimate Ω [a matrix of weights]" Also, see Shiller, Robert J.,"Arithmetic Repeat Sales Price Estimators," *Journal of Housing Economics*, 1 (1), page 123.

[9] To mimic the S&P/Case-Shiller weights, it is assumed that valuation pairs with 10-year intervals have 32.5 percent of the weight of valuation pairs with two-quarter intervals. The 32.5 percent figure is the midpoint of the 20-45 percent range reported in the S&P/Case-Shiller methodology primer. Weights are assumed to decline linearly with the holding interval.

1990s or late 1980s. The DataQuick price data are added to the Enterprise data and valuation pairs are constructed using the supplemented dataset.[10]

Because many have wondered whether price weakness at the upper end of the price spectrum explains much of the difference between OFHEO's estimates and the S&P/Case-Shiller series, the new sales price data are added incrementally for "low and moderate" and "high" priced homes. Column D reflects the impact of adding low and moderately priced homes to OFHEO's sample. These homes include those whose prices were 125 percent or less of the conforming loan limit at the time of the sale. The part of the price spectrum covered by these homes is little affected by the conforming loan limit.[11] Column D of Table 1 reveals that the addition of these low and moderately-priced homes to the estimation sample shrinks the OFHEO-S&P/Case-Shiller gap considerably.

When adding the lower-priced, non-Enterprise homes sales data to OFHEO's estimation sample, it is important to recognize that the addition of non-Enterprise sales data would likely change the relative neighborhood representation within each city. Rates of home depreciation (or appreciation) differ across neighborhoods within the same city, and aggregate estimates of citywide price changes are, in effect, weighted averages of price changes for different neighborhoods. The addition of the new sales data to OFHEO's index would thus have two effects: (a) effects stemming from heterogeneity in price trends for homes with different types of financing within an area and (b) effects reflecting the changing overall geographic composition of the data sample.

To limit the influence of changes in the neighborhood composition of the sample, when estimating the new index on the supplemented dataset, the contribution of each zip code to the citywide index is forced to be similar to the contributions in the Enterprise-only series. Citywide indexes are constructed as weighted averages of zip code indexes, where the zip code indexes are constructed using the supplemented data. Importantly, the share of Enterprise loans in each zip code is used to construct the weighted averages, thus making the weighted series broadly reflect the neighborhood composition of the Enterprise-only series. Differences between this new series and the Enterprise-only data series (i.e., column C) will then reflect more closely the effects stemming from differences in price trends for homes with different types of financing within the same areas.

Although results differ across cities, in general, the impact of adding low-priced, alternatively-financed homes to the data sample is that estimated price declines become significantly larger. The adjusted OFHEO estimates more closely resemble the S&P/Case-Shiller figures; the average difference in estimated depreciation rates shrinks by about a full percentage point. For reasons not entirely clear, price declines seem to be particularly large for low and moderately priced homes without Enterprise-purchased mortgages.

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[10] A given sales pair can thus include two sales prices from the DataQuick data, two from the Enterprise data, or one from each.

[11] With a loan-to-value ratio of 80 percent, the maximum sales price affordable with a conforming loan will be 125 percent of the loan limit.

The Impact of Other Modifications to the OFHEO Model

The remaining steps in the harmonization of the two models tend to have far less dramatic effects than the preceding adjustments. In total, once the remaining adjustments are made, the average absolute difference between the price changes measures shrinks from about 1.7 percent to 1.3 percent.

Columns E adds the additional "high" priced sales data from OFHEO's data vendor while maintaining the same neighborhood representation displayed in the Enterprise data sample. Column F adds the data points, but removes this constraint on neighborhood contributions. The implied within-city geographic distribution in column F thus likely reflects more closely the distribution in the S&P/Case-Shiller series.

The only particularly notable result evident in Columns E and F is that, in the latest year, the Enterprises' geographic coverage area seems to be performing better than the market as a whole. When the geographic composition of sales prices is unconstrained (i.e., it is allowed to reflect the full data sample, not just Enterprise data), the estimated rates of deprecation are greater than they were for the Enterprise-like geographic coverage. Note that that the unconstrained model does not provide a dramatically better "fit" to the S&P/Case-Shiller estimates. In some cases, the unconstrained model "overshoots" the actual price change estimate and the average *absolute* difference between the adjusted model in Column F and the S&P/Case-Shiller estimates is only slightly lower than in the previous column.

