



## **An Approach for Calculating Reliable State and National House Price Statistics**

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## **PREFACE**

This Federal Housing Finance Agency (FHFA) research paper describes a technique for producing state and national median and average home price statistics that incorporate less noise than traditional metrics. The approach reflects a candidate methodology for producing average price statistics required under the Housing and Economic Recovery Act. That Act requires that FHFA “establish and maintain” a technique for calculating annual changes in the national average house price for use in adjusting conforming loan limits.

The paper was prepared by Andrew Leventis of the Office of Policy Analysis and Research. Jesse Weiher of FHFA provided valuable comments, as did several outside economists, including Mick Silver (International Monetary Fund), Charles Calhoun (Calhoun Consulting), John Clapp (University of Connecticut), Eric Rosenblatt (Fannie Mae), Doug McManus (Freddie Mac), Calvin Schnure (Freddie Mac), and Amy Crews-Cutts (Freddie Mac).

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## **Background**

This paper describes a new methodology for estimating U.S. average and median house prices. The approach, which relies heavily on repeat-transactions house price indexes, attempts to construct statistics that are less vulnerable to certain types of distortions than existing metrics. Under the Housing and Economic Recovery Act of 2008 (HERA), FHFA is required to select or develop an index that tracks U.S. home prices.<sup>1</sup> Changes in that index are to be used for making annual adjustments to the national conforming loan limit. The approach detailed in this paper could be used for that purpose.

Calculating reliable “median” or “mean” home values for any geographic area is difficult, particularly if the area is large and includes homes in heterogeneous neighborhoods. Assuming the goal is to produce summary home values for the underlying *housing stock*, and not the limited exercise of producing summary statistics for *transacting* properties, a number of problems can arise. For instance, because only a small fraction of all homes sell in a given period, for calculated statistics to be unbiased estimates of true values, transacting properties must be broadly representative of the housing stock in the area. Home values vary across many different dimensions (*e.g.*, location, size) and short-term fluctuations in the types of homes that transact can produce distorted estimates of price levels and even price changes.

Problems arising from changes in the geographic composition of the underlying data sample are particularly challenging to overcome. For example, the calculation of average home values for a given state can be problematic because within-state transaction volumes may disproportionately represent certain areas in a given period. For example, if appropriate adjustments are not made, a temporary increase in transaction volume in rural areas (which tend to be relatively inexpensive) could lead the statewide average price estimate to be lower than the true average home value.

The distortions caused by geographic volume shifts are generally greatest in the context of estimating the *level* of home values. Even within relatively small geographic areas, vast differences can exist between mean and median home values in component sub-areas and thus, as each sub-area’s contribution to the entire sample varies, the overall estimate will be directly affected. The problem can arise, however, even when estimating the *change* in home values for a given area. Price appreciation rates can vary substantially within even relatively small areas and thus, as changes occur in the component areas’ contribution to the overall sample, the estimate of price changes for the area as a whole can be distorted.

FHFA published research in early 2010 that, while focusing on calculating price metrics in smaller geographic aggregations, did discuss an approach for constructing a national measure of average prices.<sup>2</sup> The methodology assembled transactional information from a number of data sources, including mortgage data, and formed a national metric as a weighted average of average home prices in metropolitan, micropolitan, and rural areas. Although the resulting

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<sup>1</sup> See Section 1124 of HERA.

<sup>2</sup> See <http://www.fhfa.gov/webfiles/15401/WorkingPaper10-1.pdf>.

measure made use of a vast, geographically representative set of transactional data, the approach had some shortcomings. For example, changes in the reported average remained susceptible to biases arising from changes in the types of homes that transacted. If, for example, heterogeneous shifts in sales volumes occurred across the price spectrum (*e.g.*, sales volumes for most expensive homes declined relatively sharply over the given year), the price change reported by the national measure would be biased.<sup>3</sup> Also, the approach assumed a relatively stable relationship between home values and mortgage loan amounts—an assumption that was not generally borne out in the data.

The national metric described in this paper relies on mechanics and assumptions that are significantly different. Changes in the calculated average prices, under the new approach, are less vulnerable to biases arising from shifts in the types of homes that transact. Also, the methodology makes use of an even greater volume of transactional data than was used in the earlier model.

### **Primer on Existing National House Price Statistics**

Existing approaches to producing “national” house price measures—indexes and summary statistics such as average and medians—vary widely. In the majority of cases, the national measure is “built up” from metrics for sub-areas, but the size of those sub-areas differs substantially.

#### *Indexes*

In all but one case, the most commonly-cited national house price *indexes* are formed using data from sub-area indexes. Repeat-transactions house price indexes released by FHFA, Freddie Mac and S&P/Case-Shiller assemble their national metrics from index data for Census Divisions, which are collections of states.<sup>4</sup> The U.S. is comprised of only nine Census Divisions and thus each is quite large and consists of sometimes very different areas. For example, the Pacific Census Division includes California, Washington, Oregon, Alaska and Hawaii—states that have very different housing markets. The Census Division indexes are directly estimated using pooled transactions data from these geographically-clustered, but very different areas.

The mechanics of the three Census Division-based indexes do differ somewhat. Quarterly changes in FHFA’s national metric are, by construction, set to reflect the weighted average of quarterly changes in the respective Census Divisions.<sup>5</sup> By contrast, the national indexes released by Freddie Mac and S&P/Case-Shiller are directly computed as weighted averages of the index *values* for the nine Census Division index estimates. Separately, the target of the

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<sup>3</sup> The approach was more susceptible to this type of bias, in fact, than is the baseline repeat-transactions price index.

<sup>4</sup> S&P/Case-Shiller also publishes a 20-city index, which covers twenty of the largest U.S. cities. Although sometimes referenced as national measures, this metric and other similar statistics with more limited coverage (for example, RadarLogic’s 25-city indexes) are not discussed in this paper.

<sup>5</sup> See <http://www.fhfa.gov/webfiles/1047/Focus4Q07.pdf> for details.

FHFA index differs from the target of Freddie Mac's Conventional Mortgage House Price Index (CMHPI) and the S&P/Case-Shiller series. FHFA's national measure is a geometric repeat-transactions index, which generally will track changes in the median home price over time. The CMHPI and S&P/Case-Shiller indexes attempt to measure changes in the arithmetic mean home price.<sup>6</sup>

The Census Bureau's Constant Quality House Price Index (CQHPI) for the U.S. is a hedonic measure of changes in prices for newly-constructed houses. It is formed as a weighted average of indexes for the four U.S. Census Regions.<sup>7</sup> All transactional data from the four regions are pooled in estimating the regional indexes. Because there are only four U.S. regions and each includes states from two or more Census Divisions, the level of aggregation is even greater for the CQHPI than for the three Census Division-based indexes.

