



# Governing the Ascendancy of Automated Valuation Models

## Regulating AI in Residential Property Valuation

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# Executive Summary

Automated valuation models (AVMs) are used to estimate the market value of homes and play a key role in mortgage lending, in some cases even replacing human appraisers. They are also a central feature of online platforms such as Zillow and Redfin. Recently, their prevalence and influence have grown as the federal agencies and the government sponsored entities Fannie Mae and Freddie Mac have allowed more mortgage lending to rely on AVM estimates.

AVMs use a vast breadth of data, including both publicly available and user-provided data. AVM developers also leverage new algorithms, such as computer vision, to improve their models. Although their accuracy is at times an improvement over human appraisers, their performance is not consistent in communities of color and low-income neighborhoods. Therefore, the ever-expanding use of AVMs raises concerns around privacy, transparency, algorithmic bias, and the perpetuation of historic redlining.

Federal agencies have provided some regulation and guidance around the use of AVMs, and a five-agency collaboration proposed a new rule in 2023. AVMs are also covered by several existing anti-discrimination laws. However, this oversight is limited and should be expanded to include: (1) expanding public transparency, (2) disclosing more information to affected individuals, (3) guaranteeing evaluations are independent, (4) encouraging the search for less discriminatory AVMs, (5) releasing more government data on AVMs, (6) regulating platform AVMs, and (7) employing new forms of AVMs to counter historic redlining.

With the use of these models poised to grow in the coming years, these policy interventions will help ensure that AVMs advance a healthy and equitable housing market, rather than jeopardize it.

# The Design and Role of AVMs in the Housing Market

Automated valuations models (AVMs) are algorithmic systems that are used to estimate the market value of properties, such as residential homes and commercial buildings. They are among the most established, ubiquitous, complex, and impactful algorithmic systems in the United States and therefore warrant significant attention from policymakers. This report is primarily concerned with the growing role of AVMs in consumer mortgage loan origination and online real estate platforms, as well as the associated effects on individuals. However, AVMs also play a critical role in government tax assessment, investment portfolio tracking, and default servicing, as well as in estimating prices of commercial properties.<sup>1,2</sup>

Early statistical models for land valuation date back to at least 1922.<sup>3</sup> In the 1970s, similar models were used to value residential properties, which have more uniform characteristics and are therefore easier to value than commercial properties.<sup>4</sup> Since the late 1980s, AVMs have become more commonly commercialized, in part because computing has become cheaper and relevant data has become more widely available. Over the past several decades, AVM providers have competed on talent, modeling complexity, and data quality to provide more and better-quality valuations.<sup>5</sup>

Traditionally, AVMs have been most impactful in their use to inform lending decisions (lending AVMs); however, their influence through online platforms (platform AVMs)<sup>a</sup> is also significant. Platform AVMs are built and used by companies, such as Redfin, Zillow, and Trulia (a Zillow subsidiary), to generate estimates of property values that they make publicly available alongside advertisements, such as for realtor services.<sup>b</sup> In some cases, home sellers may also pay for their property to be listed on the platform.<sup>6,7,8</sup> Many consumers also use these public platforms to estimate the price they offer on a home when they are buying or selling—Zillow reported having 198 million average unique monthly visitors across its websites and services in 2022, while Redfin reported 49 million.<sup>9,10</sup> Together, Zillow, Realtor.com, and Redfin generated revenue of over \$4.3 billion in 2022.<sup>11,12,13</sup>

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a. AVMs are also commonly categorized into “lending-grade” and “marketing grade” AVMs. This distinction implicitly assumes quality differences between the AVMs used by online platforms and lenders, however, there is insufficient public information to strongly substantiate this claim.

b. So-called “instant buyers” such as [Opendoor](#) and Offerpad (and, before shuttering, [Zillow Offers](#) and [Redfin Now](#)), also use AVMs in an attempt to streamline real estate transactions.

Lending AVMs are designed to inform companies that originate mortgages or other loans backed by housing equity. CoreLogic, Black Knight, Home Genius, Clear Capital, HouseCanary, and Veros Real Estate are some of the roughly two dozen lending AVM providers in the U.S.<sup>14</sup> Freddie Mac also offers its own AVM, the Home Value Explorer, to lenders.<sup>15</sup> Lending AVMs are used by financial institutions to value investment portfolios, estimate the loan-to-value (LTV) ratio of a property before (potentially) requesting an appraisal, and provide home mortgage quotes. Lending AVMs contribute to a multi-billion-dollar real estate technology market and play a growing role in the 41 trillion-dollar housing market.<sup>16</sup>

Because a typical mortgage loan can be in the hundreds of thousands of dollars, lending AVMs are used with more caution and restraint than other AVMs. Lending AVMs generally differ from platform AVMs in that they usually generate estimates for fewer properties in order to maintain minimum quality standards. If enough high-quality data is not available, lending AVMs are less likely to produce a valuation estimate. Further, lending AVM providers may provide legal compliance documentation for lenders and update more often than platform AVMs.<sup>17,18</sup>

AVMs play a growing role in mortgage lending. Historically, AVMs have not eliminated the need for an in-person appraisal by a certified appraiser. This has been the case primarily because Fannie Mae and Freddie Mac have typically required an appraisal before buying a mortgage, which they do for two-thirds of all total mortgage debt.<sup>19,20</sup> Since lenders want the option to sell mortgages to these government-sponsored enterprises (GSEs), they have been strongly incentivized to get an in-person appraisal.<sup>21</sup> However, the policies of the GSEs and federal regulatory agencies are becoming more permissive of AVMs. As a result, the use of, and dependence on, AVMs is likely to continually increase into the future, becoming more central in the mortgage origination process.

