



**THE SIZE OF THE AFFORDABLE MORTGAGE MARKET:  
2022-2024 ENTERPRISE SINGLE-FAMILY HOUSING GOALS**

August 3, 2021

This Federal Housing Finance Agency (FHFA) technical report documents the statistical forecast models that the modeling team has developed as part of the process for establishing the affordable housing goal benchmark levels for Fannie Mae and Freddie Mac for 2022 through 2024. The report was prepared by Ken Lam and reviewed by Omena Ubogu, Jay Schultz, and Padmasini Raman.

## Introduction

The Federal Housing Enterprises Financial Safety and Soundness Act of 1992 (the Safety and Soundness Act), as amended, mandates that the Federal Housing Finance Agency (FHFA) establish annual housing goals for Fannie Mae and Freddie Mac (the Enterprises).<sup>1</sup> Since 2010, FHFA has adopted a two-part approach to establishing and measuring the Enterprise housing goals. The “benchmark” level is set prospectively by rulemaking based on various factors set out in the statute, including FHFA’s forecast of the goals-qualifying market based on the econometric models described in this paper. The actual market level is determined retrospectively by FHFA based on the Home Mortgage Disclosure Act (HMDA) data for the year when it becomes available. Both the benchmark market and the retroactive market levels are determined at the national level and for a full calendar year. In any given year, an Enterprise is deemed to have met the goal if it meets or exceeds either the benchmark level or the retrospective market level. Typically, HMDA data for a given calendar year is released in the second quarter of the following year so that FHFA’s retroactive market level determination of the Enterprise’s housing goals performance is made the following year.<sup>2</sup>

The benchmark level is based on the market forecast model (and other factors) and is set in advance for the goal period to provide a planning target for Enterprise activities. The market forecast model referred to here is the national level statistical model that is estimated using monthly goal-qualifying share data from HMDA and the resulting monthly forecasts are then averaged into an annual forecast for each of the three years in the goal period.

The retroactive market level is based on FHFA’s determination of the goal qualifying market for each year based on HMDA data. This is not a statistical modeling exercise but rather an aggregation based on applying counting rules to HMDA data.

The Safety and Soundness Act sets out seven factors that FHFA is expected to consider when setting the benchmark level.<sup>3</sup> FHFA’s approach has been to incorporate as many of these factors into the statistical forecast model as possible, generating model forecasts for each of the goal years along with confidence intervals. For instance, four of the seven factors (national housing needs; economic, housing, and demographic conditions; other mortgage data; and the size of the conventional purchase money or refinance mortgage segment) are explicitly modeled in the statistical forecast models. Three factors (performance and effort of the Enterprises to lead the industry in making mortgage credit available; the ability of the Enterprises to do so; and the need to maintain sound financial condition of the Enterprises) are not readily quantifiable and there are no public data on these factors. As a result, they are not explicitly modeled in the statistical forecast models. FHFA incorporates these factors into the benchmark setting process while picking the specific point estimate within the model-generated confidence intervals for a given goal year. That process is documented in the preamble to the proposed rulemaking and is beyond the scope of this

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<sup>1</sup> 12 U.S.C. 4561(a).

<sup>2</sup> Typically, FHFA will issue a preliminary determination of each Enterprise’s housing goals performance in a given calendar year, in the following October. The Enterprises will have 30 days to respond to the determination and FHFA typically issues a final determination in December.

<sup>3</sup> 12 U.S.C. 4562(e)(2).

report. This report focuses on documenting the statistical models and the associated confidence intervals of the estimates.

The single-family goals are limited to conventional conforming mortgages on owner-occupied housing with a total of one to four units. Therefore, jumbo mortgages (with loan amounts above the conforming loan limit), mortgage loans to investors, mortgages on second homes, and non-conventional loans (loans with some form of government insurance on them) are all excluded.

FHFA is required to establish three single-family home purchase goals and one refinance goal. FHFA has also established an additional single-family home purchase subgoal for low-income areas. The single-family home purchase goals and subgoal and the single-family refinance goal are defined as follows:

- **Low-Income Home Purchase (LIP) Goal:** This goal measures the share of each Enterprise's goal-qualifying purchase loans made to families with incomes no greater than 80 percent of Area Median Income (AMI).
- **Very Low-Income Home Purchase (VLIP) Goal:** This goal measures the share of each Enterprise's goal-qualifying purchase loans made to families with incomes no greater than 50 percent of AMI.
- **Low-Income Areas Home Purchase (LIAS) Subgoal:** This goal measures the share of each Enterprise's goal-qualifying purchase loans made to two subgroups: a) families living in census tracts where the median census tract income is no greater than 80 percent of AMI; and b) families with incomes no greater than 100 percent of AMI living in census tracts with a minority population of 30 percent or more and median census tract income of less than 100 percent of AMI.
- **Low-Income Areas Home Purchase (LIA) Goal:** This goal measures the share of each Enterprise's goal-qualifying purchase loans made to the borrower groups covered by the low-income areas home purchase subgoal, and also includes families with incomes no greater than 100 percent of AMI living in designated disaster areas.
- **Low-Income Refinance (LIR) Goal:** This goal measures the share of each Enterprise's goal-qualifying refinance loans made to families with incomes no greater than 80 percent of AMI.

FHFA sets the low-income areas home purchase goal each year based on the low-income areas home purchase subgoal benchmark level, plus an additional increment based on federally declared disaster areas over the past three years. As a result, FHFA does not create a separate statistical forecast model for the low-income areas home purchase goal.

FHFA is considering replacing the LIAS and LIA goals with a set of new subgoals. Details are provided in the preamble of the Proposed Rule for the 2022-204 Enterprise Housing Goals. This report includes the statistical models that forecast the market shares for the LIAS and LIA goals using the previous structure which was operational when the models for the proposed rule were developed. Models and market share forecasts for the new subgoals will be incorporated in the revised version of the report (along with any changes that FHFA decides to make based on public comments received) when the Final Rule is published.

The current set of statistical forecast models all use outcome variables (i.e., market share estimates for the four housing goals) that are derived from the HMDA data. We rely on sixteen years of HMDA data: data from 2004 until 2019. As we will discuss in the next section, although HMDA data prior to 2004 is available, those data sets do not contain key variables needed to define the market shares for the outcome variables. The current goal cycle continues the practice established in the 2018-2020 rulemaking cycle of using Moody’s Analytics as the primary data source for the independent or driver variables.<sup>4</sup> As noted previously, not only did this practice streamline the data collection process but it also permitted FHFA to rely on Moody’s Analytics forecasts. There are some exceptions. For some of the variables, Moody’s forecasts were not available. For such cases, we use FHFA’s own forecasts. The goal of FHFA’s statistical forecast models is to provide our best estimate of various affordable market segments for the next housing goal period. This naturally relies on forecasts of the key driver variables for that period.

