DOI: 10.1111/1540-6229.12351

ORIGINAL ARTICLE

WILEY

# Appraisal overvaluation: Evidence of price adjustment bias in sales Comparisons

**Yanling G. Mayer** | **Frank E. Nothaft**

CoreLogic Inc., Irvine, California, USA

**Correspondence**
Yanling G. Mayer, CoreLogic, Inc., Irvine, California, USA.
Email: ymayer@corelogic.com

A previous version of the paper was presented at the 2017 AREUEA National Conference. The views expressed are those of the authors and do not necessarily reflect the position of CoreLogic or its management.

**Abstract**

Home appraisal came under scrutiny for contributing to the home-price bubble and enabling the origination of risky mortgages that led to the post-2006 foreclosure crisis. Subsequent regulations tried to minimize or eliminate conflicts of interest and improve valuations. Nonetheless, our study of appraisals completed in 2015 and 2016 find that appraisal bias still occurred. Our analysis delves into the underlying appraisal development to identify causes of appraisal bias. Contributing factors are that comps are generally higher valued than the subject property, and appraisers are more likely to comparatively adjust upward lower priced comps but less likely to adjust downward higher priced comps.

KEYWORDS
housing price determination, residential appraisal

JEL CLASSIFICATION
R31

## 1 | INTRODUCTION

Traditional home appraisal—in which lenders contract state-licensed or certified appraisers to provide an estimate of the fair market value of the residential property—is an integral part of the

mortgage underwriting process. Typically required in federally regulated real estate transactions, home appraisals are used by lenders to calculate a borrower's loan-to-value ratio (LTV), a key underwriting metric and an important indicator of the loan's potential risk of default.[1]

In the fallout from the 2004 to 2010 U.S. housing market boom-and-bust, home appraisal came under scrutiny for its role in contributing to risky mortgages and unsustainable home prices. Apart from anecdotal accounts of reportedly widespread appraisal irregularities (Financial Crisis Inquiry Commission, 2011), a growing financial literature on asset quality and mortgage securitization has helped shed light on how collateral misrepresentation, such as appraisal overvaluation, played a role in inflated home prices, deteriorations in loan quality, and increases in mortgage fraud (Griffin & Maturana, 2016; Lacour-Little & Malpezzi, 2003; Piskorski et al., 2015). Griffin and Maturana (2016) found that as many as 45% of the appraisal values for the securitized loan pools they analyzed were inflated and associated with higher mortgage delinquency rates.

With the central role of collateral in mortgage credit decisions, the last mortgage crisis has prompted research on the identification and measurement of appraisal overvaluation in both purchase money and refinance mortgage transactions (Agarwal et al., 2015; Calem et al., 2015; Griffin & Maturana, 2016; Kruger & Maturana, 2020). However, the underlying mechanism that leads to appraisal overvaluation remains unclear.

Available evidence generally indicates that newly strengthened regulations for ensuring appraiser independence have led to a lower frequency of appraisal overstatement in the aggregate (e.g., Agarwal et al., 2020; Ding & Nakamura, 2015; Shi & Zhang, 2015). But it has left unanswered an important question: Have the new independence rules fundamentally improved the overall appraisal accuracy, consistency, or objectivity as a valuation method? In other words, is there evidence that goes beyond the aggregate level to suggest that at the microlevel the valuation process is or has become more fundamentally sound and accurate?

This study sheds light on these issues by analyzing appraisal development. Under the sales comparison approach, appraisal development is a process in which appraisers make comparative adjustment to select a few recent transactions that are regarded as most similar or competitive to the appraisal property. Current or recent market transactions of these properties, known as comparable sales or "comps," are the primary basis for the appraisal development. The appraisal development process entails calibrations of each comp with the appraisal property (also known as the "subject" property) to make the comp a hypothetically identical bundle of housing characteristics. The resulting calibrated value of the comp property—known as the adjusted comp price–becomes a fair market value estimate for the approximation of the subject property.

Using a novel dataset that contains information on the selection as well as adjustment of representative price data, we extend prior research to examine the appraisal development process for underlying causes of appraisal bias. Available evidence (e.g., Eriksen et al., 2020; Mayer, 2015) shows that representative comps are frequently upward-biased in price. Eriksen et al. (2020) attribute a greater reliance on high-valued comps as representative price data (i.e., selection bias) to the appraiser's prior knowledge of the subject property's sale price or confirmation bias. However, existing studies did not control for exogeneous factors (e.g., thinness of market transactions), which in practice can often impact and constrain the pool of comp candidates and thus the quality

[1] Banks are regulated under Title XI of the 1989 FIRREA (Financial Institution Reform, Recovery, and Enforcement Act) to adopt prudent appraisal practices in the determination of a collateral's market value. Separately, the originations of mortgage loans insured or guaranteed by a federal agency or sold to a government-sponsored enterprise (GSE) are subject to additional appraisal requirements by these entities.

of representative price data. In this study, we utilize a larger and more representative dataset to provide quantitative evidence on comp selection.

But selection bias in itself may not be sufficient to transmit appraisal bias as long as the calibrated comp values provide unbiased estimates of the subject property. We argue that when one introduces calibration/adjustment bias into the appraisal process, the use of higher valued or better-amenity comps becomes a necessary condition. Our quantitative assessment of the appraisal process finds significant evidence of downward friction limiting the downward price adjustment of better-amenity comps. When better-amenity comps are insufficiently calibrated, it allows their value estimates for the subject property to become overstated. If the appraisal development process is for some reason prone to such calibration bias, known or unbeknown to appraisers, it becomes inevitable that the biases will be transmitted onto the final appraisal value. Eriksen et al. (2020) find evidence of appraisers applying greater weights to higher valued comps. We argue that in the presence of calibration bias, even equally weighted comp weights could allow the bias to transmit and persist.

Using a large sample of appraisals ordered to underwrite purchase-money loan applications in 2015 and 2016, we find that about 69% of comps were represented by transactions valued at more than the subject property. After controlling for the availability of market transactions and a variety of loan and property characteristics, we continue to find a greater likelihood of selecting more expensive comps. We also find a strong positive correlation between leverage and the representation of more expensive comps.

When comp price adjustments are further analyzed, we find strikingly disparate adjustment patterns between lower and higher valued transactions. Downward adjustments to higher valued comp sales are much smaller in size and increase less as the difference between the subject and comparable price widens—a proxy for potential difference in underlying housing characteristics between the two. The upward adjustments to lower valued comps appear more appropriate in magnitude and tend to rise commensurate with the subject-comp price difference. Consequently, less expensive comps typically become more price-aligned with the subject property but more expensive comps have largely remained higher priced.

Specifically, higher valued comps, which on average had a market price averaging 11.9% above the subject property's sale price, are adjusted lower by an average of 3.75%. In contrast, upward price adjustments on lower valued comps are proportionately larger at 5.7% in view of their initial 7.2% lower price relative to the subject. The disparities are more pronounced when we divide the comparable transactions into different price buckets. For instance, downward price adjustments only average 8.0% on comps that had a 20%–30% price premium, whereas comps with a 20%–30% lower price differential received a much larger upward value adjustment at 17.4%.

Moreover, when average adjustments on comps in the 20%–30% price premium bucket are compared to the adjustments received by those commanding a 30%–40% price premium, the difference is surprisingly small, rising only slightly from 8.0%–9.8%. In contrast, adjustments on lower valued comps in these two price buckets rise quickly from 17.4%–28.6%. A 28.6% upward price adjustment on lower comps seems roughly consistent and proportionate with an initial 30%–40% price difference, but a 9.8% downward adjustment on higher comps commanding a 30%–40% price premium arguably does not.