## Under the hood of AVMS

AVMs are developed on datasets with up to billions of values. These datasets can include property ownership records; parcel boundaries; public tax assessments; prior mortgages and foreclosures; lien status; property data from listings; and data brokerages called multiple listing services; as well as data on neighborhood and locality characteristics.<sup>22,23,24,25</sup> The outcome variable of AVMs is a predicted sales price, which estimates the market value of a specific residential property at any point in time. As a result, past sales prices of other homes are the single most important input into AVMs.

AVMs may use a variety of algorithms and approaches to estimate property value. The traditional approach is a hedonic model, which employs various algorithms using all available property information to predict sales price, based on prior property sale data. Alternative approaches include appraisal emulation models, which rely on sales data of comparable properties, and index models, which use the changes in price of the property of interest over time to forecast the current-day valuation.<sup>26</sup> The current state-of-the-art AVMs mostly resemble traditional hedonic models, with adjustments for regional sales price trends, sometimes called a hybrid or blended approach.<sup>27</sup> However, there has been a significant evolution in the algorithms and data used for these hedonic models.

AVM providers often reveal little about the exact algorithms underlying their models; however, linear regression is known to be the earliest algorithm used in valuation, and non-linear regression, random forests, gradient boosted trees, and neural networks have all been employed in modern AVMs.<sup>28</sup> There is evidence that these more complex algorithms improve AVM accuracy above more traditional linear regression approaches.<sup>29,30,31,32</sup> Further, AVMs may use ensemble models (i.e., a combination of multiple models) to produce a single more accurate home valuation.<sup>33,34</sup> Some AVM providers also offer AVM “cascades”, which present values for a property or properties of interest based on several AVM models. A cascade automates a comparison of several AVM estimates, choosing an estimate with a higher level of statistical confidence.<sup>35</sup>

AVM providers also continuously look for new data to improve AVM accuracy and expand other algorithmic services. Some AVM providers are beginning to analyze photos using computer vision models in order to rate the condition of properties and incorporate this condition data into their AVMs.<sup>36,37</sup> For example, Black Knight’s Validate app allows homeowners to upload photos to support their home’s valuation as part of their application to borrow against their home’s equity.<sup>38</sup> This incremental expansion of AVMs into property condition analysis is an example of “algorithmic creep,” a common phenomenon where new algorithms (in this case, deep learning computer vision algorithms) allow for continuous marginal extensions of an automated process.<sup>39</sup>

# The Societal Impacts of AVMs

AVMs play a growing role in determining the sales price of a home and can be a critical determinant of mortgage pricing and home equity loans. Housing is a key component of wealth in the U.S.—housing equity comprises nearly 60 percent of net worth for Black and Hispanic households, and 43 percent for white households.<sup>40</sup> Historically, housing equity has been central to rising wealth-to-income ratios around the world.<sup>41</sup> AVMs may be more accurate and consistent than human appraisers; mitigate, although not eliminate, racial bias in property appraisal; and offer speed advantages that benefit the housing market. However, AVMs also perpetuate historic racial disparities in property values, reduce transparency in the property appraisal process, and incentivize further data collection and risks to privacy.

Measures of AVM accuracy vary, but overall, AVMs appear to often be more accurate in predicting property sales price than human appraisals. Fitch Ratings found seven AVM providers were able to predict within 10 percent of the sales price for at least 95 percent of properties in a test set.<sup>42</sup> Researchers at the Federal Housing Finance Agency (FHFA) found that AVMs can outperform appraisals in rural areas.<sup>43</sup>

One explanation for this discrepancy is the tendency of human appraisers to set appraisal values at the exact contract price, when they know that price.<sup>c</sup> This undermines appraisal accuracy, and is notably not a problem for AVMs, which do not use contract sales price in their models. Several analyses have found that 30 percent of appraisals fall exactly at the agreed upon contract price when appraisers know that price.<sup>44,45,46</sup> In rural areas, 90 percent of appraisals confirm or exceed a known contract price—a trend that strongly suggests appraisers are overestimating appraisal values.<sup>47,d</sup> Inaccurate appraisal values skew LTV ratios, which are key inputs into mortgage pricing and approval formulas.<sup>48</sup> This has meaningful consequences: Research has shown that mortgages with appraisals set at the exact contract price are more likely to default.<sup>49</sup>

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c. Home appraisals typically take place after a home seller has accepted a buyer's offer. Mortgage buyers require appraisals to ensure the home provides sufficient collateral for the loan, and home buyers usually pay the appraisal fee.

d. Despite strengthened regulations in the Dodd-Frank Wall Street Reform and Consumer Protection Act, which lowered the frequency of appraisal overvaluations, [research from CoreLogic](#) (notably an AVM provider) suggests these overvaluations are still common.