The CoreLogic National HPI does not "build up" the national index from sub-indexes. The repeat-transactions methodology, which aims to track changes in the average U.S. home price, directly estimates national price changes from a dataset of transactions pooled from the entire United States. That is, the regression models that produce the national repeat-transactions index are estimated using all transactions data available from the entire country. No cap or floor is placed on a given area's contribution to the national metric; as an extreme example, if 99 percent of real estate property transactions occurred in a single state over a given period, the national index would be a mirror image of trends in that high-volume state.

### *Mean and Medians*

The National Association of Realtors (NAR's) Existing Home Sales series is the most widely referenced national measure of average and median home prices. The reported U.S. mean and median statistics are weighted averages of mean and median price statistics computed for the four U.S. Census regions. The respective regional median and mean price estimates are calculated by assembling volume distribution reports submitted by Multiple Listing Services (MLS) and Realtor Boards within the component regions. While the number of reporting bodies in each region is not published, the total for the U.S. as a whole exceeds 200 and thus roughly fifty or more entities' data are generally used in forming the regional numbers.

The volume reports provided by the reporting bodies are frequency counts of sales transactions for various price ranges rather than individual property transactions records.<sup>8</sup> To account for the fact that sales volumes reflected in such measures do not incorporate all sales activity,<sup>9</sup> the submitted frequency counts for each recording body are "scaled up" by factors computed from a historical comparison of Census-based transactions volumes and the reported data. Once the scaling is conducted, the total number of regional transactions in each

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<sup>6</sup> The S&P/Case-Shiller index directly measures the arithmetic mean, while the CMHPI is an approximation based on the "Goetzmann correction." For details, see Charles Calhoun, "OFHEO House Price Indexes: HPI Technical Description," available at [http://www.fhfa.gov/webfiles/896/hpi\\_tech.pdf](http://www.fhfa.gov/webfiles/896/hpi_tech.pdf).

<sup>7</sup> The weights can be found at <http://www.census.gov/const/www/priceindexa3.html>.

<sup>8</sup> See NAR's methodology description at <http://www.realtor.org/research/research/ehsmeth>.

<sup>9</sup> NAR reports that "30-40% of all existing-home sale transactions" are "captured" in these reports. See <http://www.realtor.org/research/research/ehsmeth>.

price interval is calculated by summing the imputed volumes across the component areas. The regional mean and median home values are then directly estimated from the final frequency counts for the various price intervals.

While the national median and mean statistics produced by NAR hold fixed the contribution of the individual regions, no contribution constraints are imposed *within regions*. Although the component reporting units can cover relatively small geographic areas, the volume data from such areas are aggregated without a controlling weighting scheme. Accordingly, higher transaction volumes for a given geographic area can lead it to have a larger influence on the median and mean regional statistics.

The Census Bureau calculates national median and mean price statistics for new homes each month. The statistics are derived from relatively small data samples reporting contract sales prices for homes with new building permits. Each month, the Census Bureau randomly selects a 1 in 50 sample of homes with new building permits and then tracks those properties over time, recording transaction price information when contracts are signed. The “national” statistics are then formed by taking all observed contract prices and weighting each to reflect the number new home sales it likely represents. The “national” median is then directly calculated from the weighted transactional data.

In summary, by construction, the median and mean “national” price statistics computed are designed to have the greatest geographic coverage in areas where permitting activity has been the strongest. No effort is made to hold fixed the contribution of individual geographic areas to the national measure; because the intent of the measure is to reflect values for the newest permitted homes, such an effort would be counterproductive.

### **New Methodology: Data**

The first step in the new approach to constructing national price statistics is to assemble a complete dataset of historical property sales transactions. The strategy is to pool transactional data from all available sources, removing duplicates where transactions are evident in multiple datasets. After duplicate removal, the pooled data can then be used for calculation of median and mean prices.

FHFA has five real estate transaction datasets at its disposal. The first four contain transaction information embedded within mortgage-level data. The fifth reflects property sales recorded at more than five hundred county recorder offices throughout the United States.

The first of the four mortgage-level datasets includes loan information supplied by Fannie Mae and Freddie Mac (the “Enterprises”). The data include property street address, loan origination dates, sales price, and mortgage characteristics for purchase-money mortgages that the Enterprises have purchased or guaranteed since the 1970s.<sup>10</sup> These data, which form the

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<sup>10</sup> The Enterprises provide detailed information for refinance mortgages as well, including appraisal values associated with the collateral properties. The inclusion of the relatively large volume of these transactions would increase the sample size of the estimation dataset, but would also introduce distortions related to appraisal bias.



basis for the calculation of FHFA’s monthly and quarterly house price indexes (HPIs), have virtually full geographic coverage, as the Enterprises’ have no geographic restrictions on the mortgages they finance within the U.S. The sales transactions are limited, however, by the financing type; the home sales reflected in the data, by construction, must be financed with conforming mortgages.

Transactions for homes with FHA-endorsed mortgages are reflected in the second data source. The Department of Housing and Urban Development provides mortgage-level loan origination information to FHFA each quarter for research purposes. These data, much like the Enterprise dataset, include loan origination dates, sales prices, and mortgage characteristics for loans originated since the 1970s. Importantly, street addresses are also provided for each record. Although the FHA dataset includes records for refinance loans, only purchase-money mortgages are selected.

The third dataset includes mortgage origination and associated property transaction information found in servicer-level data compiled by CoreLogic (hereafter “CoreLogic Loan-Level Servicing Data”). The dataset, like the FHA and Enterprise data, includes sales price information for purchase-money mortgages financing homes throughout the U.S. Unlike the FHA and Enterprise data, however, the loans reflected in the dataset are not constrained by financing type; loans with all types of mortgage financing<sup>11</sup> are represented in the data. Because some loan servicers do not share their loan-level data with CoreLogic, the data are incomplete within the scope of mortgage-financed homes. Inasmuch as some of the servicers that do currently provide data only began providing information over the last several years, earlier period coverage of the total market is also more limited.

An important difference between the CoreLogic Loan-Level Servicing dataset and the FHA and Enterprise counterparts is that it contains no property street addresses for individual loan records. While each record in the dataset reflects the sale of a particular property, only the home’s ZIP code and state are revealed. This data hole, as discussed below, introduces some challenges that must be resolved in using the data for price estimation.