Our analysis shows higher priced comps receive 0.36% downward adjustment for every 1% of price differential with the subject on average, whereas lower priced comps receive a 0.77% upward adjustment for each 1% of subject-comp price difference. Furthermore, the percentage adjustment varies with the extent of the discrepancy between the subject and comp prices: for an additional 1% price difference with the subject, higher valued comps will only receive 0.22% decrement in

their adjusted sales price, whereas lower valued comps will receive an equally sized 1% increment in adjusted price.

Taken together, our analysis finds that the sources of appraisal overvaluation include (1) a selection bias of representative market transactions which are valued at more than the subject; (2) a first-order calibration bias in which higher valued comps often receive relatively small downward price adjustment, whereas lower valued comps are more likely to be adjusted upward to more closely align with the subject; and (3) a second-order calibration bias in which downward adjustments on higher valued comp sales do not increase as the comp-subject price difference widens, whereas upward comparative adjustments on lower valued comparable sales increase commensurately as the price difference with the subject widens.

## 2 | SUMMARY OF APPRAISAL ISSUES

Appraisal regulations require home appraisals be performed by state-certified or licensed appraisers who, at a minimum, must follow the standards and requirements in accordance with the Uniform Standards of Professional Appraisal Practice (USPAP) in the reporting and development of the work. Although only transactions priced above the regulation threshold are required to have an appraisal, lenders will typically obtain an appraisal to determine the LTV and collateral adequacy except for low-risk loans.[2] The most recent data available indicates that lenders obtained appraisals on 98% of purchase mortgages and 88% of refinance mortgages (GAO, 2011). Appraisal is thus a generally preferred primary valuation method with the exception of some low-risk mortgages.

Appraisals produce a point estimate (also known as "opinion of value") of the probable market value of the collateral, and the required approach is known as the sales comparison approach, although appraisers may also provide a cost-based value when requested by lenders.[3] Under the comparison approach, appraisers identify recent sales of properties that are similar and competitive to the appraisal property (known as "comparables" or "comps") in terms of physical and economic characteristics such as location, attributes, property rights, and condition of sale (such as sales or financing concessions). The transaction price on each such comp is then calibrated for observable characteristic differences until the property is deemed hypothetically identical to the appraisal property (also known as the "subject"), thereby permitting its hypothetical price (that is, the adjusted price) to approximate the subject's fair market value. For instance, if a comp lacks (contains) a desirable physical or locational feature that the appraisal property has (lacks), an estimated amount of the identified feature's market value will be added to (subtracted from) the comp's transaction price. Conceptually, this process allows for the development of a valuation based on other arms-length market transactions, so that it provides mortgage underwriters with a valuation independent of the accepted offer price on the property.

[2] Effective October 9, 2019, the threshold has been increased from $250,000 to $400,000 for federally related transactions: https://www.housingwire.com/articles/its-official-appraisals-are-no-longer-required-on-some-home-sales-of-400000-and-under/

[3] The cost approach requirement for single-family homes was dropped by Fannie Mae in November 2005 when it mandated the use of the new Uniform Residential Appraisal Report -Form 1004.

## 2.1 | Appraisal independence

Among the many factors influencing the appraisal accuracy, probably one of the better known is potential institutional conflicts of interest that may directly or indirectly influence and bias the appraisal outcome. The most recent direct evidence on such institutional pressures which appraisers reportedly were subject to came from the 2011 Financial Crisis Inquiry Commission (FCIC) Report. The FCIC report cited a petition "signed by 11,000 appraisers including the name and address of each," which alleged that "lenders were pressuring appraisers to place artificially high prices on properties." The report further stated that "[a]ccording to the petition, lenders were 'blacklisting honest appraisers' and instead assigning business only to appraisers who would hit the desired price targets."

The fact that time and again following major real estate lending crises, new rules and standards were established to safeguard the integrity of the appraisal process serves as a reminder of its vulnerability by design to potential conflicts of interest. As an example, the 2009 Home Valuation Code of Conduct (HVCC) addressed conflicts of interest by enacting appraiser independence requirements, followed by the 2010 Dodd-Frank Act which phased out the HVCC but included appraiser independence requirements similar to the HVCC. Studies comparing home appraisals before- and after-HVCC found some evidence of reduced appraisal inflation (e.g., Agarwal et al., 2020; Ding & Nakamura, 2015; Shi & Zhang, 2015).

## 2.2 | Appraisal confirmation bias

Researchers often attribute the appraisal's propensity to support the collateral underwriting to agency incentives (see, e.g., Agarwal et al., 2015; Calem et al., 2015; Cho & Megbolugbe, 1996; Eriksen et al., 2020; Ferguson, 1988; Kruger & Maturana, 2020; Lentz & Wong, 1998). According to the agency theory, the principal–agent relationship between lenders and appraisers offers an institutional framework to understand the inherent bias in the appraisal process. As hired agents of the lender, appraisers have an incentive to appraise the properties at a relatively higher value to avoid becoming an impediment to the pending transactions.

However, inflated appraisals can lead to an underestimation of credit risk and thus lower profitability to lenders because of underpricing of potential loan risk or a higher-than-expected rate of nonperforming loans. Although recent regulatory changes under the HVCC and the Dodd-Frank Act have had some positive impact on reducing inflated appraisals, a majority of appraisals on purchase transactions continue to be above the subject property's price.

Cho and Megbolugbe (1996) first reported the salient pattern using residential mortgage loans that Fannie Mae securitized. The study found that with very few exceptions, appraisals associated with purchase loans exhibited a strong bias toward confirming the purchase price: the appraisal value exceeded the transaction price in 65%–67% of the loans, was identical to the transaction price in 30% of the loans, and fell short of the transaction price in only about 3%–5% of the loans.

This appraisal pattern was confirmed by other studies. A comprehensive industry review released by the Collateral Assessment & Technologies Committee in 2005 documented a similar pattern using appraisal data going back as far as 1977. Calem et al. (2015) showed that the percentage of at- or above-transaction-price appraisals never dipped below 94% even in the height of the new HVCC regulation. The study analyzed 17 million mortgage loans purchased by Fannie Mae spanning over two decades between 1992 and 2015.

Since loan applications with low appraisals are likely to be denied or result in a lower renegotiated price by the buyer and seller, sometimes re-appraised with a second appraisal, sample selection bias could affect studies that used closed-loan appraisal.[4] Mayer (2015) instead used mortgage applications data from 2010 to 2014. The results based on application data were similar to those based on loan closings: The percentage of appraised values below the subject property's contract price was slightly higher than among funded loans at 10%, and the proportions of identical or higher appraisals (30% and 60%, respectively) dominated the distribution. Using loan applications and origination data from 2007 to 2015, Calem et al. (2015) similarly observed a 90% purchase-price confirming rate for loan applications and 94%–97% among funded loans securitized by the GSEs.

More direct evidence of appraisal confirmation bias is provided by Eriksen et al. (2020) by analyzing a sample of Fannie Mae REO properties that were appraised by two different appraisers within 6 months from one another. The study found that the second appraisal—which was ordered by lenders during the loan application after a sale price had been agreed upon by the seller and the buyer ("post-contract appraisal")—often valued the property more favorably when compared to the first appraisal on the same property, which was performed for the purpose of establishing a value to list and market the property ("pre-contract appraisal"). The study attributes the post-contract appraisal's tendency to favorably confirm the contract price to the appraiser's knowledge of the contract price. On average, the sample of post-contract appraisals assigned a 4.2%–8.3% markup when compared to the initial appraisal even after controlling for zip-level home price changes between the two appraisal dates.