FHFA’s models include the best-fit model specifications and key driver variables for all goal-qualifying shares while following generally accepted professional practices and standards adopted by economists at other federal agencies. The models not only fit the historical data well, they are also robust (as indicated by the out-of-sample tests). However, as is the case with any forecasting model, whether the models yield “accurate” forecasts is crucially dependent on the accuracy of the forecasts for the driver variables that are inputs to the models. Moreover, the length of the forecast period is important: the longer out the forecast period, the wider the confidence bands around the forecasts.

This report provides technical documentation of the market models used to generate the single-family housing goal forecasts for the 2022-2024 period. It assumes familiarity with econometric methods and forecasting practices that are commonly used by economists. The report is organized as follows: Section 1 describes the mortgage market and economic forecast data used to construct the econometric models. Section 2 identifies the model driver variables and uses them to provide an overview of the housing and macro-economic environments that shape the mortgage market. Section 3 and Section 4 present the model for each of the four house goals. Finally, concluding remarks are provided in Section 5. Technical appendices on sensitivity analysis and data sources are attached at the end.

## **Section 1: Sources of Data**

The historical monthly time-series data used in estimating the Enterprise housing goals forecast models are produced by a variety of sources. We use HMDA data to construct the outcome variables – that is, the estimates for the goal-qualifying market shares for the two home purchase goals, one home purchase subgoal, and one refinance goal. Our Home Mortgage Disclosure Act (HMDA) dataset is provided by the Consumer Financial Protection Bureau (CFPB). The dataset contains loan-level records of mortgage originations that occurred during a calendar year, including the month of mortgage origination. HMDA data is considered to be broadly representative of the mortgage market in the United States. For the purpose of estimating the single-family mortgage market for goal-qualifying loans, we limit the HMDA records to

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<sup>4</sup> The variables on the right-hand-side of a forecast model are often referred to as the driver variables, while they are also called independent variables and covariates in statistics and economics.

originations of conventional conforming first lien, prime home purchase (or refinance) mortgages.<sup>5</sup> We further limit the data to originations since January 2004 because HMDA records from the pre-2004 time period do not include a number of variables that are critical in identifying the originations that are relevant to the housing goals. In particular, the pre-2004 HMDA data do not identify property type, lien status, Home Ownership Equity Protection Act (HOEPA) status, and the Average Prime Offer Rate (APOR) rate spread. The pre-2004 data were also less precise in identifying manufactured housing loans and high-priced mortgages. Since 2004, HMDA data began including: (1) rate-spread information for high-cost loans, (2) an indicator for manufactured housing loans, and (3) an identifier for first-lien mortgages. The rate-spread and manufactured housing information help to better identify subprime and chattel loans. HMDA data through December 2019 are used in these models.

Historical and forecast values of the model driver variables were downloaded from Moody's Analytics web site. Moody's Analytics obtains the historical values of the variables from various government agencies and industry trade groups and then generates forecasts for the variables using statistical models. Specifically, the unemployment rate, labor force participation rate, consumer price index, and new housing sales come from the Census Bureau and the Bureau of Labor Statistics. Constant maturity interest rates on Government notes and bonds are generated by the U.S. Department of the Treasury, while mortgage interest rates were obtained from Freddie Mac's Primary Mortgage Market Survey. The Housing Affordability Index (HAI) is provided by the National Association of Realtors (NAR) to Moody's. To measure house price changes, we use FHFA's House Price Index (HPI) (for all transactions and for home purchase loans, separately). The refinance rate and the government market share information are calculated from the HMDA data. The volume of refinance applications is captured by the refinance application index released by the Mortgage Bankers Association. The household debt service burden variable is collected by the Federal Reserve System. Per capita income information is released by the Bureau of Economic Analysis. Finally, a measure of the tightness of underwriting standards is constructed from data from the Senior Loan Officer Opinion Survey on Bank Lending Practices. The survey is conducted by the Federal Reserve System. For a complete list of data sources, see Appendix B.

The modeling team used Moody's forecasts published on July 12, 2021 (specifically the Consensus Forecast scenario) for the macroeconomic drivers where available. The Consensus Forecast scenario is designed by Moody's to incorporate the central tendency of baseline forecasts produced by reputable institutions and professional economists, including the Congressional Budget Office (CBO), the Philadelphia Federal Reserve Survey of Professional Forecasters, and the Federal Reserve System. Model results based on alternative forecast scenarios are reported in the Appendix section of the report. In cases where Moody's forecasts were not available (in particular, for the government share of home purchases and refinances), the team generated and tested its own forecasts.

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<sup>5</sup> For the purpose of this analysis, prime mortgage loans are defined as mortgage originations that are not high-priced. In HMDA data, we identify high-priced loans as those with a spread (difference) between the Annual Percentage Rate (APR) of the loan and the applicable Average Prime Offer Rate (APOR) of 1.5 percentage points or greater.

## Section 2: Housing and Mortgage Market Driver Variables

This section describes the historical and projected trends of key driver variables and the macroeconomic environment that has shaped the mortgage market for the forecast period.

### *Macroeconomic Outlook Embedded in the Models*

There are many factors that impact the affordable segments of the housing market. Interest rates are arguably one of the most important variables in determining the trajectory of the mortgage market. In an effort to continue its support of the U.S. economy and promote maximum employment and price stability, the Federal Reserve at its April 2021 meeting reiterated its commitment to seeking inflation at 2 percent in the long run by maintaining its target for the federal funds rate at between 0 percent to 0.25 percent till their goals are achieved. The target was first lowered to this level in March 2020 to mitigate the effects of the COVID-19 pandemic. Moody's July 2021 forecast assumes that this target is maintained until the third quarter of 2022 and then projects that mortgage interest rates – in particular the 30-year fixed rate, which is closely tied to the federal funds rate and the 10-year Treasury note yield – will rise gradually from the current historic low of 3.1 percent in 2020 to 4.3 percent by 2024.

Moody's forecast also projects that the unemployment rate will gradually fall from its 2020 peak to 4.0 percent in 2024. Moody's also forecasts a modest increase in per capita disposable nominal income growth – from \$56,200 in 2021 to \$59,400 in 2024. Furthermore, Moody's estimates that the inflation rate will be in the 2.2 - 2.4 percent range from 2022 through 2024.

The combination of low interest rates, high pent-up/deferred demand and low supply fueled by the pandemic, pushed house prices up by 18.0 percent in May 2021 relative to the same time the previous year based on FHFA's purchase-only House Price Index (HPI). Despite this rapid rate of increase, Moody's is predicting a slow down in HPI increases. Its July 2021 forecast of the same HPI index expects house prices to increase at the annual rates of 4.0, 3.7, and 1.5 percent in 2022, 2023, and 2024, respectively.

Everything else being equal, the expected increase in mortgage interest rates and house prices will likely affect the ability of low- and very low-income households to purchase homes. Housing affordability, as measured by Moody's forecast of the National Association of Realtors' Housing Affordability Index (HAI), is projected to decline from an index value of 166.3 in 2020 to 135.4 in 2024. (Lower values of the HAI imply that affordability has worsened). The third leg of the housing affordability stool is the supply of affordable housing, and this had not kept pace with the growth of the demographic demand even before the COVID-19 pandemic struck.