The fourth dataset, the CoreLogic LoanPerformance Securities database, also does not include street address information. The securities dataset provides loan-level information—including property ZIP codes—for securitized nonconforming subprime and jumbo mortgages. Because the U.S. securitization market has been largely dormant since 2008, the property transactions reflected in the database do not include recent sales information. The data are still useful, however, in providing additional property transactions records for the middle part of the 2000s—years in which a significant number of home sales were financed with privately securitized mortgages.

The fifth and final source dataset includes county recorder information aggregated by DataQuick Information Systems (“DataQuick”). FHFA licenses a dataset reflecting historical and recent property transactions data, including property addresses, sales prices and transaction dates, for more than 500 county recorder offices throughout the United States. Importantly, for those geographic areas covered by the dataset, the reported transactions will

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<sup>11</sup> Homes bought with cash are not included in the dataset.

represent a full census of all property sales activity within a given time frame; because all types of property transactions are recorded at such offices, property transactions with any type of financing (including cash sales) are reflected in the data.

### *Property Types*

After the pooled dataset is assembled, property type information is evaluated. All property types other than single-family, one-unit dwellings are removed from the dataset. This eliminates biases that would arise from changes in the mix of property types from period to period. For example, because sales prices for condominiums tend to be systematically lower than for single-family dwellings, if condominium transactions are not removed from the sample, calculated changes in average prices would be a mongrel of marketwide prices and changes in the share of condominium transactions.

### *Distressed Sales*

The underlying transactions data do not generally identify situations where the properties sold are owned by lenders (“Real Estate Owned” (REO)) or are short sales. Thus, “distressed sales” are present in the dataset and are treated like other transactions in the underlying calculations.

Whether such transactions ought to be included in estimating price statistics is debatable. The benefit of including such transactions is that these transactions provide valuable indications of true price levels in market downturns. Discouraged (distressed) sellers frequently pull their properties from the marketplace when prices fall, making it difficult to properly account for conditions in declining price areas because of shrinking transaction volumes.

If distressed sales were readily identifiable, arguments could be made for removing such transactions. Transaction prices for distressed sales tend to be lower than for other homes because sellers of such properties can be extraordinarily motivated to sell. Also, such homes can be in significantly worse condition than other transacting properties. To the extent that both of these factors can drive down observed prices to “artificially” low levels, removing such transactions may remove biased data points from the transactions data. The removal also would improve any estimates of price changes that are derived from those statistics.

### **New Methodology: Mechanics**

The fundamental approach produces national median and mean prices that are much less susceptible to biases from geographic shifts in transaction volumes. The primary strategy is to build up national mean and median value estimates from statistics for relatively small geographic areas. Under a proper weighting scheme, the formation of national estimates from statistics for small areas will tend to mitigate biases that can arise from changes in the geographic distribution of transactions over time.

It should be noted that the described approach does not aim to correct for long-term changes in the relative quality of homes. To the extent that the relative size or quality of homes improves over time, these secular shifts will be reflected in the median and mean price estimates.<sup>12</sup> The HERA legislation that motivates the construction of these measures does not specify that changes in average prices should be measured after excluding long-term drift in property quality.

At its core, the methodology is focused on removing the substantial noise that exists in *short-term* fluctuations in median and mean price metrics. The repeat-transactions modeling framework that provides the basis for the estimation is very good at removing many short-term distortions that afflict transactions-based estimates of median and mean price metrics.

### *Estimation of the National Median Home Value*

A time series of national median home value is estimated in four stages. The initial two stages involve estimating local area price statistics—indexes and median transactions prices—and then subsequent stages process those data, “building up” state and national measures.

The first step in the process is to calculate a quarterly repeat-transactions house price index for as many counties in the United States as possible.<sup>13</sup> The methodology used in the construction of the FHFA HPI is used at the county-level, subject to the availability of sufficient data.<sup>14</sup> The underlying repeat-transactions indexing methodology, it should be noted, does not precisely track the median home price. Rather, the approach reflects changes in the geometric mean house price. Under a number of circumstances, however, changes in the geometric mean home price are reasonably reliable approximations of changes in the median values.<sup>15</sup>

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<sup>12</sup> The impact of long-term improvements in average property “quality” is difficult to measure. While a clear secular trend exists toward larger home size and better amenities (*e.g.*, presence of air conditioning) exists, offsetting effects exist. For example, new home construction tends to occur in increasingly distant suburbs from central cities and thus, lot “quality,” might be perceived as declining. Separately, property depreciation (related to breakage and wear and tear) would also offset quality improvements.

Interestingly, the long-term growth rate difference between the FHFA repeat-transactions index—a measure that would be largely immune to the effects of quality drift—and the National Association of Realtor’s Median Existing Home Price—a measure clearly susceptible to drift—is not large and thus the impact of secular property quality change may not be large. The FHFA all-transactions house price index grew an average of 5.1 percent per year between 1975Q1 and 2010Q1 for the U.S., while the Realtors’ estimate of median home prices grew 4.7 percent.

<sup>13</sup> The “county” term will be used generically in this paper to include both counties and similar, county-equivalent areas (*e.g.*, counties, parishes, census areas).

<sup>14</sup> See Calhoun, Charles, “OFHEO House Price Indexes: HPI Technical Description” (available at [http://www.fhfa.gov/webfiles/896/hpi\\_tech.pdf](http://www.fhfa.gov/webfiles/896/hpi_tech.pdf)) for a detailed primer for the underlying HPI methodology.

<sup>15</sup> There are conditions in which changes in the geometric mean home price will more closely track changes in the average (arithmetic mean) home price. Under reasonable assumptions on the distribution of home prices and the distribution of home price appreciation rates, however, the index will tend to more closely track changes in median values.

As implied, county-level indexes are not estimated for every county in the United States. Those with relatively sparse data are pooled together before estimation. Counties that have fewer than 2,000 transaction pairs<sup>16</sup>—a relatively small sample prone to producing missing index values—are pooled together at the state level. Thus, for each of the 45 states for which small-sample counties exist—a pooled statewide “small-sample” index is formed. In total, 850 separate indexes are calculated—the 45 state pooled indexes plus 805 indexes for the large-sample counties.

Although the calculated indexes will generally be reliable indicators of trends in transaction prices (and, indirectly, values for the housing stock), they may be slightly biased in some areas because of coverage gaps in the underlying transactions data. The problem, likely to be of second order in magnitude, arises for areas of the country where the county recorder data form DataQuick are unavailable. In these locations, the only transactions data available for index construction come from FHA- and Enterprise-financed homes; the geographically-complete CoreLogic datasets (both the servicing and securities-based series) do not include the street address information necessary for transaction pairing and thus cannot be used. Loan limits for Enterprise- and FHA-financed homes will tend to skew the observed home prices toward the lower end of the price spectrum in these areas. This will not introduce bias where price trends are uniform across the price spectrum, but where they are not, the resulting index may tend to be underweight price trends that evident for more expensive homes.