Evidence from nearly 20 years ago suggests that AVM estimates could help predict likelihood of default on a mortgage and were even then more predictive than appraisal values.<sup>50</sup> Similarly, one study found appraisals that significantly exceed CoreLogic's AVM estimates correlate with higher rates of loan default and delinquency.<sup>51</sup> More generally, a recent comparison found that loans originating through Freddie Mac's AVM were 9.6 percent less likely to default than similar loans backed by an appraisal.<sup>52</sup>

However, a precise AVM estimate is highly dependent on accurate, up-to-date data, including sufficient data on recent sales of comparable homes.<sup>53</sup> The commercial AVM provider HouseCanary has estimated that only 40 percent of homes can be appropriately evaluated solely by an AVM.<sup>54</sup> Further, independent analysis of AVMs from the evaluation firm AVMetrics suggests that individual AVM performance varies significantly across geographies (e.g., between different states and between rural and urban areas) as well as over time.<sup>55</sup>

## AVMs and discrimination

While AVMs may be more accurate on average, they do not affect all communities equally. In order to understand their impact on communities of color, it is necessary to compare AVMs to human-performed appraisals. Both anecdotes and rigorous empirical analyses have suggested high degrees of racial bias in home appraisals performed by individuals, of whom 90 percent are white.<sup>56,57,58</sup> One study found that homes in neighborhoods with all white residents were appraised on average \$408,000 higher than similar homes in neighborhoods with no white residents.<sup>59</sup> An analysis from Brookings estimated that the median appraisal is 15 percent lower in majority-Black neighborhoods than entirely non-Black neighborhoods. This analysis also found that homes in majority-Black neighborhoods are 1.9 times more likely to be appraised under the contract price.<sup>60</sup> A qualitative study of appraisers found that one prominent reason for these disparities was how appraisers used racial demographics to choose comparable homes and neighborhoods in performing appraisal calculations.<sup>61</sup>

However, AVMs are themselves not without bias. A pair of studies from the Urban Institute demonstrated that AVM errors were greater in majority-Black neighborhoods than white neighborhoods in Atlanta, Memphis, and Washington D.C.<sup>62,63,e</sup> For the three U.S. cities studied, the magnitude of error as a percentage of home price was about twice as large in majority-Black neighborhoods compared to majority-white ones. Majority-Black neighborhoods also saw more significant fluctuations in percentage error over time.<sup>64</sup>

Still, research has also shown that AVMs tend to be less biased compared to appraisals. White homeowners applying to refinance their mortgage received higher appraisals on average compared to Black homeowners.<sup>65</sup> Further, the directionality of the error—whether the AVM results in an overestimate or underestimate—may favor AVMs. Human appraisers primarily underestimate home values in Black neighborhoods, which can lead to a lower sales price, reducing the amount a seller receives for their home and pulling down future valuations of homes in the neighboring area. On the other hand, AVM errors are more evenly split between overestimations and underestimations, with overestimations usually having less harmful consequences for individuals.

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e. A rebuttal from HouseCanary [noted some shortcomings](#) in the Urban Institute research, however, in our opinion, the Urban Institute reports are the best publicly available analyses on this subject.



Similar to an in-person appraisal, an undervaluation by an AVM can prevent adequate financing to be offered to the buyer, often leading to a reduced sales price, higher interest rates, or a contract falling through.<sup>f</sup> An overvaluation is less problematic for the seller, as it will likely not affect sales price, but a homeowner whose home is originally overvalued may struggle to repay the loan and have fewer options available in the event of default.<sup>66,67</sup> Of course, the real-world impact of AVMs is only so significant when there is no in-person appraisal to make a final valuation. This is only the case some of the time, but federal regulators and the GSEs are expanding the circumstances in which AVMs can be used without any human involvement.

At present, the use of AVMs is much more frequent for non-mortgage loans that use home value as collateral, specifically home equity loans and home equity lines of credit (HELOCs).<sup>68</sup> The total amount of outstanding HELOC debt is around \$340 billion, a small portion of all housing debt.<sup>69</sup> However, since there is often no in-person appraiser used for HELOCs, AVM estimates carry more weight. With HELOCs, an underestimation means a homeowner may not be able to draw as much equity from their home through a HELOC. An overestimation also comes with risks—it could mean a homeowner takes out more debt than they will be able to repay through the sale of their home.