Low interest rates coupled with rising house prices created an incentive for many homeowners to refinance, resulting in a surge in refinance activity in 2020. (In many ways, 2020 was an unusual year as it saw both record volumes of home purchase and home refinance loans). The refinance share of overall mortgage originations increased from a low of 28.2 percent in 2018 to 61.1 percent

in 2020. Moody's forecasts this share to sharply decline to 41.7 percent in 2021 and continue to decline to 38.7 percent in 2022 and then to 31.2 percent and 24.5 percent in 2023 and 2024 respectively.

The economic outlook from Moody's described above is largely consistent with the outlook provided by other forecasters. For instance, the Bureau of Economic Growth (BEG) notes that following two quarters of losses, real Gross Domestic Product (GDP) grew by 33.8 percent and 4.5 percent in the third and fourth quarters of 2020. In addition, according to the third estimate released by the Bureau of Economic Analysis (BEA), GDP grew by 6.3 percent in the first quarter of 2021, and 6.5 percent in the second quarter of 2021. According to the most recent estimate published by the Congressional Budget Office (CBO), GDP is projected to grow by 7.4 percent in 2021, after which GDP growth is projected to decline to 3.1 percent in 2022 then remain under 2 percent through 2031.<sup>6</sup>

The unemployment rate peaked at 14.8 percent in April 2020 and fell to 5.4 percent in July 2021. CBO projects this number to be 4.6 percent in the fourth quarter of 2021 and that employment will surpass its pre-pandemic level in mid-2022.<sup>7</sup>

Congress passed the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) in March 2020 to address some of the most pressing impacts of the economic disruption, including extending unemployment benefits.<sup>8</sup> Follow-up packages such as the American Rescue Plan aim to support the economy in 2021. FHFA continues to monitor how these changes and proposals may impact various segments of the market, including those targeted by the housing goals.

Exhibit 1 provides summary statistics on key macroeconomic indicators and the driver variables that are used in the forecast models. Variables that are forecasted by Moody's are presented in the first panel of the Exhibit, while those that are forecasted by FHFA are presented in the second panel of the Exhibit.

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<sup>6</sup> Congressional Budget Office (CBO), An Update to the Budget and Economic Outlook: 2021 to 2031. Published in July 2021. <https://www.cbo.gov/publication/57339>

<sup>7</sup> Ibid.

<sup>8</sup> Public Law 116–136.



## Exhibit 1: Historical and Projected Trends of Key Macroeconomic Driver Variables

|  | Historical Trends |        |        |        |        | Projected Trends |        |        |        |
|--|-------------------|--------|--------|--------|--------|------------------|--------|--------|--------|
|  | 2016              | 2017   | 2018   | 2019   | 2020   | 2021             | 2022   | 2023   | 2024   |
| Real GDP Growth Rate.....  | 1.7               | 2.3    | 3.0    | 2.2    | -3.5   | 6.7              | 4.1    | 2.5    | 2.1    |
| Unemployment Rate.....   | 4.9               | 4.3    | 3.9    | 3.7    | 8.1    | 5.4              | 4.1    | 4.0    | 4.0    |
| Labor Force Participation Rate.....                                  | 62.8              | 62.8   | 62.9   | 63.1   | 61.7   | 61.8             | 62.3   | 62.4   | 62.6   |
| Inflation Rate (Change in CPI).....                                  | 1.3               | 2.1    | 2.4    | 1.8    | 1.2    | 3.5              | 2.4    | 2.3    | 2.2    |
| Consumer Confidence Index.....                                       | 99.8              | 120.5  | 130.2  | 128.3  | 101.0  | 115.2            | 113.5  | 111.3  | 114.1  |
| 30-Year Mortgage Fixed Rate.....                                     | 3.6               | 4.0    | 4.5    | 3.9    | 3.1    | 3.3              | 3.9    | 4.1    | 4.3    |
| Per Capita Disposable Income (1,000s \$).....                        | \$43.9            | \$45.8 | \$48.2 | \$49.8 | \$53.1 | \$56.2           | \$55.4 | \$57.1 | \$59.4 |
| Household Debt Service Ratio.....                                    | 4.4               | 4.2    | 4.1    | 4.1    | 3.9    | 4.1              | 4.4    | 4.4    | 4.5    |
| Existing Home Sales (1,000s).....                                    | 4,822             | 4,904  | 4,735  | 4,750  | 5,079  | 5,483            | 5,488  | 5,559  | 5,835  |
| Net Percent of Banks Tightening Standards.....                       | -7.7              | -6.6   | -7.9   | -0.6   | 18.1   | -7.4             | -2.9   | 6.1    | 3.3    |
| Refinance Mortgage Application Share.....                            | 55.3              | 42.4   | 36.0   | 50.6   | 63.5   | 54.3             | 49.9   | 41.7   | 34.0   |
| Housing Affordability Index.....                                     | 166.5             | 159.3  | 143.5  | 165.7  | 166.3  | 143.6            | 138.5  | 134.9  | 135.4  |
| Percent Change in House Prices (Purchase Only) <sup>1</sup> .....    | 6.0               | 6.3    | 5.7    | 5.4    | 10.9   | 7.9              | 4.0    | 3.7    | 1.5    |
| Percent Change in House Prices (All Transactions) <sup>2</sup> ..... | 5.5               | 5.6    | 4.9    | 5.0    | 6.1    | 6.2              | 4.6    | 3.8    | 1.5    |
| Refinance Mortgage Share.....  | 48.1              | 35.2   | 28.2   | 42.8   | 61.1   | 41.7             | 38.7   | 31.2   | 24.5   |
| Percent Gov. Insured Home Purchase Loans.....                        | 33.9              | 31.6   | 29.7   | 30.0   | 29.7   | 29.7             | 29.5   | 29.1   | 30.6   |
| Percent Gov. Insured Refinance Loans.....                            | 22.7              | 22.4   | 20.2   | 23.3   | 18.5   | 18.9             | 19.7   | 19.2   | 19.8   |

Note: Historical values and projected trends are provided by Moody's Analytics. Government shares of the home purchases and refinances are forecasted by FHFA.