The second step in the methodology is to calculate quarterly median prices for the 850 areas (counties plus small-county aggregates) identified in the first stage. Median transaction prices are calculated for historical quarters extending back more than a decade, and in many cases, back to the 1970s. Importantly, the dataset that is used in calculating these medians is substantially larger than the sample that can be used for estimating the indexes because it includes the CoreLogic securities and servicing datasets. The absence of property street addresses precluded the CoreLogic data from being used for repeat-transactions indexing, but street addresses are not necessary in this context; the only property information necessary for calculating local medians is price and county information. While the CoreLogic data do not report county *per se*, they do report property ZIP code. This can be used to infer the associated county for each transaction.<sup>17</sup>

The use of the CoreLogic data in calculating the price levels (the median value in this case) is important because it allows for a complete view of all transactions activity across the price spectrum where recorder data are unavailable. The transactional information from the

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<sup>16</sup> As discussed in Charles Calhoun, “OFHEO House Price Indexes: HPI Technical Description”, a “transaction pair” reports the change in a property’s selling price over a given interval. Pairs are constructed using historical transactions data for the same home over time. Homes with two historical transactions can generate a single transaction pair (showing price appreciation between the first and second transaction), while more transactions leads to more pairs. For example, three historical sales for a given home will produce two pairs—the first reflecting the price change between the first and second transactions and the second pair reflecting the change in selling price between the second and third transactions.

<sup>17</sup> The ZIP code-to-county relationship is not always one-to-one, but roughly 80 percent of ZIP Codes are associated with only one county. For multi-county ZIP codes, the assigned county is that which historically had the majority of property transactions..

CoreLogic samples effectively “fill in” the data sample for more expensive homes. This is particularly important for producing unbiased estimates of price levels, because censoring of data, in this context, directly affects estimates. The problem of underrepresentation of expensive homes biases price change estimates only if price trends differ across the price spectrum. Price level statistics (*e.g.*, medians and means), by contrast, are directly biased if there is underrepresentation for such homes.

The third stage is in the estimation of national median prices entails using the relationship between the calculated medians and the local-area indexes to estimate a time series of “true” local medians. The assumption is that, when considered over a relatively long time frame—say the prior 20 quarters—the average ratio of the calculated median from stage 2 to the index values from stage 1 should be relatively constant. The ratio amounts to a conversion factor which will fluctuate from quarter to quarter depending on the types of homes that are transacting in any given period. For example, the ratio might be \$1,000/index point in a quarter in which relatively expensive homes transact and \$850/index point in another period with more sales among inexpensive properties. Over a long interval, however, the average of the prior twenty quarters’ ratios should provide a reliable multiplier factor that can be used to convert the index series into a levels series. The resulting series of median prices—calculated by multiplying the average ratio by the index values—will mirror the path of the repeat-transactions index. By construction, changes in the resulting median series will generally have the same desirable attributes (*e.g.*, minimal noise caused by short-term changes in the types of homes that transact) as the repeat-transaction index itself has.

As suggested above, the average conversion ratio is calculated on a rolling basis over the last 20 quarters—a time series long enough to incorporate data from much of the boom and bust and to ensure that the average is not overly influenced by short-term fluctuations. Although slightly longer or shorter intervals might also be reasonable, the resulting estimates for the national median home price (and changes in the national median price) do not change significantly under different calculation windows.<sup>18</sup>

The fourth and final step in calculating the national median value is to take the weighted average of the local area median values. A state median value series is calculated as the weighted average of the median values for the component counties and aggregated pooled area. The weights are the proportion of single-family detached properties that were in the respective counties (and pooled county aggregate) as of the 2000 Census.<sup>19</sup> The national median home value is then built up from the state values in the same way, except that the state-medians form the basis for the weighted averages. The state housing stock shares as of the year 2000 are used as the respective weights.

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<sup>18</sup> Note that, if there is significant drift in house quality over time, the “conversion” factor will reflect that drift (*e.g.*, if homes become bigger and better, the conversion factor will drift upward). In effect, the median and mean prices that result from the procedure can then be interpreted as reflecting the average home quality in the middle of the lagged period. With a 20-period (*i.e.*, 5-year) lag, then, the most recent median and mean prices will generally reflect average property quality during the period.

<sup>19</sup> More recent estimates of county-level housing stocks for detached properties are not available for every county in the U.S.

## *Estimation of the National Average Home Values*

Only two minor modifications to the methodology are necessary to generate a series of average U.S. house values rather than medians. First, the index values produced in the first step must be modified to reflect changes in the *arithmetic* mean local home value instead of changes in the geometric mean. A convenient way of performing the conversion is through applying the “Goetzmann correction,” an imperfect-but-simple adjustment that can be easily made using summary statistics from the basic (geometric) repeat-transactions indexing model estimated in stage 1.<sup>20</sup> The second necessary modification involves computing a time series of average prices rather than median prices in stage 2. With this change, the first and second stages of the basic methodology then are consistent in that they both focus on average values (rather than medians).

The remainder of basic methodology proceeds as before. In this case, the average “conversion” factor in the third stage will be a multiplier for translating arithmetic repeat-transactions index values into local average price estimates. Then, once the local average price series is generated, as before, it is weighted by housing stock shares to produce the state and national series.

### **New Methodology: Empirical Estimates**

#### *Price Levels*

Figures 1a and 1b compare the median and mean price series constructed under the new methodology against the medians and means published by the National Association of Realtors. As indicated earlier, NAR’s series are the most widely-published summary statistics for U.S. house prices.

The median and mean values produced by the new methodology generally follow similar trajectories vis-à-vis the NAR series. Also, at least in recent periods, the median and mean price levels reflected in the respective series are not dramatically different. Under the new methodology, the U.S. median house value in the second quarter of 2010 is estimated to be \$180,200, about \$3,100 above the \$177,100 median published by the NAR. The mean home value estimate is farther from the NAR value, with a difference of \$8,900.