Lending AVMs are not the only ones to affect home sales. AVMs on online platforms may significantly impact the listing price and eventual sales price of many residential properties. A working paper on the effect of updates to Zillow's AVM in Austin, Boston, and Pittsburgh suggests that a 1 percent increase in the Zestimate resulted in a 0.733 percent increase in the listing price.<sup>70</sup> A different unpublished study on the same locations found that a 1 percent increase in the Zestimate led to a 0.15 percent increase in sales price.<sup>71</sup> This research is inconclusive, and more analysis is needed. However, it suggests platform AVMs can significantly affect home sales, a finding which would align with previous literature on the anchoring effect of a stated home price.<sup>72</sup> This responsiveness to AVM estimates is also an example of automation bias, a well-demonstrated phenomenon in which people are overly trusting of outputs from software systems.<sup>73,74</sup>

Related to the Urban Institute's research on bias in AVMs, evidence also suggests that platform AVMs specifically experience higher error rates in marginalized communities. An analysis of 4,000 homes in the Pittsburgh market found that Zestimates were more uncertain in low-income neighborhoods. However, the researchers noted the AVMs potentially still benefit these neighborhoods more because they reduce uncertainty about home values more than in wealthier neighborhoods (due to higher starting uncertainty in low-income neighborhoods).<sup>75</sup> In the related areas of both pricing rental properties (at Airbnb) and mortgage pricing, algorithms have also been demonstrated to reduce, but not remove, racial bias.<sup>76,77</sup> Despite the potential for AVMs to reduce discrimination, the higher error rates of AVMs in majority-minority communities remain a significant concern. Further, as there is little meaningful public transparency or independent review of AVM estimates, it is impossible to know if deployed AVMs are collectively living up to this potential.

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f. This is the case when an AVM estimate is used in lieu of an appraisal, and no appraisal is performed later in the real estate transaction process.

Even if AVMs were perfectly accurate in predicting eventual sales prices in minority communities, they may further entrench and perpetuate the effects of historical redlining.<sup>78</sup> This is inherent to the design of current AVMs, because they predict the sales price of a home, learning from past sales prices and using geography as an input. This will invariably perpetuate past bias into future estimates, although the degree of this effect is difficult to measure. A similar phenomenon has been seen in property tax assessments, leading Black and Hispanic residents to pay disproportionately high property taxes.<sup>79</sup> Despite the evidence of bias in AVMs, researchers at both Freddie Mac and the Urban Institute have argued for using AVMs more prominently in the home valuation process, highlighting their potential to reduce racial bias relative to human appraisals.<sup>80,81</sup>

## Speed, transparency, and privacy implications

AVMs are run continuously, and the resulting estimates are constantly available, therefore AVMs offer a property valuation far earlier in a home purchasing or mortgage pricing process than a traditional appraisal. This may often mean more clarity for sellers (in terms of sales price), buyers (in terms of sales price, estimated mortgage interest, and estimated payments), and underwriters (in terms of transaction value) earlier in the process.<sup>82</sup> While this clarity could increase the odds of a successful transaction, GSEs typically require human-performed appraisals, as noted earlier. Therefore, while AVMs offer property valuations sooner, they have largely not replaced in-person appraisals, which take between 7 to 21 days on average, with significant variation between states.<sup>83</sup> The cost advantage of AVMs is similarly currently limited. Since AVMs are usually supplementing in-person appraisals, rather than replacing them, borrowers are unlikely to save any of the cost, often at least hundreds of dollars, of a property appraisal.<sup>84,85</sup> Going forward, these advantages may become more pronounced as AVM use replaces more of the human appraisal process.

Similar to many algorithmic processes, AVMs also reduce transparency into property valuation. Most providers do not publicly detail the variables used as inputs into their AVMs, nor do they precisely describe the statistical models used. One study determined that sellers were unable to distinguish between the quality of AVMs used by different iBuyers, but instead relied entirely on brand awareness, which was not indicative of quality.<sup>86</sup> The growing use of more complex statistical models, including machine learning and ensemble modeling, makes AVMs much harder to intuitively understand. This lack of transparency has several potential harmful effects. First, it may be harder for sellers and buyers to identify data errors that contribute to reduced or inflated AVM estimates. Second, sellers and buyers may be less able to identify variables that are missing (e.g., as is often the case, property condition) or improperly accounted for in the AVM (even if the data is technically correct), undermining their ability to contest a valuation.

The proliferation of AVMs also has significant repercussions for data privacy. The commercial value of AVMs is not in dispute, and there is significant competition across AVM providers to expand and improve the statistical accuracy, robustness to market conditions, geographic coverage, and degree of automation of AVMs. This growth has sparked extensive demand for new data sources and wider coverage of that data for developing better AVMs. Beyond the many data sources already mentioned, the rise of online real estate platforms has dramatically expanded the degree of user-submitted data, especially in the form of floor plans, photos, and even 3D virtual tours.<sup>87,88</sup> More recently, some AVM

providers may be incorporating aerial photography of homes, which is captured multiple times per year for over 80 percent of the U.S. population with sufficient resolution to “count the number of tiles on the roof” of a home.<sup>89,90,91</sup> Other AVM providers make references to tracking behavioral characteristics of buyers and sellers across real estate transactions.<sup>92</sup> Some of the resulting databases are massive—CoreLogic claims to have property data for 99.9 percent of all U.S. properties, totaling an estimated 4.5 billion records spanning 50 years.<sup>93</sup>

That individual companies have near universal datasets of U.S. residential property, including sufficient data for realistic 3D tours, is cause for concern. Researchers found 3D tours often included photos, letters, and documents that could be used to inform scams or credit card fraud.<sup>94</sup> Photos and floorplans of private homes could also encourage or enable home invasions or burglary. This imagery may reveal, or enable inference of, educational degrees, product preferences (e.g., furniture, pantry items), and medications used, potentially enabling highly targeted advertising. Increasingly routine and detailed aerial photography of homes may capture a wide variety of outdoor activities on private property that undermine privacy.