<sup>1</sup> Purchase transactions only (Q4/Q4 % Change)

<sup>2</sup> All transactions (Q4/Q4 % Change)

### *Expectations Regarding Key Driver Variables*

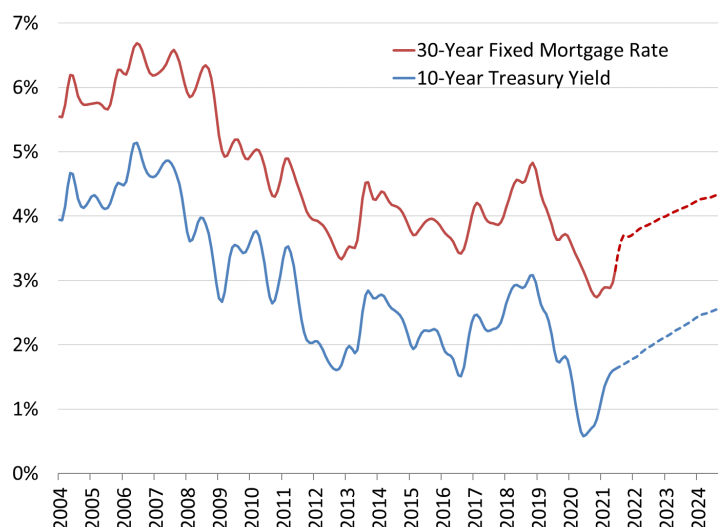
#### Interest Rates

Interest rates are affected by many demand and supply factors. Trends in interest rates on longer term financial instruments such as mortgages typically follow the fluctuations of the 10-Year Treasury note yield, with approximately a 110 to 160 basis point spread between the 1-year and 10-year Treasury yields reflecting the differences in liquidity and credit risk expected for the 2022 through 2024 period. This expected rate spread is higher than what was experienced during the past five years. Interest rates are heavily influenced by the monetary policies of the Federal Reserve Board's Federal Open Market Committee (FOMC). Since mid-2008, the FOMC has maintained an accommodative monetary policy in support of its dual mandate of fostering maximum employment and price stability. While near-term risks to the economic outlook appear roughly balanced, the FOMC is monitoring the inflation rates closely. Exhibit 2 shows the historical and forecast values of the 30-year fixed mortgage interest rate (FRM) and the 10-year Treasury yield.

The 30-year fixed-rate mortgage interest rate fell to a low of 3.3 percent in November 2012 and rose to a high of 4.5 percent in September 2013, before eventually falling to its another low of 3.4

percent in August 2016. Over the following two years, the rate gradually rose to another high of 4.8 percent in November 2018. The rate has dropped sharply since then and it reached a historic low of 2.7 percent in December 2020. For the forecast period, that rate is expected to rise gradually to 4.1 percent in 2023 and then 4.3 percent in 2024.

**Exhibit 2: Historical and Projected Trends of Mortgage Rates and 10-Year Treasury**



## Unemployment, Labor Force Participation, and Inflation

In addition to being an indicator of the health of the economy in general, changes in employment affect the housing market directly because buying a house is the single largest investment for many households as well as a long-term commitment that requires stable employment. The unemployment rate had fallen steadily from 9.1 percent in August 2011 to around 3.5 percent in last quarter of 2019. The rate then rose sharply in the first quarter of 2020 and peaked at 14.8 percent in April 2020 due to the pandemic and related economic shutdowns. Because of the aggressive fiscal and monetary policies, the unemployment rate has fallen back down to 5.4 percent in July 2021.

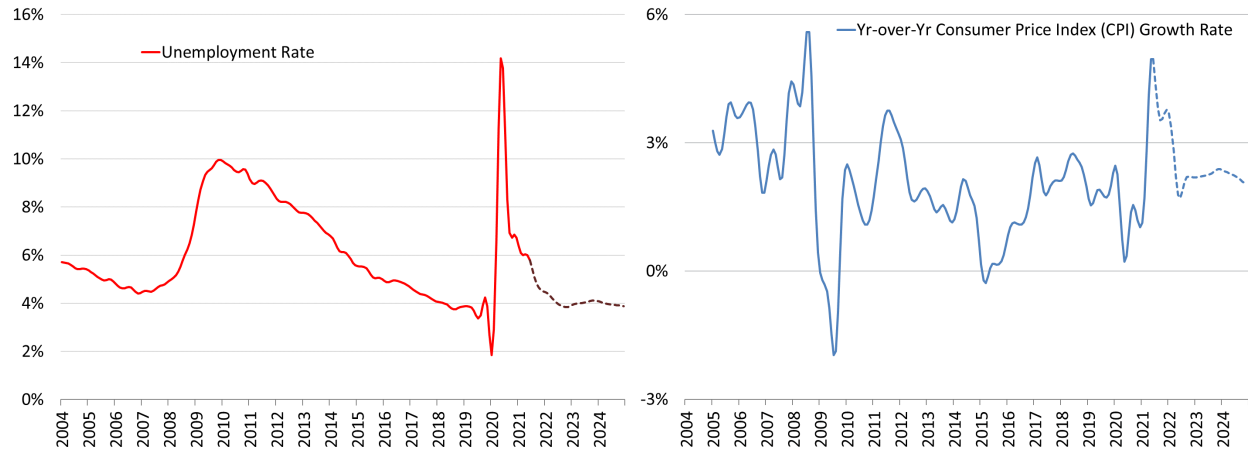
The labor force participation rate was rising gradually in the past few years prior to the pandemic and reached 63.1 percent in 2019. As expected, the rate dropped noticeably in 2020 (to 61.7 percent) because of the recession. Based on Moody’s forecasts, it is expected to rise steadily over the next few years to 62.6 percent in 2024 as the economy continues its recovery.

One of the stated objectives of the FOMC's interest rate policy is fostering maximum employment. Given the foreseeable monetary policy and the continued growth in the economy, the unemployment rate is expected to average about 4 percent for the 2022 to 2024 period according to Moody’s forecasts. Its impact on the affordable home purchase market will depend on the composition of the unemployment rate and could be expected to be greater if the unemployment rate of lower-wage earners is a big driver of the change in the overall unemployment rate.

The second stated objective of the FOMC in determining its interest rate policy is maintaining price stability. Moody's forecast predicts inflation to be generally in check, averaging around 2.2 to 2.4 percent through 2024.

Exhibit 3 plots the history and forecasts of the unemployment rate and the annual growth rate of the consumer price index (CPI).