The graphs do reveal that the respective median and mean estimates do differ significantly in some earlier periods. Notably, the NAR median values seem to systematically exceed the estimates from the new methodology in the earliest part of the decade. At least two factors may explain this outcome. First, the transactions dataset assembled by FHFA, though extremely large, may still lack full representation for the most expensive properties during this period. In areas of the country where no county recorder information is available, FHFA’s data sample relies on mortgage data from CoreLogic—both its servicer-sourced and its securitized mortgage datasets—to incorporate price information for the most expensive

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<sup>20</sup> See pages 10-11 of the HPI methodology primer ([http://www.fhfa.gov/webfiles/896/hpi\\_tech.pdf](http://www.fhfa.gov/webfiles/896/hpi_tech.pdf)) for a discussion.

homes. Collectively, these datasets may have had more limited coverage in earlier periods and thus their ability to “fill in” transactions information for the most expensive homes may have been limited.

The second potential explanation is that transactions volumes in the most expensive areas may have been relatively high in the early part of the boom. This issue—which is one of the factors the new methodology attempts to address—is illustrated in Figure 2. The figure plots California’s share of total transactions activity in the West Census Region between 2000 and 2010. The graph reveals that, in the earliest part of the decade, California’s transaction activity was relatively high; its share of transaction volume generally exceeded its share of the housing stock in the West Region.<sup>21</sup> Thus, in that period, California’s higher-priced homes would have greater influence on NAR’s (transactions-based) median and mean price estimates than on the estimates produced under the FHFA methodology.

More generally, with the vast swings in relative volumes over time, Figure 2 provides an excellent illustration of the need to control for volume shifts over time. The relative volume shifts—and thus the potential distortionary effects of volume changes—are extreme, particularly during the financial crisis. Between the second quarter of 2007 and the first quarter of 2009, for example, California’s share of West Region transactions rose from a trough of 36 percent, to a peak of 59 percent.

Figure 3 evaluates the extent to which differences between the NAR values and the new estimates can be attributed to the new fixed weighting system (*i.e.*, the new methodology) as opposed to differences in data samples. The graph adds a new series to Figure 1a—a series constructed with the pooled FHFA dataset but with a methodology similar to that employed by NAR.<sup>22</sup> Comparison of this new series to the already-produced NAR and FHFA median value estimates allows for a general determination of how much of the “gap” between the series is explainable by the respective factors.

FHFA’s NAR-like median price series, interestingly, is very similar to the original FHFA median price series for the early part of the decade, but converges toward the NAR estimates in the latter years. The natural interpretation of this result is that, for the early part of the decade, the major explanator of the difference is data-related. The NAR-like median is very similar to that produced by the fixed-weighting system devised in this paper and thus the implementation of the new methodology had little aggregate effect. Over the last several years, however, the opposite phenomenon exists; the NAR-like series produces estimates much closer to the NAR’s median than to the estimates produced under the new methodology. The two series’ estimates are also no longer systematically higher than the new approach’s

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<sup>21</sup> The reported housing stock share reflects the proportion of one-unit detached properties in California as a share of the total stock in the West Region. For 2000, the estimates are derived from the decennial census, while for 2004-2008, values are obtained from the one-year American Community Survey estimates. Shares for 2001 through 2003 are (straight-line) interpolated based on the 2000 and 2004 share estimates. The plotted share values for 2009 and 2010 merely reflect the 2008 estimate.

<sup>22</sup> Details underlying the NAR approach—for example, the weights applied to each of the Census Region median values in constructing the national values—are not available. Thus the estimates are imperfect measures of what the values would be under the NAR approach.

estimates. These finding suggests not only that fixed-weighting system implicit in the new approach has become more important, but also that any coverage gaps in FHFA's pooled dataset have been minimized.

### *Price Changes*

Table 1 reports changes in the newly-constructed U.S. median and mean value estimates over the last three years. The changes are shown in the context of price change estimates calculated from NAR data as well as from widely-cited price *indexes*. Price changes are shown for the latest four-, eight-, and twelve-quarter intervals.

Over the latest year, the price changes reflected in the various series are quite different. The median and mean price series produced by NAR and the series produced in the approach described here estimate price increases of between 1 and 2 percent, but the repeat-transactions-based series show much different estimates. The two FHFA series estimate declines of between 2 and 5 percent, while the CoreLogic and S&P/Case-Shiller series show increases of just below 4 percent.

Over the three years, the respective series all clearly show relatively large price declines, with the FHFA repeat-transactions indexes evidencing the least severe declines (11 to 12 percent over the past three years) while the CoreLogic and S&P/Case-Shiller indexes declining nearly 25 percent. For those metrics that have shown increases over the latest year, it is clear that those increases have only slightly offset much larger price declines over the preceding years.

Another notable observation that can be made from the table is that the FHFA median and mean price series produced in this paper show much greater declines than the FHFA price *indexes*. This finding generally stems from the inclusion of additional transactions data for non-Enterprise-financed homes in the median and mean price estimation. As reported in Leventis (2008),<sup>23</sup> significant differences in price trends across financing types have been observed, even controlling for differences in the geographic clustering of homes.

### *Median and Median Prices by State*

No public or private data providers release timely time series data for median and mean house prices by state. Estimates of price *changes* derived from house price indexes are released by various entities (including FHFA and CoreLogic), but these entities and NAR do not release summary statistics for price levels for individual states.

Fortunately, state estimates of median and mean house prices can easily be produced as a by-product of the approach described in this paper. The state mean and median prices are merely built-up from the component counties' relative share of the statewide housing stock. A time series of mean and median house price estimates by state has been produced and is available for download at: <http://www.fhfa.gov/Default.aspx?Page=87>.

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<sup>23</sup> See <http://www.fhfa.gov/webfiles/1165/pricesandfinancing.pdf>.



## **Alternatives and Issues**

The estimation approach described in this report goes a long way toward mitigating biases that can arise from short-term shifts in transaction volumes across geographic areas and home types. Because state and national statistics are built up from relatively small geographic areas and those areas are given constant weights, the resulting aggregate statistics provide reliable estimates of price levels and price trends over time.

It should be noted that, with a census of accurate property addresses for the United States in each period and at least one sale price for each property, the weighting problem that is mitigated by this approach could be avoided. If values for each U.S. property were generated in every period, state and national summary statistics could be directly calculated from those, which would maintain fixed weighting.

Of course, valuing each property in every period would involve significant difficulty and error. Because transaction prices would not be available for some properties, observed summary statistics would still need to be weighted to ensure that the unobserved housing stock was properly accounted for.<sup>24</sup> Separately, for homes that did have transactions data, implementation questions would arise with respect to valuations in “in-between” periods. For example, while one might use repeat-transactions index values to “backcast” or “forecast” period-specific values in cases where only one historical transaction was available, it is not obvious how to optimally fill-in values in cases where multiple historical transactions are available for the same property.