It is worth noting that these privacy risks are in tension with the accuracy and inequity concerns of AVMs. More data and more accurate data improve AVM accuracy. This is particularly true for communities of color for two distinct reasons. First, since there are fewer majority-minority communities than majority-white communities, AVMs have fewer similar home sales to learn from, increasing the relative importance of complete data for each home sale. Further, there is evidence that communities of color experience higher variation in property condition, and therefore home sales price, which can be improved only with accurate property condition data.<sup>95</sup>

# The State of AVM Governance

A range of federal laws, regulations, guidance, and standards affect lending AVMs, while platform AVMs are much less explicitly covered by existing rules.

## Governing lenders' use of AVMs

The Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) requires the Office of the Comptroller of the Currency (OCC), Federal Deposit Insurance Corporation (FDIC), and Federal Reserve Board (FRB) to set a threshold—or “de minimis”—value for real estate transactions below which an appraisal is not required. In 2019, these regulators raised the de minimis value from \$250,000 to \$400,000, causing the number of exempted transactions to rise from 56 percent to 72 percent based on 2017 data.<sup>96,97</sup> Under this threshold, regulators allow AVMs to be used as the primary valuation approach for real estate transactions.

The practices of GSEs also significantly impact when AVMs can be used to replace appraisals. Historically, the proportion of mortgages on residential properties receiving appraisal waivers has been low, hovering around 1 percent of GSE loans.<sup>98</sup> During the first year of the COVID-19 pandemic, temporary measures by Fannie Mae and Freddie Mac encouraged the use of appraisal waivers, leading the number of such waivers received to skyrocket.<sup>99,100</sup> With the end of these temporary measures in 2021, appraisal waivers began to fall, but they remain above pre-pandemic levels (above 10 percent of GSE loans).<sup>101</sup> In 2023, the GSEs have signaled that they are moving toward allowing more alternatives to traditional appraisals. Fannie Mae has explicitly said it is “moving away from implying that an appraisal is a default requirement.” It now expects to allow for an increased proportion of AVM estimates, paired with a short in-home inspection of property condition, as an alternative to a full appraisal.<sup>102,103</sup> This change, along with the raised de minimis value, likely means that AVMs will become more frequently used as the most crucial factor in property valuation in mortgage origination. The GSEs also maintain and use their own AVMs, whose design and risk management is outlined by the FHFA.<sup>104,105</sup>

Title XI of FIRREA requires minimum standards for appraisals and evaluations in real estate transactions with any federal agency involvement.<sup>106</sup> To fulfill this obligation, the OCC, FRB, the FDIC, the Department of the Treasury, and the National Credit Union Administration (NCUA) have issued

interagency guidelines that include best practices for AVMs.<sup>107,g</sup> Particularly noteworthy in these guidelines is the requirement of an independent evaluation, although there are only two primary companies that assess AVMs in the United States: Mercury Network (owned by CoreLogic) and AVMetrics, in addition to ratings agencies such as Fitch.<sup>108,109,110</sup> AVM providers do not disclose what organizations perform these reviews. However, materials from AVMetrics show they provided evaluations for 25 different AVMs from at least 11 providers as of 2020.<sup>111,h</sup> While the AVM evaluators may be enabling better market competition by benchmarking AVM accuracy, they are not demonstrably informing the public. Further, because the AVM providers are themselves players in the market—they earn money by selling AVM evaluations, and CoreLogic offers products integrated with Mercury Network—their independence is not entirely assured.<sup>112</sup>

In 2010, the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) amended FIRREA to require that lenders and financial institutions that sell mortgage-backed securities implement four quality control factors for AVMs. These are to “ensure a high level of confidence in the estimates produced by automated valuation models,” “protect against the manipulation of data, seek to avoid conflicts of interest,” and “require random sample testing and reviews.”<sup>113</sup>

As appraisal bias has received increased scrutiny, government and nongovernmental organizations have launched new initiatives to study and guide AVMs and other algorithmic technology used in housing. In 2021, the Biden administration announced the creation of the Interagency Task Force on Property Appraisal and Valuation Equity (PAVE), which is responsible for generating recommendations to end racial and ethnic bias in home valuations. The 2022 PAVE Action Plan recommended including nondiscrimination in federal rulemaking on AVM quality control and the creation of a PAVE Research Working Group that would conduct additional research on potential bias in AVMs.<sup>114</sup> Just over a year later, FHFA launched its Office of Financial Technology to understand housing technology and facilitate innovation within the GSEs.<sup>115</sup>

## Anti-discrimination laws

The Fair Housing Act (FHA) prohibits discrimination in the rental, sale, and financing, appraising, and brokerage of residential housing, which includes mortgage origination.<sup>116</sup> Because mortgage lenders and their use of AVMs are covered under the FHA, courts may consider AVMs to be in violation of the Fair Housing Act if they cause disparate impact between marginalized groups.<sup>117</sup> Past cases on disparate impact suggest that if a mortgage lender uses an AVM that resulted in home buyers of color being disproportionately denied mortgages, they have violated the Fair Housing Act, regardless of whether the disparity was intentional. Notably, this rule was almost changed during the Trump administration, which would have erected several barriers to bringing lawsuits against the users of algorithmic systems under disparate impact.<sup>118</sup>