Column G implements value-weighting into the estimation process. As discussed in the July reconciliation article, OFHEO's standard index is unit-weighted; all else equal, each valuation pair is given the same weight. The S&P/Case-Shiller index, by contrast, is value-weighted so that a given transaction pair is given a weight proportional to the home's value. The results in column G are obtained by implementing the Goetzman correction, a basic approximation of value-weighting.

The effect of value-weighting is relatively small in most cities for this time period and does not have a consistent impact across metropolitan areas.[12] In six of the ten metropolitan areas, estimated price declines are slightly smaller under value-weighting. The average absolute difference between the adjusted OFHEO series and the S&P/Case-Shiller index shrinks slightly (from 1.5 percent to 1.4 percent) when the value-weighting is implemented.

When viewed in conjunction with the finding that the incorporation of "high" priced non-Enterprise sales data into OFHEO's model contributed little to explaining the OFHEO-S&P/Case-Shiller gap, the limited impact of value weighting suggests that OFHEO's underrepresentation of price trends at the upper-end of the price spectrum has little effect.[13]

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[12] For details on value-weighting, see Goetzmann, William, "The Accuracy of Real Estate Indexes: Repeat Sales Estimators," *Journal of Real Estate Finance and Economics*, 5 (1), 1992. Note that, besides the Goetzman correction, another crude method for approximating value-weighting was also used. That procedure, which was discussed in the July article, produced a similar qualitative finding.

[13] The July article also found little difference between unit and value-weighted indexes.

These data, as well as recently-published price-tier-specific indexes published by S&P/Case-Shiller, show that relative price trends for expensive homes differ in significant ways across cities. Thus, the recent OFHEO-S&P/Case-Shiller results gap is not typically explained by differing price trends for expensive homes.

While the Enterprise data do not include sales prices from many types of transactions, the data provided by the private data vendor do not include all sales records available in the Enterprise data (contrary to reportedly "full coverage" of the geographic area). Spot checks of select sales records on county recorder websites indicate that the unique Enterprise observations include *bona fide* transactions. Under the presumption that these records might also be absent from the datasets used in the S&P/Case-Shiller modeling, column H re-estimates the OFHEO model after omitting the data points. The impact of the omission is generally small, with limited exceptions.

The final adjustment to the OFHEO model entails harmonizing some basic data filters. As discussed in the July reconciliation article, the S&P/Case-Shiller model drops valuation pairs that occur less than six months apart. OFHEO's basic model, by contrast, drops valuation pairs with less than 90 days between valuations. Also, although not explicitly indicated, it seems that the S&P/Case-Shiller model may omit valuations from before 1987.[14] No such constraint is present in the OFHEO models.

Column I reflects the effects of changing OFHEO's data filters to implement the six-month filter and remove valuations from before 1987. These alterations generally magnify the measured price declines over the most recent year, with adjusted deprecation rate estimates increasing (in absolute terms) in nine of the ten cities. They do not, however, materially shrink the gap between the OFHEO and S&P/Case-Shiller measures; the average absolute difference between the two measures does not significantly change when the new filters are implemented.

Summary and Comments

Figure 1 graphically summarizes the results in Table 1. The graph clearly displays the relatively large impact of the first three model modifications—those related to appraisal valuations, the interval weights, and low-priced, non-Enterprise loans.

The significance of the latter two effects is striking and unexpected. Although it has been discussed in house price indexing literature for quite some time, the interval weighting is likely arcane to many and its effect may surprise house price modelers. A review of the historical differences between the adjusted OFHEO index (with the muted downweights) and OFHEO's fully-weighted model suggests that the relative impact of this change is much smaller in prior periods.

The depressing effect of the inclusion of low-priced houses without Enterprise-related financing raises many questions. Some of these houses were undoubtedly financed with subprime mortgages and thus one might wonder whether some of the effect somehow relates to turmoil in that market. For example, subprime homes may be clustered in neighborhoods with relatively

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[14] The historical index data provided to the public do not include index estimates for periods before 1987.

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intense recent foreclosure activity. While this analysis attempted to rule out such "neighborhood effects" at the zip code level, zip codes are large areas and analysis of smaller geographic regions (e.g., census tracts) might reveal more localized differences. Another plausible explanation is that borrowers with subprime loans may not have spent as much on home improvements, maintenance or repair. If these types of expenditures were lower for subprime borrowers, then deprecation rates may have been greater for the homes with subprime financing.

A review of the impact of adding the low-end, non-Enterprise properties to OFHEO's dataset suggests that, during the latter part of the housing boom, these properties may have appreciated significantly more than Enterprise-financed properties. Accordingly, it seems these properties are different from Enterprise properties in ways that are correlated with price trends.