Absent a period-specific listing of home property addresses for all U.S. homes, an alternative would be to use the universe of property addresses observed in the dataset assembled for this paper. Although specific property addresses are not available in the CoreLogic mortgage-level data,<sup>25</sup> more than 40 million unique property addresses are observed in the Fannie Mae, Freddie Mac, FHA, and DataQuick transactions data. The repeat-transactions indexes could be used to produce period-specific value estimates for each of those properties. Then, to ensure that the other 30+ million properties are accounted for, price statistics for the observed dataset could be weighted using housing stock estimates from the census. State and national values could be “built up” using the estimated summary statistics and the housing stock estimates. Another difficulty is that many of these properties have not had the same house on them for the entire period of the indexes.

FHFA is investigating whether such an approach, or one that would rely on a census of properties (with street addresses), could act as a complement or a substitute to the

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<sup>24</sup> Accounting for new homes (whose existence might be recorded in any data source) and torn-down homes would be particularly difficult in this stage.

<sup>25</sup> As indicated earlier, these mortgage data include ZIP codes, but not street addresses. It is thus not possible to precisely determine whether transactions recorded in the CoreLogic data are for homes that are observed in the other data sources.

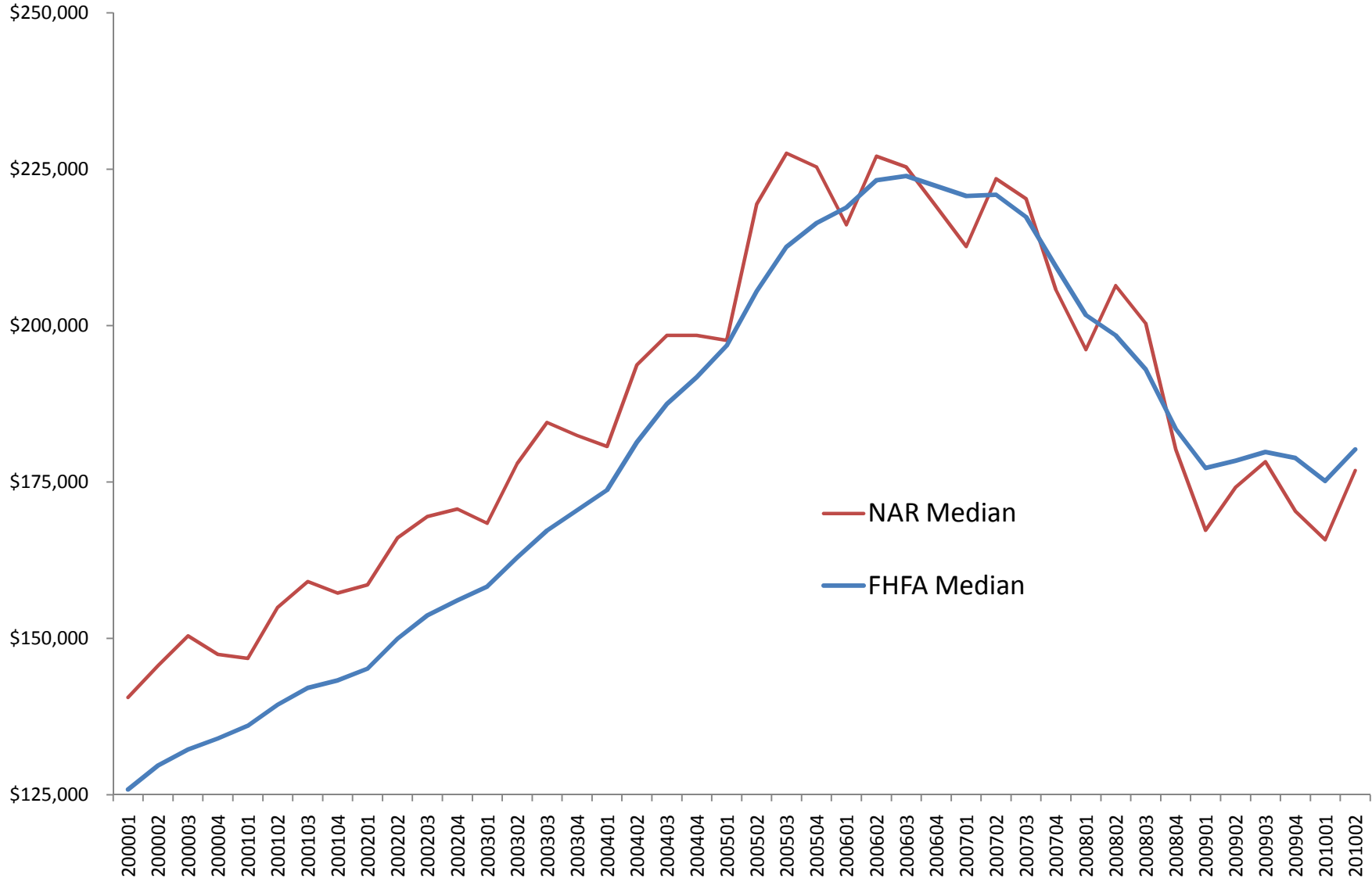
methodology described in this paper. These methodologies are considerably more involved in estimation and thus would need to provide some significant benefits (with significantly different results) to be worthwhile.

Separately, FHFA is evaluating the closeness of the relationship between trends reflected in geometric repeat-transactions house price indexes and median prices. Also under investigation is the extent to which the weighted average of median prices for sub-areas closely tracks median prices for larger areas. In building state and national median price statistics, the methodology in this paper presumes that the unit-weighted average of median price for sub-areas will be reasonably close to the (unobserved) median for the larger area. FHFA intends to ensure that this assumption holds under a range of circumstances.