**Exhibit 3: Historical and Projected Trends of Unemployment Rate and Annual Growth Rate of Consumer Price Index (CPI)**



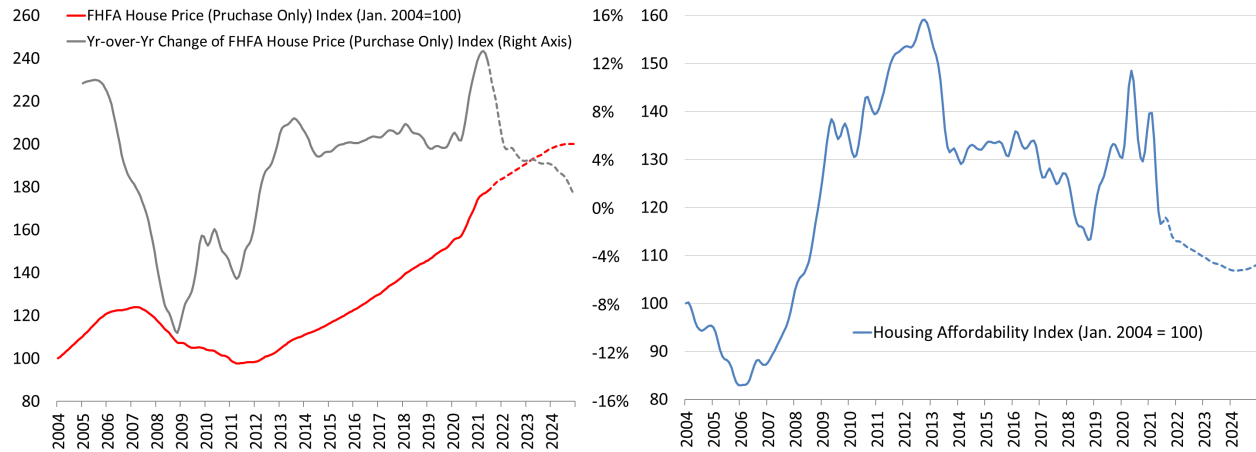
### House Prices and Affordability

Trends in house prices influence the housing and mortgage markets. In periods of house price appreciation, home sales and mortgage originations may increase as the expected return on investment rises. In periods of price depreciation and/or price uncertainty, home sales and mortgage originations tend to decrease as risk-averse homebuyers are reluctant to enter the market. To measure house price appreciation, we use FHFA’s purchase-only House Price Index (HPI). In the left-hand-side panel of Exhibit 4, we plot the level of the HPI (red line, represented by the left axis) and the year-over-year growth rate of the HPI (grey line, represented by the right axis) over the 2004-2024 period. As the graph shows, house prices fell dramatically during the 2007 financial crisis but eventually recovered and turned around since 2012 with price increases in excess of 5.0 percent per year. The growth rate began to accelerate in the beginning of 2020 and reached 10+ percent on a year-over-year basis during the fall quarter of 2020. According to Moody's, the housing markets are expected to remain robust for the forecast period, with house price appreciation rate at 4.0 percent and 3.7 percent for 2022 and 2023. Moody’s expects the growth rate to decline to 1.5 percent in 2024, as the housing markets cool down.

The expected rise in interest rates and house prices will contribute to a decrease in housing affordability. To measure housing affordability, we use the housing affordability index (HAI) published by the National Association of Realtors and provided by Moody’s. It takes general house prices, mortgage interest rates, and borrower incomes into consideration. Higher HAI values means that housing is more affordable. The right panel of Exhibit 4 presents the history and trends of the index. It shows that housing affordability has been increasing since early 2019, largely

because of falling interest rates. Despite the economic downturns caused by the pandemic, housing affordability remained high during 2020 due to the historic low interest rates. However, affordability is expected to decline for the 2022-2024 period because of rising interest rates, robust house prices, supply shortage, and demand pressures created by the increasing share of Millennials generation households entering homeownership.<sup>9</sup>

**Exhibit 4: Historical and Projected Trends of House Prices and Affordability**



### Refinance Share of Mortgage Applications

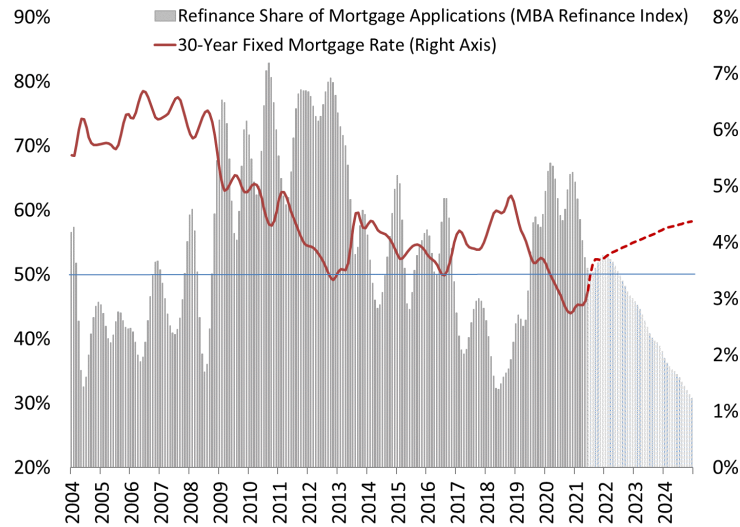
The size of the refinance mortgage market has an impact on the affordable share of refinance mortgages. Historically, refinance mortgage volume increases when the refinancing of mortgages is motivated by low interest rates (“rate-and-term” refinances). Higher-income borrowers tended to make up a greater share of this increased volume. As a result, in periods of low interest rates, the share of lower-income borrowers tended to decrease. Likewise, refinancing that occurred when interest rates were high tended to have a higher proportion of lower-income homeowners who were consolidating their debts or who were drawing equity out of their homes for other uses.

Exhibit 5 plots the historical and projected values of the 30-year fixed mortgage rate and refinance share of mortgage applications (measured by MBA’s refinance index). As expected, it shows a roughly negative correlation between the refinance share and mortgage rate. The refinance share had consistently exceeded 50 percent of the mortgage applications for the period between 2009 and 2016 because of the low interest rate. 2020 represented another solid “refinance boom” year due to the historic low mortgage rates. However, according to Moody's forecasts, as interest rates

<sup>9</sup> According research by CoreLogic, the largest generation of households – the Millennials have made up the largest share of home purchase mortgage applications for the past five years, rising about 2 to 4 percentage points each year. However, during 2020, the Millennial share in mortgage applications increased around 7 percentage, from 33 percent in 2014 to 47 percent in 2019 to 54 percent in 2020. As CoreLogic notes, "while half of the increase is consistent with the natural growth rate seen since 2014, the additional half of the 2020 jump was likely driven by the pandemic. In other words, the increase was accelerated by record low mortgage interest rate and flexibility to work remotely". See the CoreLogic blog post: "Millennials Lead the Pack for Home Purchases": <https://www.corelogic.com/blog/2021/4/millennials-lead-the-pack-for-home-purchases.aspx>

are projected to rise during the 2021-2024 period, the refinance share will drop below 50 percent and eventually reach the 34-percent mark by 2024.

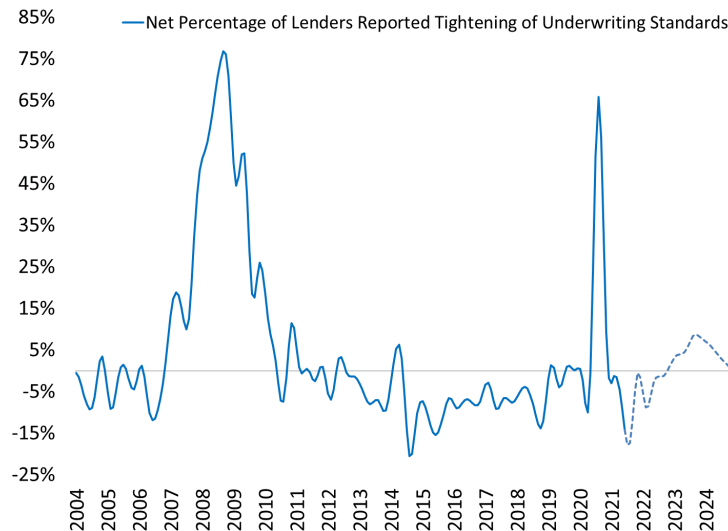
### Exhibit 5: Historical and Projected Trends of Refinance Share and 30-Year Fixed Mortgage Rate