Table 1: Reconciling Price Change Estimates for 2006Q3-2007Q3 for the OFHEO and S&P/Case-Shiller Price Indexes
Ten Original S&P/Case-Shiller Metropolitan Area Indexes

OFHEO's Method's and Sample Become More Similar to S&P/Case-Shiller ▶

	HPI (Geo areas aligned with S&P/CS)	Geo-Align; Purchase-Only (PO)	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals;	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low and moderate-priced** sales not observed (maintain Ent-like geo coverage within cities)	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low, moderate, and high-priced** sales not observed (maintain Ent-like geo coverage within cities)	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low, moderate, and high-priced** sales not observed (**within-city geo coverage unconstrained**)	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low, moderate, and high-priced** sales not observed (**within-city geo coverage unconstrained**); Value-weighting	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low, moderate, and high-priced** sales not observed (**within-city geo coverage unconstrained**); Value-weighting; Omit Enterprise-only sales	Geo-Align; Purchase-Only (PO); Lesser-downweighting of long-intervals; Add **low, moderate, and high-priced** sales not observed (**within-city geo coverage unconstrained**); Value-weighting; Omit Enterprise-only sales; Different data filters	S&P/ Case-Shiller (Sep06-Sep07)	Difference: Replication minus S&P/CS
	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[I]-[J]
Boston	-2.51%	-3.28%	-3.27%	-3.58%	-2.62%	-3.25%	-2.17%	-2.18%	-2.24%	**-3.18%**	0.94%
Chicago	2.16%	1.08%	-0.66%	-2.08%	-1.56%	-2.14%	-1.01%	-1.13%	-1.64%	**-2.48%**	0.84%
Denver	-0.32%	-1.21%	-2.23%	-1.48%	-1.19%	-4.93%	-2.55%	-2.39%	-2.32%	**-0.86%**	-1.46%
Las Vegas	-2.51%	-8.34%	-8.63%	-9.79%	-9.42%	-12.21%	-11.66%	-11.85%	-12.72%	**-9.05%**	-3.67%
Los Angeles	-0.60%	-3.79%	-4.82%	-6.80%	-6.39%	-6.20%	-6.46%	-6.42%	-7.11%	**-6.99%**	-0.12%
Miami	-1.40%	-2.10%	-3.96%	-5.05%	-4.26%	-7.31%	-7.67%	-7.92%	-8.17%	**-9.96%**	1.80%
New York	0.25%	-0.43%	-1.66%	-1.21%	-0.95%	-2.47%	-2.64%	-3.32%	-3.70%	**-3.64%**	-0.06%
San Diego	-5.07%	-2.31%	-4.22%	-10.08%	-9.27%	-8.43%	-8.29%	-8.17%	-8.75%	**-9.64%**	0.89%
San Francisco	-3.87%	-7.36%	-8.67%	-8.56%	-7.44%	-5.52%	-4.87%	-4.69%	-5.48%	**-4.58%**	-0.90%
Washington DC	-0.38%	-1.96%	-3.29%	-3.85%	-4.30%	-7.16%	-8.03%	-8.33%	-9.10%	**-6.58%**	-2.52%
Avg Diff from S&P	**4.27%**	**2.73%**	**1.56%**	**0.45%**	**0.96%**	**-0.27%**	**0.16%**	**0.06%**	**-0.43%**		
Avg Abs(Diff)	**4.27%**	**3.38%**	**2.67%**	**1.68%**	**1.67%**	**1.50%**	**1.37%**	**1.30%**	**1.32%**		

Note: For details concerning methodology alterations and data filters, see report text.

Figure 1: Explaining Differences between the OFHEO and S&P/Case-Shiller Estimates of Price Change

Average OFHEO-S&P/Case-Shiller Differences Across Ten Original Metropolitan Areas

Legend:
- Average Difference in Price Change Estimates for 2006Q3-2007Q3: OFHEO vs. S&P/Case-Shiller
- Average Absolute Difference in Price Change Estimate for 2006Q3-2007Q3: OFHEO vs. S&P/Case-Shiller

Categories:
- Original HPI (with Geographic Alignment)
- Purchase-Only
- More Muted Downweighting
- Add New Sales (Low-Priced)
- Add New Sales (Low & High-Priced)
- Remove Neighborhood Coverage Constraints
- Value-Weight
- Omit Enterprise-Only Observations
- Change Data Filters