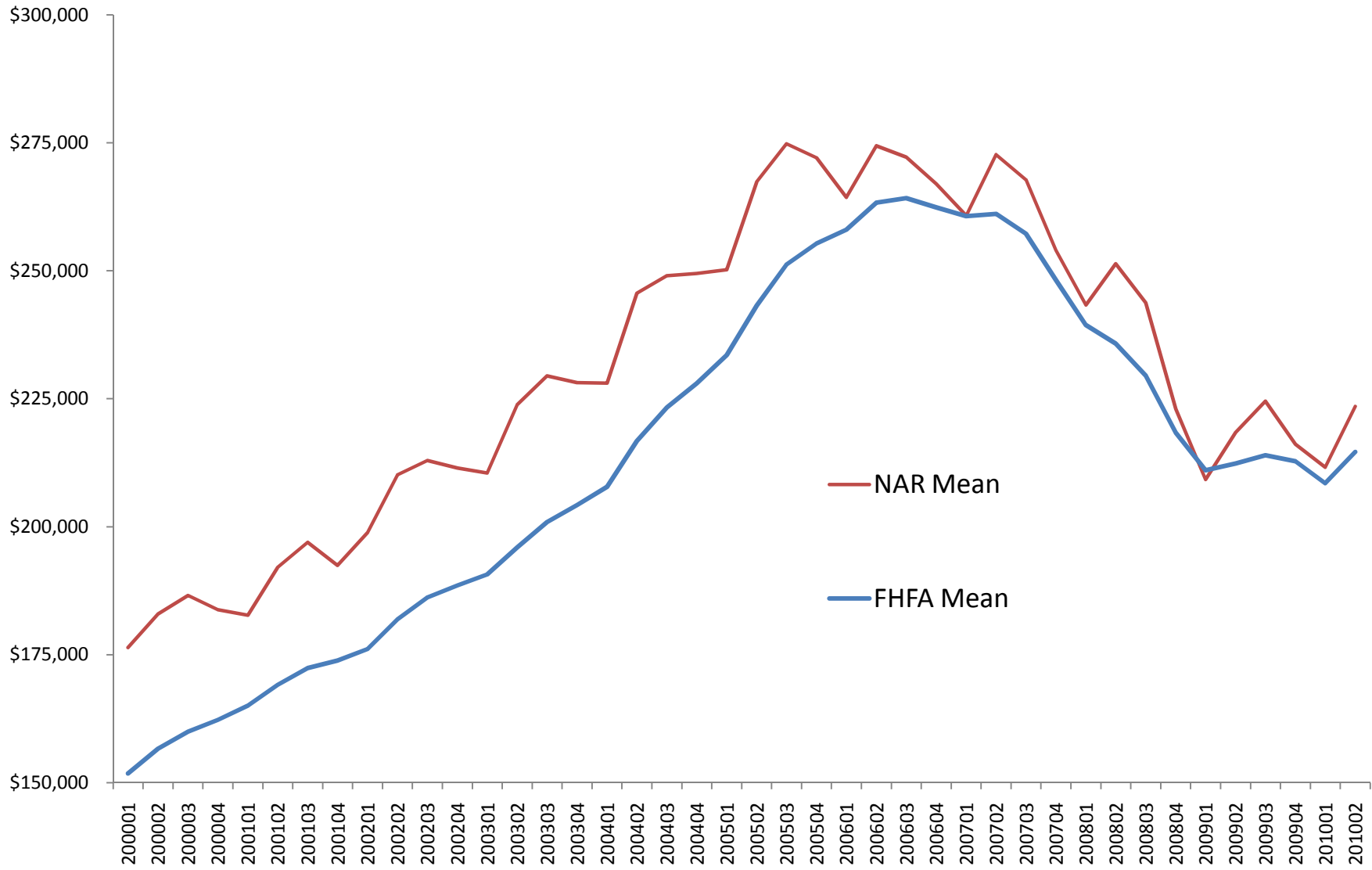
FHFA welcomes comments and questions about any of these issues, as well as about the general methodology. Comments and questions can be addressed to Andrew Leventis, Senior Economist, Office of Policy Analysis and Research (email: <mailto:andrew.leventis@fhfa.gov>).