Calem et al. (2015) reported an effect of leverage on appraisal's overvaluation bias. The study found that important LTV thresholds had a predictably positive impact on appraisal's confirming rate of the purchase price. More appraisals were found to cluster at or above the purchase price when a lower appraisal would otherwise send a loan's LTV to a higher leverage bracket, thus with likely implications for less favorable terms on points, interest rate, or mortgage insurance. Cho and Megbolugbe (1996) first observed a correlation between LTV and positive appraisal bias.[5]

## 3 | THE APPRAISAL DEVELOPMENT PROCESS: EVIDENCE OF BIASED SELECTION OF REPRESENTATIVE COMP PRICE DATA

To develop an appraisal, the appraiser selects recent sales of properties (typically three sales) deemed comparable and competitive to the subject property. Important considerations are given to a comp property's proximity, neighborhood similarity in terms of affordability and urban amenities, recentness of the sale, and similarity in physical attributes such as the gross living area, the number of bedrooms and bathrooms, property age, and others.

Given heterogeneous housing characteristics, the appraisal process under the sales comparison method entails upwardly adjusting a comp's transaction price with a dollar amount reflecting the market value of a desirable physical or locational feature that the comp lacks but the subject property has, or a downward adjustment if the comp contains a desirable attribute that

[4] According to the 2015 Home Mortgage Disclosure Act (HMDA) data, collateral was the third most frequently cited reason for loan application denial or 13.7% on first-lien purchase mortgages.

[5] Systematic appraisal bias or over-valuation in refinancing transactions are discussed and documented in Agarwal et al. (2015), Agarwal et al. (2020), Shi and Zhang (2015), Griffin and Maturana (2016), and Kruger and Maturana (2020). Evidence of potentially inflated appraisals in HUD-backed reverse mortgage lending, Home-Equity Conversion Mortgage (HECM) program, can be found in Park (2017) and Mayer (2020).

the subject property lacks.[6] In principle, each comp sale price is adjusted to match closely with the subject property in all relevant physical and economic features and as such, permitting its adjusted/calibrated value as fair market value estimate for the subject's probable value.

In practice, however, evaluating and calibrating relevant physical, locational, or transactional characteristics between heterogeneous properties is rarely as straightforward as it seems. The additional value of housing services provided by additional amenities can be difficult to quantify, which means appraisers will often rely on their subjective judgment and market experience and knowledge. Additionally, when market conditions are challenging, as in a soft or declining market with few current sales, appraisers may have to rely on sales that would not otherwise be considered a close substitute, which will only further complicate the adjustments.

There is limited formal evidence available to help assess the overall accuracy and objectivity of the valuation process. So, partly because of its subjective nature and data availability, the appraisal development process has largely remained unexplored until recently.

Existing evidence has so far identified biases in appraisal practice towards using better-amenity comparable transactions as a likely transmitting mechanism. Evidence of bias is typically evaluated based on comps' initial transaction price (i.e., unadjusted price) as well as their calibrated/adjusted price. Using purchase-loan applications data, Mayer (2015) found appraisers made a greater use of more expensive comps to develop the appraisal. About two-thirds of comp sales had a price greater than the subject property, averaging 12%–13% above the subject's contract price. The other one-third lower valued comps were on average 7% below the subject.

Evidence of appraisers favoring higher valued comps is also provided by Eriksen et al. (2020). Their analysis of pre- and post-contract appraisals found that the second appraiser, who had the knowledge of the sale price, was more likely to select higher priced comps when compared to the first appraiser who had no such information to anchor on. Before calibration of comp prices, higher valued comps accounted for 80.7% of the comps among the post-contract appraisals, versus 67.7% among the pre-contract appraisals; post-calibration, the two ratios became 82.2% and 54.1%, respectively, indicating that comps used in post-contract appraisals were disproportionately higher valued.

With their additional finding that post-contract appraisals were more likely to exceed the arithmetic average of calibrated comp prices, Eriksen et al. (2020) suggested another likely bias implicit in appraisal practice, that is, appraisers often implicitly apply more weight to higher valued comps when arriving at the final appraisal value.

Although Mayer (2015) and Eriksen et al. (2020) have suggested the use and weighting of higher valued comps as potential transmitting mechanisms, there remains an unanswered question as to why higher valued comps have frequently managed to remain significantly higher valued even after calibrations. Under an unbiased calibration process, one would expect calibrated comp values to become compactly and symmetrically distributed around the contract price. But if the process itself is prone to error or bias, then it could allow a disproportionate representation of higher value comps to persist and bias to transmit. In other words, in the absence of calibration biases, selection bias by itself is not sufficient to generate biased appraisals. We address the measurement of calibration bias in this study and observe that when the calibrations of fair market value estimates of the subject property are biased, even an equal weighting of calibrated comp prices will result in an overvalued appraisal.

[6] Because appraisers often obtain comp price data from an MLS, Allen et al. (2015) found that overstatement of sales price on an MLS could be another cause of appraisal overstatement. However, Mayer and Nothaft (2021) compared comp prices taken from MLS with public record data and found no systematic bias in MLS-reported prices.

### 3.1 | Data and summary statistics

In this study, we provide an in-depth analysis of the appraisal process by taking advantage of extensive appraisal report and market transaction data. We conduct a two-part analysis of the appraisal process to examine the selection and calibration of representative price data separately. Our analysis does not evaluate whether selected comps in the appraisal report were the "best" comps for the subject property, but rather treats them as given while acknowledging that the selections are subject to the availability of current or recent market transactions. Unlike prior studies, our study is able to control for the availability of recent market transactions as well as property characteristics in analyzing the decision of comparable transactions.

*Data*: The appraisal data on single-family, first-lien purchase-loan applications were extracted from appraisal orders submitted to the CoreLogic Collateral Management System (CMS), an automated appraisal workflow platform, for the fulfillment of appraisals and collateral underwriting.[7] The appraisals were ordered by lenders during loan applications, thus, both accepted and denied applications are included. These are full appraisals completed with Fannie Mae's Uniform Residential Appraisal Report 1004 with an interior inspection. Lenders and Appraisal Management Companies that use the service are of various sizes and include some of the nation's largest bank and nonbank lenders. The sample represents about 10% of first-lien home purchase originations reported in HMDA. Compared to existing studies (e.g., Calem et al., 2015; Eriksen et al., 2020) that typically use GSE loan and appraisal data, our data are more expansive in that it includes loans sold to the GSEs (i.e., conventional conforming loans) as well as Federal Housing Administration (FHA), Veterans Affairs (VA) and jumbo loans. Further, our dataset includes distressed and nondistressed sales, with nondistressed sales accounting for most of the dataset.

Appraisal orders over a 2-year period, 2015 and 2016, were used in the analysis. The sample period marks a time during which the appraisal practice has come under greater regulatory oversight and standards under the appraiser independence requirements of the Dodd-Frank Act (which codified the 2009 HVCC). Meanwhile, the appraisal data reporting has become subject to new reporting requirements under the Uniform Appraisal Dataset (UAD), which took effect in the fall of 2013. By focusing on a time period characterized by enhanced regulatory compliance amid a steadily improving housing market, this analysis provides insight into the current state of appraisal practices under the new industry norm.