### Underwriting Standards

Mortgage underwriting standards obviously have an impact on mortgage originations. One measure of the tightness of underwriting standards is the net percentage of lenders who reported a tightening of underwriting standards in the Federal Reserve Board’s Senior Loan Officer Opinion Survey on Bank Lending Practices. If the net percentage is greater than zero, it means that there is a higher percentage of lenders reporting a tightening of underwriting standards than lenders reporting a loosening of underwriting standards. On the other hand, a negative net percentage implies that more lenders are reporting a loosening of underwriting standards. The variable is by nature a qualitative assessment but is very useful in capturing underwriter attitudes as well as the use of credit score overlays and other ways in which underwriting standards might tighten. Exhibit 6 plots the series over time. During the housing boom years, as can be seen from the graph, underwriting standards became loose. The graph shows that, following the housing bust in 2007, lenders tightened underwriting standards considerably for a number of years. The underwriting standards in 2020, as indicated by this variable, are almost as tight as those during the 2007-2009 period. Moody’s forecasts that underwriting standards will be relatively less tight for 2021 and 2022. Underwriting standards are forecast to get tight again in 2023 and 2024, although they will not be as tight as the conditions in 2020.

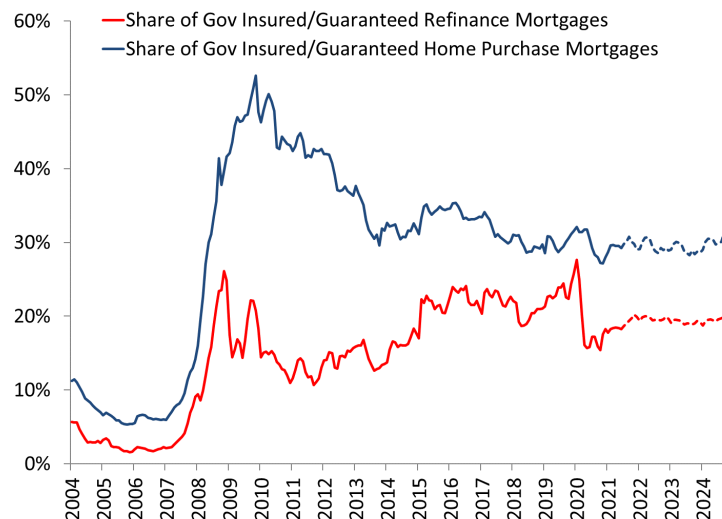
## Exhibit 6: Historical and Projected Trends of Mortgage Underwriting Standards



### Share of Government-Insured and Guaranteed Mortgages

Moody's does not publish forecasts for the government share of home purchase and refinance originations. The modeling team has developed basic forecast models to project these series for the 2022-2024. Government shares are modeled to be driven by trends in the unemployment rate, interest rates, the spread between FHA and conventional mortgage rates, existing home sales, relative underwriting tightness, and house prices. Exhibit 7 plots the historical and projected paths of the two series. Both series, especially the refinance share, declined noticeably during the pandemic in 2020 but they have since rebounded. It is expected that the government share of home purchases and refinances will reach 30.6 percent and 19.8 percent by 2024.

## Exhibit 7: Historical and Projected Trends of Government Shares of Mortgages



## Section 3: Econometric Models of the Single-Family Housing Goals

The purpose of the statistical models is to forecast the market share of the goal-qualifying mortgage originations in the mortgage market for the 2020-2024 period. The focus is on generating reliable model forecasts, rather than testing economic hypotheses or trying to explain the relationship between the variables. Moreover, the forecast equation itself is in the nature of a reduced-form model for the affordable market. Separate models are developed and estimated for each of the four single-family housing goals. We use a type of time-series regression models called Autoregressive Integrated Moving Average (ARIMA) models. Widely used in the field of economic forecasting, ARIMA models are known for their flexibility and ability to generate good fit to various historical series. FHFA has employed these ARIMA models in past rulemaking cycles to generate market forecasts. We have updated the model specification of the ARIMA models in this goal cycle from the models used in the 2018 rulemaking cycle as needed.

The outcome variable for each of the models is expressed in percentage share format. It is constructed as a monthly time-series using the 2004-2019 HMDA data, as described earlier. All the outcome variables and driver variables were first-differenced to ensure that the data series have the statistical property that they are stationary. The augmented Dickey-Fuller tests (ADF) have been conducted on each of the first-differenced series to confirm that they are stationary.

Fitting an ARIMA model on first-differenced variables means that the reported regression coefficients can no longer be interpreted in the way the “beta” coefficients are interpreted in linear regression. Not only are the estimated equations non-linear (indicating the slope of the line is dependent on the specific point the reader is interested in), the coefficients themselves represent the change in the first difference of the dependent variable. Fortunately, since the goal of our models is to forecast rather than explain the reduced form equation of the various housing goal

“markets,” we are able to rely on “hold-out” sample and out-of-sample forecasts to test the robustness of the model specifications as is common among forecasters.

In order to model the non-contemporaneous nature of the relationship between macroeconomic variables, both lagged and un-lagged versions of each driver variable were tested and the appropriate form of the variable chosen.<sup>10</sup> Moreover, to avoid multi-collinearity (or correlation among driver variables), the modeling team has examined the correlation between potential driver variables and ensured that the final model specification did not include driver variables that are highly correlated. Monthly indicator variables are included in the models to control for the seasonal/cyclic patterns of the mortgage activities. Finally, to allow for non-linearity between the outcome variable and driver variables, we tested and included some of the variables in natural logarithm scale. For example, the consumer confidence index variable is entered in logarithm scale in the model for the low-income home purchase market share because it provides a better fit to the data in that form.

During the model development process, we grouped the factors that are expected by housing market economists to have an impact on the market share of affordable housing into seven broad categories. They are:

- Demand side factors such as per capita income and household debt service indicators;
- Interest rate environment including the 30-year FRM mortgage rate;
- Expectation factors and indicators of the health of the economy such as the unemployment rate, labor force participation rate, the consumer confidence index and consumer confidence index;
- House price level including FHFA’s house price indices and the Housing Affordability Index;
- Supply side factors including indicators of existing home sales;
- Underwriting standards including the Senior Loan Officer Opinion survey; and
- Other factors including the share of government insured or guaranteed mortgages.

For each category of variables, many variables were tested but only retained when they exhibited predictive power. For each model, we tested and succeeded in including at least one driver variable per category. We concentrated on the theoretical and behavioral implications when selecting the driver variables but since our goal was to develop robust forecasting models (rather than developing explanatory models), we retained driver variables depending solely on the strength of the explanatory power as long as each category was represented.

### *Market Forecast for Low-Income Home Purchase Goal (LIP)*

Exhibit 8 reports the final set of model driver variables that we have selected for the low-income home purchase goal. It also reports the regression coefficients and their level of statistical significance.

The driver variables that were found to be statistically significant are:

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<sup>10</sup> Lagged variables are reported with a subscript such as  $t_{-1}$  in the tables for the regression coefficients.