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g. The OCC also advises financial institutions on model risk management, including validation of vendor and third-party models such as AVMs, through OCC Bulletin 2011-12. For more information, see: The Office of the Comptroller of the Currency. (2011, April 4). Sound Practices for Model Risk Management: Supervisory Guidance on Model Risk Management. OCC Bulletin 2011-12. <https://www.occ.gov/news-issuances/bulletins/2011/bulletin-2011-12.html>.

h. This includes AVMs from Black Knight, Collateral Analytics, CoreLogic, Data Quick, Equifax, Freddie Mac (FHLMC), Five Bridges, Fannie Mae, Quantarium, Real Info and Veros.

A regulation from the Department of Housing and Urban Development applies FHA to advertisements for homes, including on platform AVMs.<sup>119</sup> Redfin was sued by a coalition of fair housing organizations over its practice of providing services (such as realtor services, 3D virtual tours, and professional photography) only to homes for sale over a certain specific price, leading to a settlement that ended the practice.<sup>120</sup> Meta was sued by the Department of Justice under FHA and ultimately agreed to modify its ad delivery services and pay a small civil penalty in the resulting settlement.<sup>121</sup>

The Dodd-Frank Act also amended the Equal Credit Opportunity Act (ECOA), leading to a 2013 regulation that requires creditors to automatically provide appraisals and valuations to credit applicants.<sup>122</sup> This includes providing AVM estimates within one week of receiving them—however, it does not specify what information should be provided alongside the estimate.<sup>123</sup>

In addition to creating the four quality control factors for AVMs, the Dodd-Frank Act also tasked several agencies with creating regulations to implement these quality control standards and any others they deemed necessary. In June 2023, several federal agencies—including FRB, OCC, FDIC, NCUA, Consumer Financial Protection Bureau (CFPB), and FHFA—released a proposed rulemaking on AVMs (hereafter, the FIRREA AVM rulemaking) under the authority granted in Dodd-Frank. The agencies proposed adding a fifth quality control factor, specifically that AVMs “comply with applicable non-discrimination laws.” However, not all AVMs are covered by this rule; it covers only uses of AVMs by mortgage originators and financial institutions that sell mortgage-backed securities used to determine “the collateral worth of a mortgage secured by a consumer’s principal dwelling.” Platform AVMs and AVMs used for tax assessment or appraisals do not fall under the proposed rule.<sup>124</sup>

## Rules on appraisers’ use of AVMs

Appraisers’ use of AVMs is guided by the Appraisal Standards Board, specifically Advisory Opinion 18, which details how appraisers can appropriately use AVM estimates in the course of their appraisals.<sup>125,126</sup> The Advisory Opinion outlines how and under which conditions an appraiser may use an AVM (e.g., if they understand how an AVM works, if the AVM output is credible) and emphasizes the importance of having an understanding of how the AVM works and not using an AVM to replace an appraisal.<sup>127</sup> The Appraisal Standards Board also writes the Uniform Standards of Professional Appraisal Practice (USPAP), which state-licensed or state-certified appraisers conducting federally related real estate transactions are required to comply with.<sup>128</sup>

## Nongovernmental standards

Beyond the regulations discussed above, AVM providers are mostly left to set their own standards of practice. The International Association of Assessing Officers, which sets international standards for tax assessing agencies, publishes a voluntary AVM standard.<sup>129</sup> The National Fair Housing Alliance has developed the Purpose Process and Monitoring (PPM) framework for auditing algorithmic systems in housing and lending, which advises ensuring the algorithm is appropriate to addressing the business problem, auditing the potential risks of the algorithm; and evaluating data availability and quality.<sup>130</sup>

# Policy Recommendations

AVMs already play a significant role in the housing market, and their importance can only be expected to grow. This expansion of AVMs is enabled by the federal government through the raising of the minimum real estate transaction price that requires an appraisal and through the GSEs allowing AVMs to play a more substantive part in mortgage origination. Further, AVM developers are subsuming more aspects of an appraisal into their AVMs through new algorithms and expanded data collection. As AVMs become more capable, especially by integrating property condition data, their speed, cost, and accuracy advantages may become more pronounced.

There is currently less oversight and regulation of AVMs than of human appraisers. As a consequence, as the industry transitions further toward AVMs, the default outcome is lower regulatory standards. This is why, if the role of AVMs is to be expanded, additional government safeguards should be put into place. Specifically, these new AVM safeguards should include (1) expanding public transparency, (2) disclosing more information to affected individuals, (3) guaranteeing independent evaluations, (4) encouraging search for less discriminatory AVMs, (5) releasing more government data on AVMs, (6) regulating platform AVMs, and (7) employing new forms of AVMs to counter historic redlining.<sup>i</sup> Collectively, these policy interventions can help ensure that the transition toward AVM-oriented valuations results in broad and equitable benefits to everyone in the housing market.