*Summary statistics*: The unit of observation in the sample was a subject-comp pair, and there were multiple subject-comp observations per appraisal depending on the number of comps used by the appraiser. Data filters were applied to eliminate observations with erroneous or missing measurement on the subject or comparable property. Observations that had appraisal value, the subject property's pre-closing contract price, or comp price lying outside the top and bottom one percentile were removed from the analytic sample. To ensure data consistency and accuracy, we also removed observations with a price ratio (appraisal value-to-contract price ratio, subject-to-comp price ratio, and appraised value-to-comp price ratio) outside the bottom and top one percentile. Because of wide dispersions in house prices across states, the percentiles for aforementioned price or price ratios were computed and applied at the state level for the removal of erroneous or extreme values.

Table 1 contains the summary statistics for the subject and comp properties. The appraisal-to-contract price ratio is the appraised value relative to the subject property's contract price. The

[7] The CMS was developed by FNC, Inc. FNC was acquired by CoreLogic in 2015.

**TABLE 1** Subject and comp properties summary statistics

| Subject property (= 732 K) | 1th Percentile | 5th Percentile | 50th Median | 95th Percentile | 99th Percentile |
|---|---|---|---|---|---|
| Appraisal value | $56,000 | $88,000 | $240,000 | $800,000 | $1,539,000 |
| Contract purchase price | $52,850 | $85,000 | $236,000 | $797,500 | $1,525,000 |
| Appraisal-to-contract price ratio | 0.880 | 0.960 | 1.004 | 1.100 | 1.320 |
| Comparable transactions ($N = 2.2$ million) | | | | | |
| Comp sale price | $57,000 | $89,000 | $249,000 | $854,000 | $1,688,000 |
| Comp-to-contract price ratio | 0.768 | 0.874 | 1.030 | 1.299 | 1.616 |
| Comp-to-appraisal ratio | 0.775 | 0.873 | 1.019 | 1.237 | 1.438 |
| Recentness of comp sales (Days) | 0 | 0 | 39 | 292 | 371 |

*Notes*: This table shows the subject and comparable properties' price and price ratio percentiles at the national level. The appraisals were ordered for single-family, first-lien purchase mortgage applications in 2015 and 2016. The percentiles for comparable transactions are based on matched subject-comp pairs. The comp-to-contract price ratio uses the unadjusted comp sale price, whereas the comp-to-appraisal ratio is based on the calibrated comp price.

comp-to-contract price and comp-to-appraisal ratios measure the similarity in price between the subject and comparable properties before and after comparative adjustments.

The recentness of comp sales (in days) is the number of days between the comp transaction and current appraisal date. When a comp transaction is flagged by the appraiser as an active listing or sales pending, the recentness of the comp sale is set to zero. Appraisers often use for sale or pending-sale listings as comp sales when there are few recent sales. Listing comps made up about 40% of all comp transactions in the sample analyzed.

## 3.2 | Regression analysis of comparable selection: New evidence of selection bias

We begin by exploring whether there are patterns in the choice of comps, which may help understand why appraisal values are often above the subject property's contract purchase price. Prior studies (e.g., Eriksen et al., 2020; Mayer, 2015) provided descriptive evidence of appraisers favoring higher valued comparable transactions as value representation for appraisal development. However, there exist external factors such as the availability of the candidate pool of recent market transactions that invariably could constraint comp selection. For instance, compared to thin markets, active markets with more frequent transactions can offer more potential comps to choose from. A larger candidate pool can also mean the quality or the substitutability of the comps is likely better. For these reasons, it is important to control for exogeneous factors as such when analyzing the select decision.

It is beyond the scope of this study to determine whether the comparable transactions in our sample are indeed the best comps available for the subject property. We take as given the comp selections made by the appraiser and focus instead on the pricing features of reported comp sales. We use the price similarity between the subject and comp properties to proximate their similarity or competitiveness. Although not a perfect indicator, houses that buyers regard as close alternatives will likewise command a similar market price reflecting their substitutability in the services

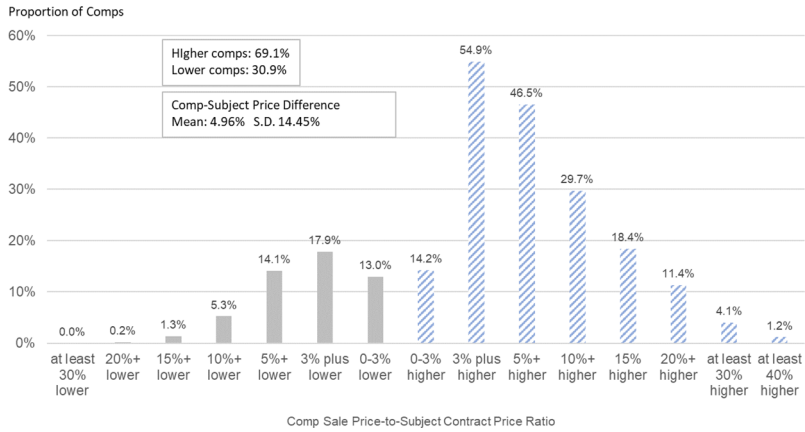


**FIGURE 1** Distribution of comparable transactions before calibration adjustments [Color figure can be viewed at wileyonlinelibrary.com]

and amenities provided. Additionally, household budget constraint and mortgage financing need will also drive homebuyers to consider similarly priced homes as competing substitutes. On the other hand, one can expect homes with greater price differentials to exhibit greater dissimilarities in various physical and locational characteristics.

Figure 1 shows the price distribution of comp properties relative to the subject property using the ratio of comp sale price to the contract price. About 2.2 million subject-comp pairs from nearly 732,000 appraisals are used in the analysis. As previously evidenced, the distribution of select comp transactions is skewed towards higher valued comps.

For instance, 54.9% of the comps have a recent sale price at least 3% higher than the subject property's contract price, compared to 17.9% that had a sale price at 3% or more on the downside. Similarly, while 29.7% of the comps have a price at least 10% higher than the subject property, only 5.3% had such a similar price differential on the downside. In total, 69.1% of the comps are priced above the subject property and 30.9% below, with a mean price difference of +10.7% and −5.6%, respectively. The distribution is consistent with the one reported in Mayer (2015) based on the same data source but for an earlier time period of 2012–2014, where 67% were higher priced comps commending a 12% price premium above the subject property and 33% lower priced with a negative 7% premium.

We use a binary logit model to further examine whether loan or property characteristics may influence the likelihood of using higher valued comp sales. It is important to control for such exogeneous factors and others which in practice often impact and constrain the pool of comp candidates. The dependent variable was equal to 1 if a given comp sale price before adjustment was above the subject property's contract price by a threshold amount and 0 otherwise. The analysis focuses on select comps with a significant price difference with the subject property. For robustness, the choice was modeled with two alternative price thresholds – 5% or 10% above the subject's price, each representing 46.5% and 29.7% of the sample observations. The control variables include dummy variables for loan and property characteristics, such as whether the subject property's loan application is for a high or low-LTV loan, whether the subject property is an entry-level or a more expensive home, or whether the subject property is REO sale. Also included are 49 state dummies, a year dummy for 2015, and three quarterly dummies to allow for regional, time, and seasonal variations in the local market which can affect or constraint comp selections.