- Household debt service ratio (as percentage of disposable income)
- Labor force participation rate (working age)
- Consumer confidence
- Consumer price index
- Sale of existing homes
- Share of government insured or guaranteed mortgages

The Chi-square statistics and other model fit measures reported at the bottom of the table are reasonable for forecasting models for this kind of data. The Pr(Chi-square) statistic, for instance, indicates the probability that, after including the relevant driver variables in the model, the regression residuals are following a white noise distribution (therefore random).

To test for reliability and accuracy of the model's forecasts, we have conducted out-of-sample tests where we withhold the last 12 months (2019) of the HMDA series and estimated the model using the remaining data series (that is, 2004-2018). We then compared the model forecasts in the "hold-out" period (2019) to the actual values in the same period (2019). Results of this analysis are presented in Exhibit 9. The blue line represents the historical HMDA series, while the red line represents the model forecast. Focusing on the out-of-sample forecast period (2019), while the two lines do not track each other perfectly, the forecast model is able to capture the downturns and upturns in the actual data (blue line), albeit with a lag. This is an indication of the robustness of the model specification.

## Exhibit 8: Regression Coefficients of Market Forecast Model for the Low-Income Home Purchase Goal

| <b>Outcome Variable (First Difference)</b>   |                             |
|--|-----------------------------|
| Share of Borrowers with Low Income   |                             |
| <b>Driver Variable (First Difference)</b>  | <i>Coefficient Estimate</i> |
| <i>Demand Side Factors</i>   |                             |
| Household Debt Service Ratio (% of Disposable Income) <sub>t-2</sub>                       | 0.0260 *<br>(0.0138)        |
| Per Capita Income <sub>t-1</sub>   | 0.0038<br>(0.0025)          |
| <i>Interest Rate Environment</i>   |                             |
| 30-Year Fixed Mortgage Rate <sub>t-2</sub>   | -0.0005<br>(0.0043)         |
| <i>Expectations Factors &amp; Health of Economy</i>  |                             |
| Unemployment Rate  | 0.0005<br>(0.0034)          |
| Labor Force Participation Rate (Working Age)   | -0.0120 *<br>(0.0070)       |
| Ln(Consumer Confidence)  | 0.0173 *<br>(0.0092)        |
| Consumer Price Index (CPI) <sub>t-1</sub>  | -0.0021 **<br>(0.0010)      |
| <i>House Price Levels</i>  |                             |
| Housing Affordability Index  | 0.0004<br>(0.0002)          |
| <i>Supply Side Factors</i>   |                             |
| Sale of Existing Homes   | 0.0199 ***<br>(0.0046)      |
| <i>Underwriting Standards</i>  |                             |
| Senior Loan Officer Opinion Survey: Percent of lenders reported tightening of underwriting | 0.0033<br>(0.0140)          |
| <i>Other</i>   |                             |
| Share of Government-Insured or Guaranteed Mortgages  | 0.1811 ***<br>(0.0421)      |
| AR(1)  | 0.0027<br>(0.0781)          |
| <i>Model Diagnostics</i>   |                             |
| $\chi^2$   | 6.71                        |
| Prob(> $\chi^2$ )  | 0.24                        |
| AIC  | -1414.57                    |
| SBC  | -1339.77                    |

**Notes:**

All variables are in first-difference format. Model includes monthly dummy variables that control for seasonal variations. Standard Errors are reported in parentheses. Significance levels: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

### Exhibit 9: Robustness Test of Market Forecast Model for the Low-Income Purchase Goal

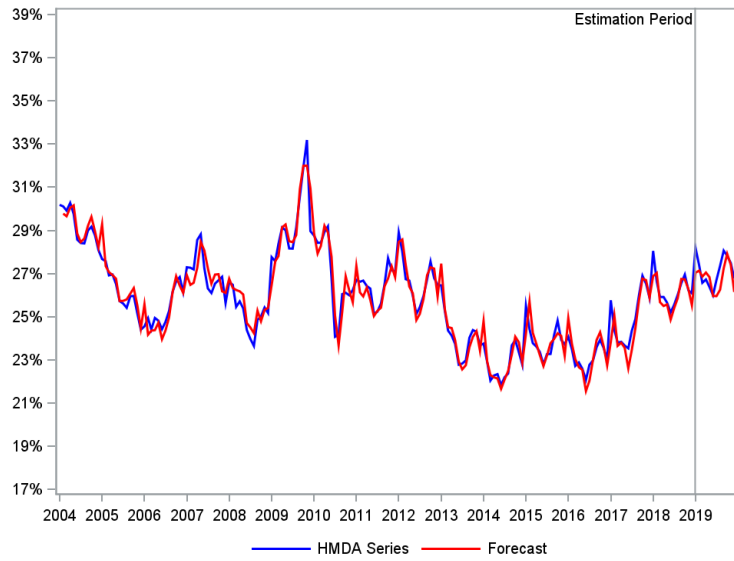


Exhibit 10 plots the monthly forecasts generated by the model for 2020-2024 period. The red line represents the forecast, while the yellow lines are the corresponding confidence intervals. As expected, the LIP market share is rising gradually in 2020 and 2021 before leveling out.

### Exhibit 10: Model Forecast for the Low-Income Purchase Goal

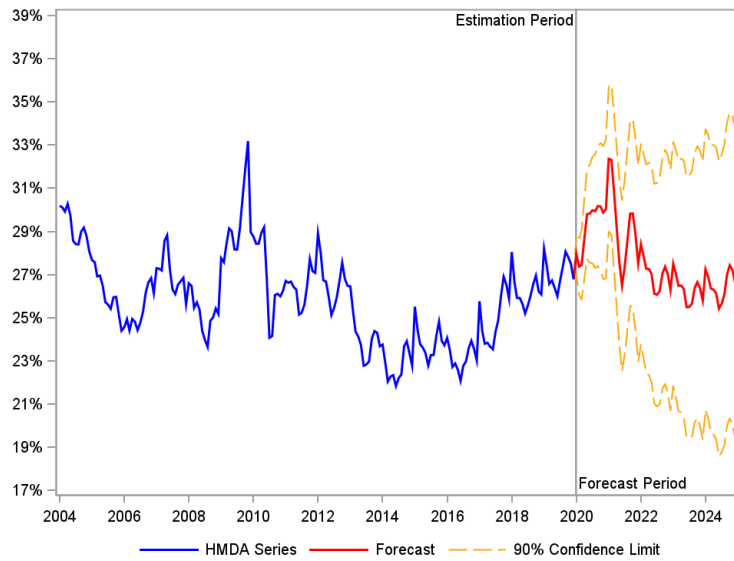


Exhibit 11 presents a summary of the annual forecasts (and their confidence intervals), together with the historical market shares (HMDA) and the benchmark levels that FHFA set for the Enterprises in the past. As a reference, it also shows the model forecasts for the 2016-2020 period that FHFA published in the Federal Register for the 2018 Final Rule. Forecasts from the new model are shown in the last row: 26.9 percent for 2022, 26.2 percent for 2023, and 26.4 percent for 2024. The average annual forecast across the 2022-2024 period is 26.5 percent.