## 1. Expanding public transparency

The current state of transparency to the general public by AVM providers is inconsistent, making it hard to compare AVMs and enabling AVM providers to cherry pick the statistics they share about their models' accuracy. In advertising documents, AVMs typically report average or median percent error—that is, how different the AVM estimate is from the final sales price of a property, expressed as a percent of the sales price and then averaged across all properties. This is a useful overall measure of AVM accuracy but is insufficient to understand AVM performance across different geographies, communities, and home values. Further, these error estimates do not communicate the proportion of undervaluation and overvaluation of properties, which have distinct risks.

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i. Note that while there are clearly emerging data privacy concerns due to the proliferation of AVMs, as discussed, these challenges warrant policy interventions integrated into the broader context of comprehensive data privacy legislation. This report focuses instead on policy interventions more narrowly in response to the algorithmic harms of AVMs.

AVM vendors should expand their public reporting to include:

- Both mean absolute error and mean percentage error by geography (e.g., zip code and county) and by bands of property sales price (e.g., homes valued between \$250,000 and \$300,000).
- The magnitude and directionality of that error—i.e., what percentage of houses were undervalued or overvalued by geography, and the average and median magnitude, as well as deciles, of those undervaluations and overvaluations.
- The relative accuracy on low- and high-value properties (sometimes referred to as vertical inequity).<sup>131</sup>

Further, AVM providers should communicate to the public the methods by which they calculate these metrics. This should include, for instance, the judicious use of cross-validation to reach AVM performance metrics, and the guarantee that only pre-listing estimates are used for AVM performance testing and validation.<sup>j</sup>

The FIRREA AVM rulemaking formalizes the applicability of nondiscrimination rules to AVMs, offering an opportunity to incorporate these requirements into this quality control standard. Further, the first quality control standard in FIRREA requires mortgage originators and others engaged in credit decisions to create policies and practices that “ensure a high level of confidence in the estimates produced” by the AVMs that they use. Although the current proposed rule would not mandate public disclosure, such a requirement could be added to the proposed rule to supplement this quality control standard. Making this information public would also benefit institutions covered by the Interagency Appraisal and Evaluation Guidelines in their process of choosing an AVM.

## 2. Disclosing more information to affected individuals

The current state of transparency to affected individuals (i.e., to buyers, sellers, and credit applicants) is also insufficient. Aside from a home value estimate from an AVM, AVM providers often provide a measure of statistical uncertainty. The most common uncertainty estimate for AVMs is called a forecast standard deviation (FSD), which is intended to provide a measure of how confident the AVM is for that specific estimate. FSDs are themselves a result of statistical modeling and are also highly inconsistent between AVM providers.<sup>132,133,134,k</sup> FSD calculations should adhere to a standardized set of best practices, including testing using cross-validation.<sup>135,136</sup> Further, AVM providers should publicly detail the process, testing, and validity of their FSD calculations.

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j. All AVM estimates made public and provided to individuals should be pre-listing estimates. This means that all the measurement to determine the accuracy and uncertainty estimates should be performed without the model knowing the listing price of a home. This listing price is highly predictive of a final sales price, and therefore reporting outcome metrics that benefit from using listing price will be inflated and overly optimistic in representing AVM equality. For a longer discussion, see: Lwowski, B. (2023). Why we need to move towards prelist/list blind benchmarks if we want to advance AVMs. <https://www.linkedin.com/pulse/why-we-need-move-towards-prelistlist-blind-benchmarks-lwowski-phd-/>.

k. For examples, see: [RPR](#), [CoreLogic](#).



In addition to standardizing FSDs, AVM providers should show affected individuals more intuitive numbers, such as a range of values within which the home value should fall, based on the model (called prediction intervals).<sup>137</sup> Further, AVM providers can directly provide individuals with the average error, and directionality of that error, for the individual's geography and home price range as discussed in policy recommendation (1). As additional research on measuring AVM performance becomes available, these standards should be adapted to reflect new best practices.

There are several potential paths to encouraging AVM providers to disclose these measures, each by amending the guidelines and regulations that affect lenders' use of AVMs. The ongoing FIRREA AVM rulemaking could incorporate these requirements into the first FIRREA quality control standard. Alternatively, an update to the Interagency Appraisal and Evaluation Guidelines might accomplish the same goal. Lastly, the CFPB could update Regulation B of ECOA to require that lenders disclose performance metrics to affected individuals.

### 3. Guaranteeing independent evaluations

The Interagency Appraisal and Evaluation Guidelines require independent testing of AVMs. Presently, AVM providers do not disclose which organizations perform these independent reviews.<sup>l</sup> Further, the companies that provide independent assessment also do not publicly disclose how they evaluate AVMs—the details of which are key to understanding the validity of AVMs. This status quo can be much improved.

AVM providers should publicly disclose from where they receive independent evaluations, and independent evaluators should disclose which AVM providers they review. Independent evaluators should also provide extensive details on the process they use for independent evaluations. Their process should include ensuring that the tests are of pre-listing AVM estimates, testing that AVMs are following FIRREA's quality control standards (e.g., by conducting random sampling and rigorous testing), and carefully guarding against other forms of data leakage or overfitting.<sup>138</sup> These independent assessments should be routinely provided to the GSEs and pertinent regulators.