**TABLE 2** Appraisal likelihood of using higher valued comparable transactions

| | $Y = 1$ (Comp-to-subject price ratio > = 1.05) | | | | $Y = 1$ (if Ratio > = 1.10) |
|---|---|---|---|---|---|
| **Control variables** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
| Intercept | −0.634*** | −0.754*** | −0.752*** | −0.742*** | −1.508 |
| Subject a starter home | 0.560*** | 0.564*** | 0.553*** | 0.558*** | 0.734*** |
| Subject a high-end home (*in top 10th percentile*) | −0.042*** | −0.045*** | −0.039*** | −0.045*** | 0.015* |
| Subject in MidTier1 (*within +/−20% median price*) | 0.102*** | 0.106*** | 0.0989*** | 0.102*** | 0.124*** |
| Subject in MidTier2 (*in top 20th percentile*) | −0.028*** | −0.028*** | −0.027*** | −0.0267*** | −0.0355*** |
| Subject a distress sale | 0.205*** | 0.247*** | 0.247*** | 0.248*** | 0.367*** |
| Comp sold within 1 month | 0.023*** | 0.021*** | 0.021*** | 0.021*** | 0.020** |
| Comp sold within 3 months | 0.050*** | 0.049*** | 0.049*** | 0.049*** | 0.0307*** |
| Comp at least 9 months old | 0.0079 | 0.0036 | 0.0038 | 0.0036 | 0.0027 |
| Listing Comp | 0.791*** | 0.764*** | 0.760*** | 0.755*** | 0.769*** |
| FHA loan | | −0.122*** | −0.155*** | −0.237*** | −0.164*** |
| LTV 80 or above | | 0.110*** | 0.081*** | 0.087*** | 0.083*** |
| LTV 95 or above | | | 0.089*** | 0.027*** | 0.058*** |
| FHA loan * LTV95 | | | | 0.154*** | |
| N | 2,199,915 | 1,084,486 | 1,084.486 | 1,084,486 | 1,084,486 |

*Note*: This table reports the results from logit regression of appraisal likelihood of using higher priced comps. The sample's unit observation is a subject-comp pair. The dependent variable takes the value of one if a paired comp has a price at least 5% or 10% higher than the subject property's contract price, and zero otherwise. The coefficients on 49 state dummies, three quarterly dummies, and a year dummy for 2015 are not reported. Due to space limitation, t-statistics are not reported.

Abbreviations: FHA, Federal Housing Administration; LTV, loan-to-value.

*Statistically significant at the 10% level; **Statistically significant at the 5% level; ***Statistically significant at the 1% level.

The top rows of Table 2 report four dummy price-tier variables for the control of the size/availability of the comp pool. For instance, if the subject property is a high-end property with a price in the top 10% of all recently sold homes in the market, then the set of relatively cheaper comps is likely larger than the set of more expensive ones. Consequently, there is greater probability that a select comp might be a lower valued sale. In an extreme case, for example, the comps for the most expensive home on the market can only come from the pool of homes sold at a lower price. The opposite is likely true if the subject property is a lower priced starter home (measured by contract sales price below the 33rd price percentile) for which the pool of higher priced sales above 33rd price percentile is much larger and more readily available.

The signs of estimated coefficients on these distributional measures are as expected and consistent with our availability hypothesis–positive on starter homes and negative on high-end ones. Similarly, the coefficients on MidTier2 indicator (i.e., subject property has a price in the upper 20th percentile) is negative and significant. But more interestingly, the coefficients on the MidTier1 indicator—if the subject property falls within ±20% of the median price of all recently sold homes—are positive and significant, suggesting a greater tendency of relying on higher priced comps when appraising a median-priced home.

The coefficient for the indicator of whether the subject property is a distressed sale (i.e., REO sale) is positive and significant. We also attribute positive REO coefficient—that is, comps used in appraising REO properties are more likely higher valued sales—to our availability hypothesis: the pool of nondistressed sales is typically much larger than the distressed pool. The positive REO coefficient seems to partly help explain the finding in Eriksen et al. (2020) that an overwhelming majority of the comps in appraising REO properties are higher priced comps (80.7%). As shown in the Eriksen et al.'s study, REO sales are typically low-end homes and our availability hypothesis would suggest that all else the same, comps are more likely to draw from those with a price distributed to the right. During the sample period of 2015–2016, REO sales represented only about 10% of sales.

The first two indicators for the recentness of comp sales, sold within 1 month of the appraisal date and sold within 3 months, have the expected positive sign. In an appreciating market as the one experienced during the sample period, more recently sold comps are expected to command a higher price, all else being the same.[8] The third recentness of comp sales measure, if a comp is at least 9 months old, is insignificant. The positive coefficient for the listing-comp dummy is also expected, since listing prices typically are higher than the final offer price negotiated between the buyer and the seller.

When observable loan attributes such as LTV or whether the loan is an FHA financing are added, more than a half of the observations were lost due to frequent missing LTV information in our appraisal data. Estimated coefficients on LTV indicators suggest a significant positive correlation between leverage and the use of higher comps. Also shown in Column 4, a second indicator for high-LTV loans (LTV 95 or above) continues to capture an incremental, positive impact of leverage on the comp selection. Contrary to our expectation, FHA financing is associated with a lower probability of using higher valued comps. Since FHA loans tend to be highly leveraged and frequently used by first-time homebuyers, we expect FHA financing to capture a positive leverage effect on comp selection. Interestingly, the coefficient on the interaction term, FHA loan*LTV 95, turns out to support a positive leverage effect on the comp selection.

On the surface, our observations of positive leverage effects on the use of higher priced comp sales are consistent with those made by Calem et al. (2015) and Cho and Megbolugbe (1996) that appraisals were more likely to become skewed upward at a number of important LTV underwriting thresholds. But the use of higher valued comps in itself does not necessarily lead to high appraisals. If their values are adequately calibrated with the subject property so that calibrated values closely approximate the subject's fair market value, we should expect the final appraisal value to exhibit a relatively normal distribution at the contract price. In the next section, we show that because of calibration bias, higher priced comps frequently remain significantly higher valued estimates for the subject property's fair market value.

## 4 | SALES COMPARISONS: EVIDENCE OF CALIBRATION BIAS

The concept of the sales comparison approach is intuitive and straightforward. In practice, however, evaluating and calibrating relevant physical, locational, or transactional characteristics between heterogeneous properties can be challenging and will require a great deal of both qualitative and quantitative analyses. Good comps may require fewer or smaller price adjustments. But

[8] The CoreLogic Case-Shiller Home Price Index for the United States rose 5.2% in 2015 and 5.3% in 2016 (December-to-December).

**TABLE 3A** Comparable-subject price difference before and after calibration adjustments

| | All pairs | Higher priced comp pairs | Lower priced comp pairs |
|---|---|---|---|
| Before ajustment | | | |
| mean price difference, % (SD) | 4.96 (14.4%) | 11.93 (12.6%) | −7.23 (6.6%) |
| After adjustment | | | |
| mean rice difference, % (SD) | 3.87 (10.4%) | 7.32 (10.5%) | −2.28 (6.2%) |
| Mean adjustment, % (SD) | −0.34 (8.5%) | −3.75 (6.6%) | +5.68 (7.8%) |
| Sample size | 2,190,925 | 1,462,353 | 730,572 |

*Note*: This table summarizes the before- and after-adjustment price differentials between subject and comparable properties, as well as the price adjustment, which is computed as the percentage difference in adjusted and unadjusted comp sale price.

when the quality of comp sales is questionable, or when the availability of good comps is limited so that appraisers may have to rely on sales that would not otherwise be considered a close substitute, comparison adjustments will become inevitably more complex, increasing the risk that the adjustments are less accurate and more subjective.