**Figure 1a: FHFA-Estimated Median Price vs. NAR Median Price Estimate**

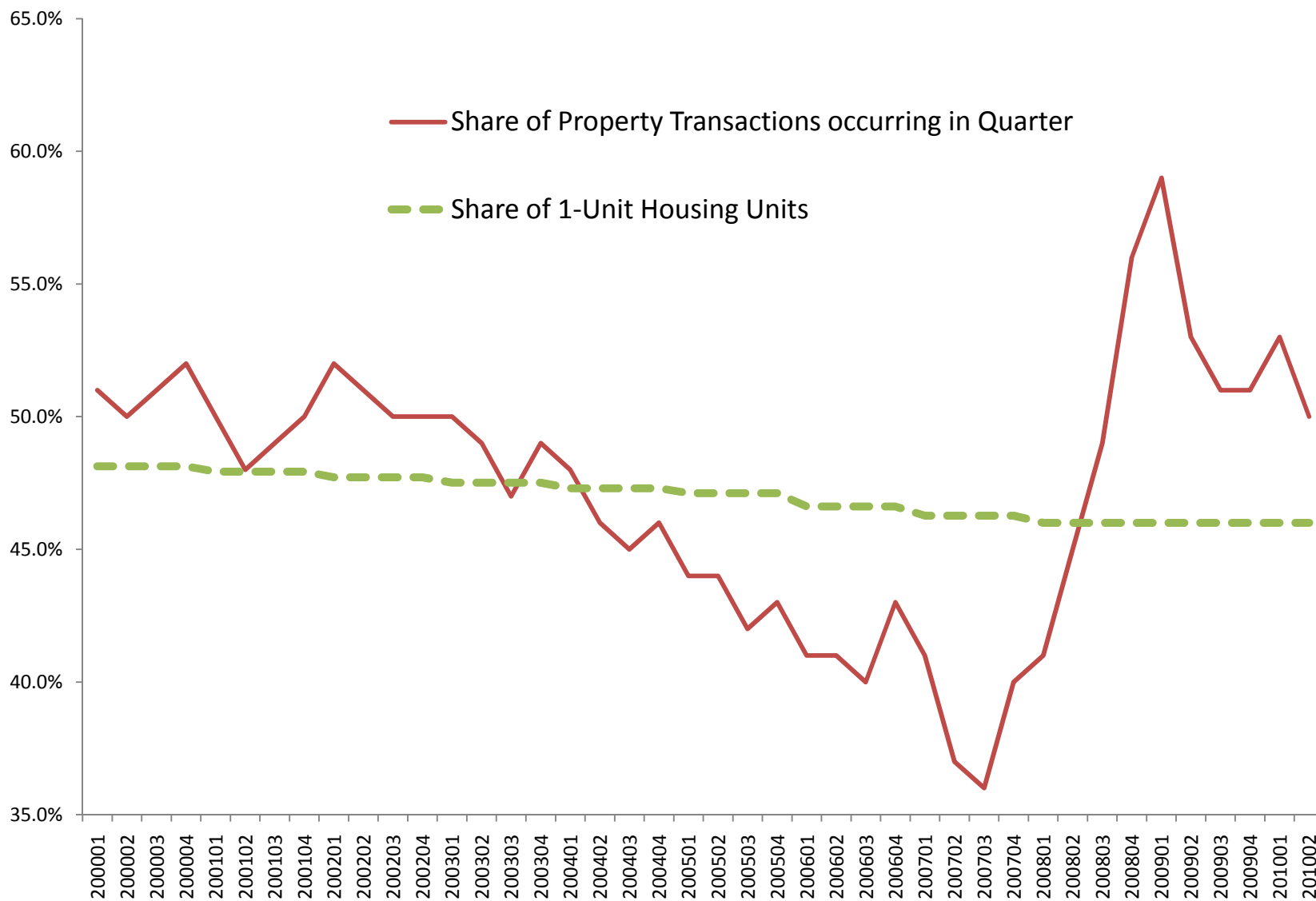
USA



**Figure 1b: FHFA-Estimated Mean Price vs. NAR Mean Price Estimate**  
USA



**Figure 2: California's Contribution to the West Census Region**



**Figure 3: Median U.S. House Prices Calculated under Various Approaches**

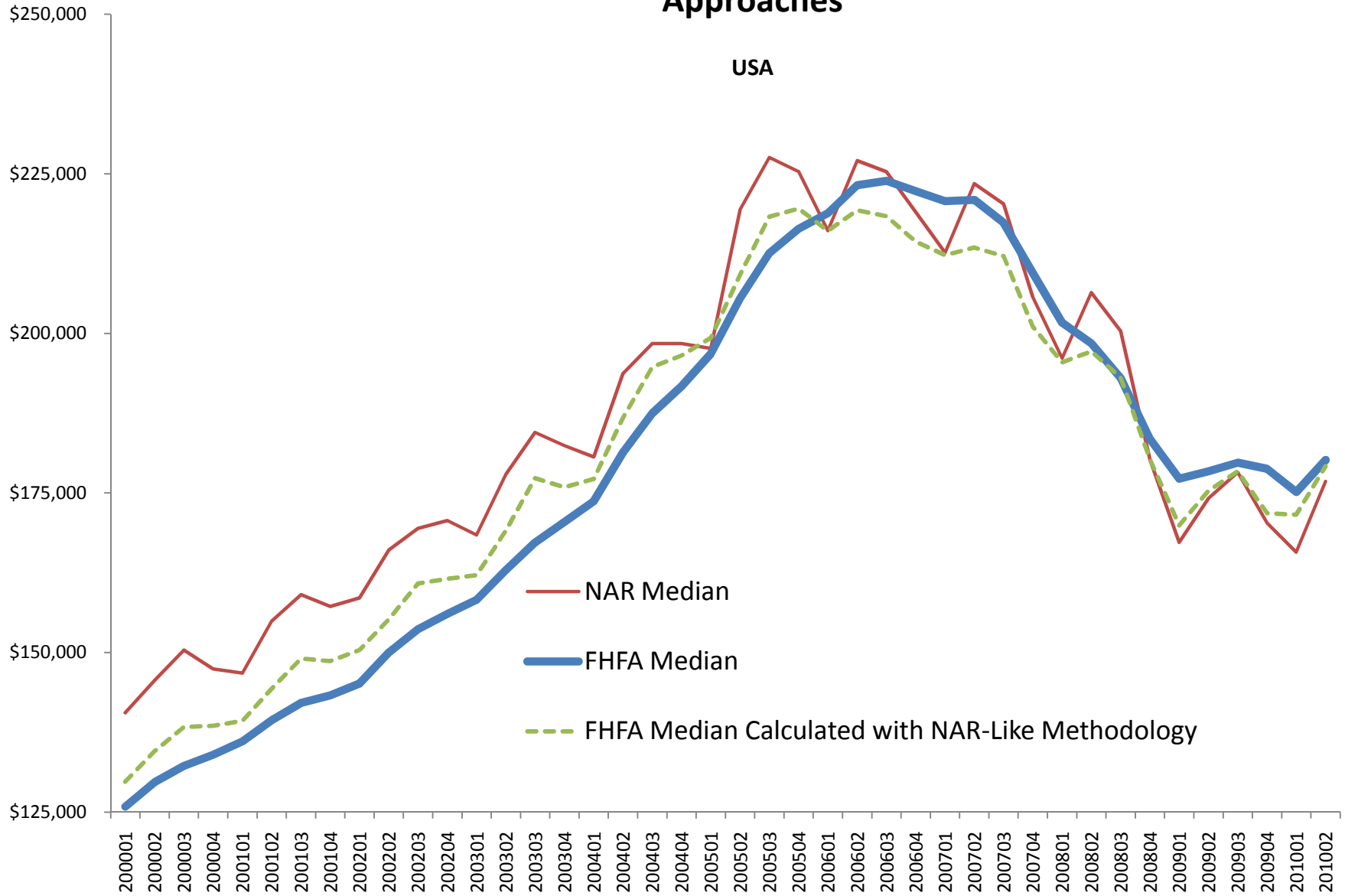


Table 1: Total Estimated Changes in U.S. House Prices  
New Summary Metrics versus Existing Price Measures

	2009Q2-2010Q2	2008Q2-2010Q2	2007Q2-2010Q2
<u>Price Levels</u>			
[1] <b>FHFA-Computed National Median</b> (Unit-weighted average of county-level median estimates. County estimates formed using historical relationship between repeat-transactions index values and median of transaction prices)	1.0%	-9.2%	-18.4%
[2] <b>NAR National Median Price</b>	1.5%	-14.3%	-20.9%
[3] <b>FHFA-Computed National Mean</b> (Unit-weighted average of county-level average price estimates. County-level estimates formed using historical relationship between repeat-transactions index values and mean of transaction prices)	1.1%	-9.0%	-17.8%
[4] <b>NAR National Mean Price</b>	2.3%	-11.1%	-18.1%
<u>Repeat-Transactions Indexes</u>			
[5] <b>FHFA Purchase-Only</b> [ <i>Geometric</i> ]	-1.6%	-7.3%	-12.3%
[6] <b>FHFA All-Transactions</b> [ <i>Geometric</i> ]	-4.9%	-8.7%	-11.2%
[7] <b>S&amp;P/Case-Shiller Index--National</b> [ <i>Arithmetic</i> ]	3.6%	-11.5%	-24.6%
[8] <b>CoreLogic National Index</b> [ <i>Arithmetic</i> ]	3.8%	-12.7%	-24.4%

Note: NAR's national median and mean values are reported monthly. The monthly values are converted to quarterly estimates by averaging the values for the three component months in each quarter.