Because current regulations apply to users, not developers, of AVMs, updated regulations must require the users of AVMs, such as mortgage lenders, to provide the details of the independent assessments they receive to regulators. This change could be made through updating, and adding more specificity to, the AVM section of the Interagency Appraisal and Evaluation Guidelines. Alternatively, the GSEs could require that all AVMs used in lieu of an appraisal be independently evaluated under these more rigorous standards.

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l. At times, one can find evidence of the evaluations, such as Black Knight working with AVMetrics for independent ordering of their [AVM cascade](#).

## 4. Encouraging the search for less discriminatory alternative AVMs

Regulators should require or encourage lenders to search for less discriminatory AVMs for properties in communities of color and low-income neighborhoods. This recommendation could be included in the FIRREA AVM rulemaking. Alternatively, FHFA could implement this by requiring the GSEs to require lenders to use one of the most accurate AVMs for low income communities or communities of color based on independent evaluations, or by requiring that AVM providers search for a less discriminatory alternative model.<sup>139</sup> Such a least discriminatory alternative test is not unprecedented: Evidence of searching for and selecting the least discriminatory approach to a decision is one way to meet criteria of ECOA and FHA.<sup>140,141</sup>

Further, the GSEs and FHFA should explore the use of AVM cascades for producing less discriminatory AVM estimates. AVM cascades, such as CoreLogic's Optival, Black Knight's ValuEdge, and Veros's VeropRECISION enable different AVMs to be automatically selected based on their performance in different counties.<sup>142,143,144</sup> When used carefully in geographies with high AVM error rates, such as communities of color, AVM cascades may enable the reduction of systemic bias.<sup>m</sup> Cascades therefore merit further research by FHFA and the GSEs to understand whether and under what conditions they may help produce less biased estimates than standalone AVMs.

## 5. Releasing more government data on AVMs

Starting in late 2022, FHFA began releasing quarterly aggregated data representing nearly 50 million appraisals over ten years, called the Uniform Appraisal Dataset (UAD).<sup>145</sup> This data includes meaningful statistics that show higher levels of appraisal undervaluation in communities of color.<sup>146</sup> The UAD could be expanded to provide more information about AVMs, first by collecting AVM data, including value estimates and uncertainty estimates (e.g., FSD) that are used in the real estate process. FHFA can then disaggregate and report on trends in those estimates, as well as comparisons to appraisal values. Further, FHFA should consider enabling expanded access to the microdata—that is, non-aggregated data on appraisals—either to the public, or if necessary, to a limited set of approved independent researchers, such as through Federal Statistical Research Data Centers.<sup>147</sup>

This data would be highly valuable, not only to inform future policymaking on AVMs, but also to enable better public scrutiny, including journalism and civil liability, in circumstances where significant disparities in AVM estimates may be harming individuals and communities. Several AVM providers and users, as well as advocacy groups, have called for such data in comments on the proposed interagency rule.<sup>148,149,150,151</sup>

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## 6. Regulating platform AVMs

Despite their substantial and growing role in the real estate market, AVMs deployed by online platforms have not received sufficient regulatory attention. The AVMs deployed by Zillow and Redfin have significant impact on the U.S. housing market and appear to be subject to the Fair Housing Act (which covers housing advertisements) based solely on the use of the AVM estimates to attract users to the online platforms.<sup>152</sup> However, Zillow is not just an online platform. After buying Mortgage Lenders of America in 2019, Zillow launched Zillow Home Loans, its in-house mortgage origination.<sup>153</sup> This means Zillow's AVMs could also be covered under FIRREA, if they are used in the mortgage origination process. Due to both their broad market impacts, and their specific application for realtor services and mortgage origination, the online platform AVMs should no longer be left aside by housing regulators.

The applicability of FIRREA to specific platform AVMs, depending on their usage, can be clarified in the ongoing FIRREA AVM rulemaking or as an update to the Interagency Appraisal and Evaluation Guidelines.

## 7. Employing new forms of AVMs to counter historic redlining

AVMs revolve around the goal of predicting the eventual sales price of a home. Even if AVMs were perfectly accurate for all communities and all homes, regardless of racial or ethnic composition, these estimates would still reflect human discrimination that results in the undervaluation of homes in communities of color. Put another way, if an AVM predicted sales prices perfectly, with no error whatsoever, those sales prices would still reflect existing systemic discrimination. It is not clear that any policy interventions aimed at AVMs of this design can enable AVMs to meaningfully improve much beyond the limits of today's systemic discrimination.

However, alternative forms of AVMs may be able to contribute to undoing the impacts of systemic discrimination and redlining. AVM providers, online real estate platforms, GSEs, and other financial institutions should research and develop alternative modeling approaches that are not dependent on current sales price. For instance, these alternative models could display to individuals a normalized estimate of the value of a property based on its characteristics, but independent of its location and geographic features. Alternatively, models could be developed to display a counterfactual estimate of how much a home would be worth if it were in a different neighborhood.

These are far from perfect approaches to solving systemic discrimination. However, the limits of today's AVMs to counteract past discrimination are stark, and AVM stakeholders should experiment and explore new approaches that could provide a path to greater equity.

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