To calibrate comp sales with the subject property, appraisers will analyze and compare individual physical features between the subject property and the comparables. For example, in the widely used Fannie Mae 1004 Form of the Uniform Residential Appraisal Report for single-family homes, 16 physical features (property location, site, view, design, quality of construction, actual age, condition, bedroom count, bathroom count, gross living area, basement, functional utility, heating/cooling systems, energy efficient items, garage/carport, and porch/patio/deck) are explicitly listed for analysis and a dollar adjustment required if warranted by the difference between the subject and comp properties. Other important price adjustment considerations include differences in the time of sale, financing/sales concessions, or property rights between the subject and the comparables. Our analysis focuses on the price adjustment at the property level, or the sum of all adjustments for differences in individual housing attributes between the subject and comparable properties.

Table 3A reports summary statistics on the price difference between the subject and comparables before and after comparison adjustment. Unadjusted mean comp-subject price difference for the full sample is 4.96% with an SD of 14.45%, compared to an adjusted mean and SD of 3.87% and 10.42%, respectively. The reductions in the full-sample mean and dispersion of price differences are significant at the 1% statistical level. Also reported is the mean comp price adjustment (i.e., the percentage difference between adjusted and unadjusted comp prices) of 0.34% with an SD of 8.49%.

The before and after mean price differences and comp price adjustments are also shown separately for higher and lower priced comps. Higher valued comps were on average 11.93% more expensive than the subject property before adjustment; after adjustment, the price difference decreased about 7.32%, along with a reduction in the price dispersion from 12.6% to 10.46%. On average, high-valued comps received 3.75% downward price adjustment. Among lower valued comps, the mean price difference declined from 7.23% to 2.28% after receiving a larger 5.68% upward price adjustment.

Table 3B shows the representation of comps in various price ranges of the subject contact price before and after adjustment. It shows that a significant portion of calibrated comps continue to exhibit a sizable price difference with the subject. See Figures 1 and 2 for a graphical representation of Table 3, where Figure 1 shows the distribution of subject-comp price difference before adjustment and Figure 2 after adjustment.

**TABLE 3B** Composition of compaprable properties before and after calibration adjustments

| | Lower comps | | | | | Higher comps | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | At least 30% lower | 20%–30% Lower | 10%–20% Lower | 5%-10% Lower | 0%–5% Lower | 0%–5% Higher | 5%–10% Higher | 10%–20% Higher | 20%–30% Higher | At least 30% higher |
| Before adjustment | 0.05% | 0.15% | 5.1% | 8.9% | 16.7% | 22.6% | 16.8% | 18.4% | 7.3% | 4.0% |
| | Total: 30.9% | | | | | Total: 69.1% | | | | |
| After adjustment | 0.1% | 0.6% | 2.8% | 6.6% | 21.5% | 36.5% | 15.2% | 10.8% | 2.0% | 3.9% |
| | Total: 31.6% | | | | | Total: 68.4% | | | | |

*Note*: This table shows the compositon of comparabe properties based on their unadjusted and adjusted value relative to the subject property.

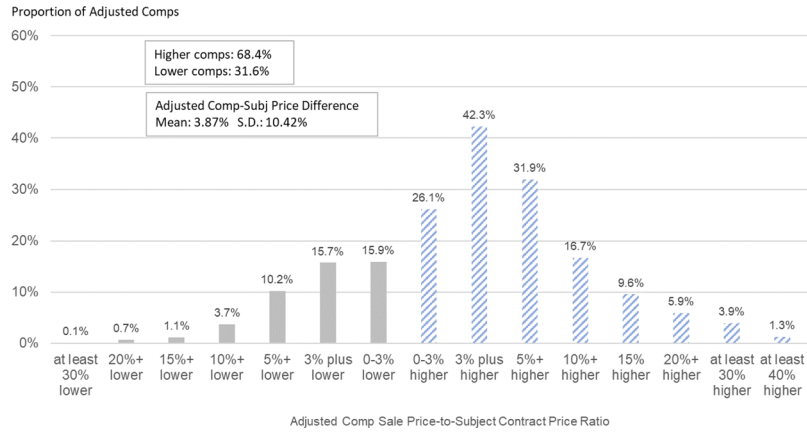


**FIGURE 2** Distribution of comparable transactions after calibration adjustments [Color figure can be viewed at wileyonlinelibrary.com]

More detailed summary statistics on comp price adjustment are shown in Table 4, where comp transactions are divided into six price buckets based on unadjusted comp prices. These different price ratios provide useful indications of potential underlying characteristic differences between the subject and comp properties. The larger the price gap, the more likely there are greater physical or locational dissimilarities between the two, thus requiring a larger price adjustment. For each comp group, Table 4 reports their unadjusted price difference with the subject (Columns 1H and 1L), corresponding price adjustment (Columns 2H and 2L), and resulting adjusted price difference with the subject (Columns 3H and 3L).

Several striking patterns are revealed by Table 4. First, when the mean adjustment is compared between higher and lower comps (Columns 2H vs. 2L), price adjustments received by lower comps (Column 2L) are typically much larger than those received by higher comps (Column 2H). For instance, at a 20%–30% subject-comp price differential, adjustments on higher comps average −8.0%, compared to 17.4% on lower comps. While a 17.4% upward adjustment on lower comps appears to track relatively well with the 23.7% pre-adjustment price differential (Column 1L), an 8.0% downward adjustment on higher comps appear rather small next to the 24.2% average price difference pre-adjustment (Column 1H). Similar disparate adjustments between lower and higher comps are also notable for other groups.

Second, the mean adjustment in Column 2H increases less than in Column 2L as one compares successive rows. For instance, moving from a 20%–30% price difference to 30%–40%, average adjustments on higher comps only increase from −8.0% to −9.8%. In contrast, adjustment on lower comps goes up from 17.4% to 28.6%, more consistent with potentially widening underlying characteristic differences between the subject and comp properties.

Consequently, resulting calibrated price differences with the subject property remain consistently larger among higher valued comps (Column 3H) than those by lower comps (Column 3L). The differences between the two groups are statistically significant across each price bucket. The development is to the contrary that unadjusted price differences between higher and lower valued comps (Columns 1H vs. 1L) are statistically insignificant across all price buckets.[9]

[9] Although not reported in Table 4, gross adjustments exhibit similar patterns. While the net adjustment sums all itemized adjustments to result in an adjusted price, the gross adjustment sums the absolute value of all adjustments and then divides

**TABLE 4** Comp price adjustments by pre-calibration subject-comp price differential

| | Higher valued comps | | | | Lower valued comps | | | |
|---|---|---|---|---|---|---|---|---|
| | (1H) Unadjusted mean price difference (SD) | (2H) Mean adjustment | (3H) Adjusted mean price difference (SD) | (4H) Obs | (1L) Unadjusted mean price difference (SD) | (2L) Mean djustment | (3L) Adjusted mean price difference (SD) | (4L) Obs |
| 0%–5% | 2.3%(1.5%) | −0.3% | 1.9%(4.3%) | 478,148 | 2.4%(1.4%) | +2.4% | 0.08%(4.3%) | 395,052 |
| 5%–10% | 7.3%(1.4%) | −2.8% | 4.3%(5.0%) | 355,930 | 7.2%(1.4%) | +5.5% | 2.1%(5.0%) | 210,505 |
| 10%–20% | 14.1%(2.8%) | −5.3% | 8.0%(6.7%) | 388,243 | 13.7%(2.7%) | +9.9% | 5.1%(6.6%) | 120,456 |
| 20%–30% | 24.2%(2.8%) | −8.0% | 14.2%(9.2%) | 154,003 | 23.7%(2.7%) | +17.4% | 10.5%(9.4%) | 3,538 |
| 30%–40% | 34.3%(2.8%) | −9.8% | 21.1%(11.9%) | 61,238 | 35.7%(5.0%) | +28.6% | 17.6%(11.9%) | 1,019 |
| >40% | 54.6%(12.6%) | −12.1% | 35.7%(18.5%) | 24,788 | n/a | n/a | n/a | n/a |
| Overall | 11.9%(12.6%) | −3.9% | 7.3%(10.5%) | 1,462 k | 7.2%(6.6%) | +5.7% | 2.3%(6.3%) | 730,572 |

*Note*: This table summarizes price adjustment to comp transactions. The adjusmtents are tabulated separately for higher and lower priced comps in six price ratio buckets based on the unadjusted comp price. In parantheses are the SDs of comp-subject price differentials.

The differences in unadjusted mean price difference between higher and lower comps (Columns 1H vs. 1L) are all statistically insiginificant. The differences in adjusted mean price difference between higher and lower comps (Columns 3H vs. 3L) are all statistically siginificant at the 5% or 1% level.

To better quantify these asymmetric price adjustment patterns, that is, downward adjustments on higher valued comps are relatively small and downwardly rigid, whereas upward adjustments on lower valued comps seem commensurate to the subject-comp price difference—a panel data model was used to estimate adjustment coefficients:

$$\Delta\%\, Price\, Adj_{i,j,z,t} = a_j + \delta_z + \tau_t + \beta_1 * PriceDiff_{i,j,z,t} + \beta_2 * PriceDiff^2_{i,j,z,t} + \epsilon_{i,j,z,t}$$

The dependent variable $\Delta\%\ Price\ Adj$ is the actual price adjustment, that is, percentage difference between before- and after-adjustment comp prices. The independent variable $PriceDiff$ is the price differential between the subject and (unadjusted) comp sale price. It is measured as a continuous variable, not categorical as shown in Table 4. A second quadratic term for the price differential is included to capture a nonlinear impact on the price adjustment rising from what is often a nonlinear relationship in home prices with respect to property characteristics (Dorsey et al., 2010; Hill, 2013).

Among the subscripts, $i$ is the $i$th subject-comp pair; $j$ is the $j$th subject mapped to a subject-comp pair; $z$ captures the local market area where the appraisal is performed, and $t$ indicates a time period. The sample consists of about 730,000 appraisals and more than 2.1 million subject-comp pairs, averaging three comps per appraisal. These purchase-loan appraisals were ordered by lenders during 2015 and 2016, but $t$ was expanded to also consider the impact of quarterly seasonality on market activities, making it a 1 by 8 vector of time coefficients. $z$ is specified at the zip code level to control for variations across different local markets (13,750 zip codes were in the sample). The equation is estimated with a fixed-effects panel data model, treating $\alpha, \delta, \tau$ as fixed group effects.

Table 5 reports estimated adjustment coefficients (fixed-effect estimates for the three group effects are omitted). In Panel A, the equation is fitted using the full sample of subject-comp pairs for a baseline scenario. When a dummy indicator for higher priced comps is included, it confirms earlier observations of asymmetric adjustment pattern between lower and higher priced comps. The adjustment equation is then fitted separately to the sub-samples of higher and lower valued comps, and the results are shown in Panels B and C. $\beta_1$ in specification (1) or $\beta_1 + \beta_2 * PriceDiff$ from specification (2) indicates the average size of comp price adjustment for every percent of pre-adjustment price difference with the subject property. $\beta_2$ measures the extent of incremental value adjustment as the subject-comp price differential rises.

In panel B under specification (1), the adjustment coefficient for higher priced comps is estimated at negative 0.364, indicating that higher priced comps receive 0.36% downward adjustment for every 1% of price differential. At 0.766 for lower priced comps, the average size of adjustment has doubled: for each 1% of subject-comp price difference, lower comps receive a 0.77% upward adjustment in value.

In specification (2) with $PriceDiff^2$ added, the adjustment coefficient ($\beta_1 + \beta_2 * PriceDiff$), or the first-order effects, remain essentially unchanged from those obtained in specification (1). However, the rate of adjustment, captured by $\beta_2$, rises much faster for lower valued comps than for higher valued ones: 0.966 versus 0.217. That is, for additional 1% price gap between the subject and comparable, lower valued comps will receive nearly another 1% increment in upwardly adjusted

the sum by the unadjusted comp price. For instance, when the price difference widens from 10%–20% to 20%–30%, mean gross adjustment on lower comps increases from 15.8% to 24.8%, compared to a smaller change from 13.8% to 15.9% on higher comps.

**TABLE 5** Comp price calibration adjustment coefficients

| **Panel A: Full sample** | | | |
|---|---|---|---|
| **Independent variable of interest** | **(1)** | **(2)** | **(3)** |
| Subject-comp price difference | −0.44* | −0.59* | −0.59* |
| Subject-comp price difference-squared | | 0.393* | 0.39* |
| Higher comp indicator | −0.02* | | −0.0007* |
| R-squared | 72.7% | 74.5% | 74.6% |
| **Panel B: Higher priced comps sub-sample (*N* = 1,462,343)** | | | |
| Subject-comp price difference | −0.364* | −0.476* | |
| Subject-comp price difference-squared | | 0.217* | |
| R-squared | 69.7% | 69.8% | |
| **Panel C: Lower priced comps sub-sample (*N* = 730,572)** | | | |
| Subject-comp price difference | −0.766* | −0.568* | |
| Subject-comp price difference-squared | | 0.966* | |
| R-squared | 81.5% | 81.8% | |

*Note*: The dependent variable is the percentage difference between adjusted and unadjusted comp sales prices. The explanatory variable of interest is the difference between the subject contract price and the unadjusted comp sales price. Other explanatory variables are fixed effects for the subject property, local market area, and time and seasonality. The estimates are obtained using the fixed-effect panel data model.

*Statistically significant at the 1% level.

price, whereas higher valued comps will only receive 0.22% increment in the lowering of their sales price.

These findings highlight our earlier descriptive results that there is a considerable degree of adjustment asymmetry between the two comp types. Comparison adjustments on higher valued comps are not only disproportionately much smaller in size, but also downwardly less sensitive to widening price differentials between the subject and comparable properties. In contrast, upward adjustments on lower valued comps are generally more adequate and responsive to the initial price differential with the subject property. Following the calibration, while less expensive comps typically have become more price-aligned with the subject property, more expensive comps have largely remained more expensive. Consequently, the post-calibration comps continue to be disproportionately represented by more expensive homes.

To summarize, the results in this section show that there are empirically important valuation differences when aligning comparable properties with the subject. We find significant evidence of friction limiting the downward price adjustment of better-amenity comps. When better-amenity comps are insufficiently calibrated, it may cause fair value estimates of the subject property to become overstated. If the appraisal development process is for some reason prone to such calibration bias, known or unbeknown to appraisers, it may be inevitable that the biases will be transmitted onto the final appraisal value. Furthermore, our evidence suggests that in the presence of calibration biases, it does not require appraisers to apply differential weights to calibrated comps to arrive at a biased appraisal.

## 5 | CONCLUSION

The 2004–2010 housing boom-and-bust and related financial crisis have prompted research into the role of asset value misrepresentation, including appraisal overstatement of the collateral value.

Accurate valuation is central to credit risk management and fraud prevention. Home appraisals are generally required on home-purchase and lower down payment or cash-out refinance loans. Because the LTV on a home-purchase loan is calculated using the lesser of the sales price and the appraised value, an overappraisal on a purchase application should not affect the LTV. However, an overappraisal on a refinance application will result in an LTV that is biased downward and credit risk to be larger than expected. The Mortgage Bankers Association has estimated that there were more than 7 million refinance loans originated during the 2020 refinance boom ($2.4 trillion in refinance originations), thus the downward bias on refinance LTVs could imply that credit risk in bank and GSE portfolios has been underestimated.

Available evidence generally indicates that newly strengthened regulations for ensuring appraiser independence have led to a lower frequency of appraisal overstatement in the aggregate. But it has left unanswered an important question: have the new independence rules fundamentally improved the overall appraisal accuracy, consistency, or objectivity as a valuation method? In other words, is there evidence that goes beyond the aggregate level to suggest that at the micro-level, the valuation process is or has become more sound and more accurate?

This study provides one of the first systematic analyses into the appraisal process to evaluate its accuracy, consistency, or objectivity. In particular, our analysis delves into the underlying appraisal development to identify causes of widely documented appraisal overvaluation. The appraisal development process is one in which fair market value estimates for the subject property are derived by making adjustments to representative comp prices for any differences in property characteristics. These fair market value estimates, in turn, are the basis of the final appraisal value.

Our quantitative assessment of the appraisal process finds a significant upward bias in the post-calibration values of higher priced comps. Calibrated values of higher priced comps remain significantly higher valued and disproportionately represent fair market value estimates for the subject property. We attribute appraisal overvaluation to this calibration bias. We suggest that the selection of higher valued comps by itself is not sufficient to transmit appraisal bias, should their calibrated values adequately align with the subject property's market value?

Our evidence of calibration bias, although helpful to understand appraisal overvaluation, cannot answer the question of how it occurs without further research into the development of calibrated values. To that end, a hedonic pricing model can be a helpful tool to assess the accuracy of a price adjustment associated with a given property attribute or amenity while also ensuring consistency and accuracy in the aggregate. Incorporating hedonic pricing techniques into appraisal development is limited. Given the amount of detailed property information and modeling technology that are available today, the appraisal practice could benefit from employing data-driven analytics to help assess appraisal accuracy in an efficient and quantifiable manner. Future research in this direction can develop a better understanding of the underlying appraisal valuation process.

## ACKNOWLEDGMENTS

We would like to thank the Editor, Brent Ambrose, two anonymous referees, and Nuno Mota for their helpful comments, and Rob Corey, a colleague at FNC and CoreLogic, for providing valuable data support. All errors are the responsibility of the authors.

## ORCID

*Yanling G. Mayer* https://orcid.org/0000-0003-3683-4640
*Frank E. Nothaft* https://orcid.org/0000-0002-0259-0564

## REFERENCES


Agarwal, S., Ben-David, I., & Yao, V. (2015). Collateral valuation and borrower financial constraints: Evidence from the residential real estate market. *Management Science*, *61*(9), (Sep), 2220–2240.

Agarwal, S., Ambrose, B. W., & Yao, V. W. (2020). Can regulation de-bias appraisers? *Journal of Financial Intermediation*, *44*(Oct), 100827.

Allen, M. T., Lusht, K. M., & Weeks, H. S. (2015). Reported price errors: A caveat for appraisers. *The Appraisal Journal*, *83*(4), 289–94.

Calem, P. S., Lambie-Hanson, L., & Nakamura, L. (2015). Information loss is home purchase appraisals. Federal Reserve Bank of Philadelphia Working Paper No. 15-11.

Cho, M., & Megbolugbe, I. F. (1996). An empirical analysis of property appraisal and mortgage redlining. *Journal of Real Estate Finance and Economics*, *13*(1), 45–55.

Collateral Assessment & Technologies Committee (2005). Systematic risks in residential property valuations: Perceptions and reality. Real Estate Information Professional Association.

Ding, L., & Nakamura, L. (2015). The impact of the home valuation code of conduct on appraisal and mortgage outcome," Federal Reserve Bank of Philadelphia Working Paper No. 15–28.

Dorsey, R. E., Hu, H., Mayer, W. J., & Wang, H. (2010). Hedonic versus repeat-sale housing price indexes for measuring the recent boom-bust cycle. *Journal of Housing Economics*, *19*(2), (Jun), 75–93.

Eriksen, M. D., Fout, H. B., Palim, M., & Rosenblatt, E. (2020). Contract price confirmation bias: Evidence from repeat appraisals. *Journal of Real Estate Finance and Economics*, *60*(1), 77–98.

Ferguson, J. T. (1988). After-sale evaluations: Appraisals or justifications. *Journal of Real Estate Research*, *3*(1), 19–26.

Financial Crisis Inquiry Commission. (2011). The financial crisis inquiry report–-Final report of the National Commission on the causes of the financial economic crisis in the United States.

Griffin, J. M., & Maturana, G. (2016). Who facilitated misreporting in securitized loans? *Review of Financial Studies*, *29*(2), 384–419.

Hill, R. J. (2013). Hedonic price indexes for residential housing: A survey, evaluation, and taxonomy. *Journal of Economic Surveys*, *27*(5), (Dec), 879–914.

Kruger, S., & Maturana, G. (2020). Collateral misreporting in the residential mortgage-backed security market. *Management Science*. https://doi.org/10.1287/mnsc.2019.3569

Lacour-Little, M., & Malpezzi, S. (2003). Appraisal quality and residential mortgage default: Evidence from Alaska. *Journal of Finance and Economics*, *27*(2), 211–233.

Lentz, G. H., & Wang, K., (1998). Residential appraisal and the lending process: A survey of issues. *Journal of Real Estate Research*, *15*(1), 11–39.

Mayer, Y. G. (2015). Underneath inflated appraisals. *Mortgage Banking*, *76*(3), 46–53.

Mayer, Y. G. (2020). Despite significant improvement over the years, there remain worrying signs of overappraisal of HECM loans, Retrieved from https://www.corelogic.com/blog/2020/2/despite-significant-improvement-over-the-years-there-remain-worrying-signs-of-overappraisal-of-hecm-loans.aspx

Mayer, Y. G., & Nothaft, F. E. (2021). The Accuracy of comparable sales data in appraisal reports: Evidence from California. *The Appraisal Journal*, *89*(1), 25–33.

Park, K. A. (2017). Reverse mortgage collateral: Undermaintenance or overappraisal? *Cityscape*, *19*(1), 7—28. https://www.huduser.gov/portal/periodicals/cityscpe/vol19num1/ch1.pdf

Piskorski, T., Seru, A., & Witkin, J. (2015). Asset quality misrepresentation by financial intermediaries: Evidence from the RMBS market. *Journal of Finance*, *70*(6), 2635–2678.

Shi, L., & Zhang, Y. (2015). Appraisal inflation: Evidence from the 2009 GSE HVCC intervention. *Journal of Housing Economics*, *27*(Mar), 71–90.

United States Government Accountability Office. (2011). *Residential appraisal: Opportunities to enhance oversight of an evolving industry*. GAO-11-653 (Jul).


**How to cite this article:** Mayer YG, Nothaft FE. Appraisal overvaluation: Evidence of price adjustment bias in sales comparisons. *Real Estate Economics*. 2022;*50:*;862–881. https://doi.org/10.1111/1540-6229.12351