**Exhibit 11: Historical Performance and Model Forecast for the Low-Income Purchase Goal**

|                        | Historical Performance |      |      |      |      |      |      |      |      |      | Projected Performance |      |      |      |      |
|------------------------|------------------------|------|------|------|------|------|------|------|------|------|-----------------------|------|------|------|------|
|                        | 2010                   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020                  | 2021 | 2022 | 2023 | 2024 |
| <b>Actual Market</b>   | 27.2                   | 26.5 | 26.6 | 24.0 | 22.8 | 23.6 | 22.9 | 24.3 | 25.5 | 27.0 | 27.6                  |      |      |      |      |
| <b>Benchmark</b>       | 27                     | 27   | 23   | 23   | 23   | 24   | 24   | 24   | 24   | 24   | 24                    | 24   |      |      |      |
| <b>2018 Final Rule</b> |                        |      |      |      |      |      | 22.7 | 21.9 | 22.7 | 24.4 | 24.3                  |      |      |      |      |
| <b>Market Forecast</b> |                        |      |      |      |      |      | +/-  | +/-  | +/-  | +/-  | +/-                   |      |      |      |      |
|                        |                        |      |      |      |      |      | 1.1  | 2.5  | 4.3  | 5.5  | 6.5                   |      |      |      |      |
| <b>Current Market</b>  |                        |      |      |      |      |      |      |      |      |      | 29.5                  | 28.9 | 26.9 | 26.2 | 26.4 |
| <b>Forecast</b>        |                        |      |      |      |      |      |      |      |      |      | +/-                   | +/-  | +/-  | +/-  | +/-  |
|                        |                        |      |      |      |      |      |      |      |      |      | 2.3                   | 4.0  | 5.1  | 6.1  | 6.9  |

*Market Forecast for Very Low-Income Home Purchase Goal (VLIP)*

The market model for the very low-income home purchase goal includes the same set of driver variables that are included in the model for the low-income home purchase goal. The coefficient estimates and their level of significance are, of course, different from those for the model of the low-income home purchase goal. Exhibit 12 presents the model driver variables and the corresponding coefficient estimates as well as the model fit diagnostic measures.

The driver variables that were found to be statistically significant are:

- Labor force participation rate (working age)
- Consumer confidence
- Consumer price index
- Housing affordability index
- Sale of existing homes
- Share of government insured or guaranteed mortgages

Exhibit 13 presents the out-of-sample robustness test with the red line representing the model estimated on 2004-2018 data and the blue line representing the actual HMDA estimates for the entire period. As can be seen in the graph, for the out-of-sample period (2019), the model forecast (red line) does a fairly good job capturing the turns in the actual data for 2019 (blue line), indicating the robustness of the model specification.

Exhibit 14 plots the monthly forecasts generated by the model for 2020-2024 period. The red line represents the forecast, while the yellow lines are the corresponding confidence intervals. It shows

that similar to the LIP market, the VLIP market share is predicted to rise in 2020 and 2021, reaching a peak in early 2021. From there, it eventually returns to the 2018/2019 level in 2024.

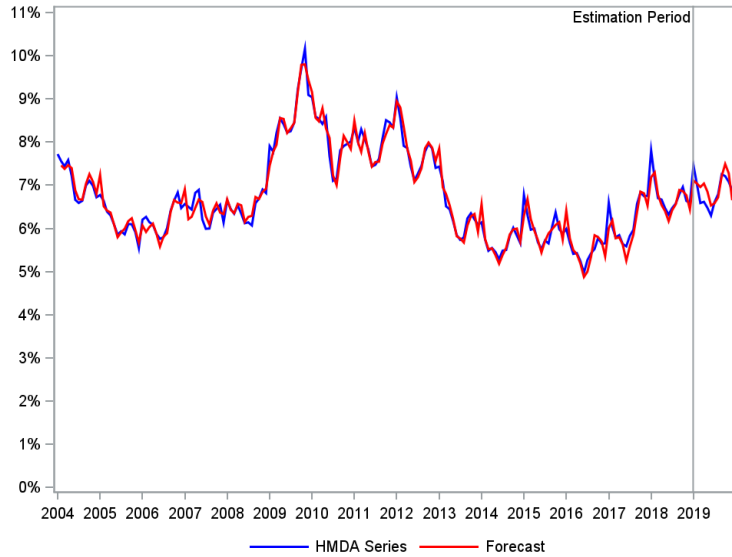
## Exhibit 12: Regression Coefficients of Market Forecast Model for the Very Low-Income Purchase Goal

| <b>Outcome Variable (First Difference)</b>   |                             |
|--|-----------------------------|
| Share of Borrowers with Very Low Income  |                             |
| <b>Driver Variable (First Difference)</b>  | <i>Coefficient Estimate</i> |
| <i>Demand Side Factors</i>   |                             |
| Household Debt Service Ratio (% of Disposable Income) <sub>t-2</sub>                       | 0.0071<br>(0.0049)          |
| Per Capita Income <sub>t-1</sub>   | 0.0008<br>(0.0009)          |
| <i>Interest Rate Environment</i>   |                             |
| 30-Year Fixed Mortgage Rate <sub>t-2</sub>   | -0.0002<br>(0.0015)         |
| <i>Expectations Factors &amp; Health of Economy</i>  |                             |
| Unemployment Rate  | 0.0008<br>(0.0012)          |
| Labor Force Participation Rate (Working Age)   | -0.0042 *<br>(0.0025)       |
| Ln(Consumer Confidence)  | 0.0060 *<br>(0.0033)        |
| Consumer Price Index (CPI) <sub>t-1</sub>  | -0.0006 *<br>(0.0003)       |
| <i>House Price Levels</i>  |                             |
| Housing Affordability Index  | 0.0002 **<br>(0.0001)       |
| <i>Supply Side Factors</i>   |                             |
| Sale of Existing Homes   | 0.0065 ***<br>(0.0016)      |
| <i>Underwriting Standards</i>  |                             |
| Senior Loan Officer Opinion Survey: Percent of lenders reported tightening of underwriting | 0.0039<br>(0.0050)          |
| <i>Other</i>   |                             |
| Share of Government-Insured or Guaranteed Mortgages  | 0.0526 ***<br>(0.0153)      |
| AR(1)  | -0.0170<br>(0.0784)         |
| <i>Model Diagnostics</i>   |                             |
| $\chi^2$   | 10.27                       |
| Prob(> $\chi^2$ )  | 0.07                        |
| AIC  | -1802.42                    |
| SBC  | -1727.62                    |

Notes:

All variables are in first-difference format. Model includes monthly dummy variables that control for seasonal variations. Standard Errors are reported in parentheses. Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

**Exhibit 13: Robustness Test of Market Forecast Model for the Very Low-Income Purchase Goal**



**Exhibit 14: Model Forecast for the Very Low-Income Purchase Goal**

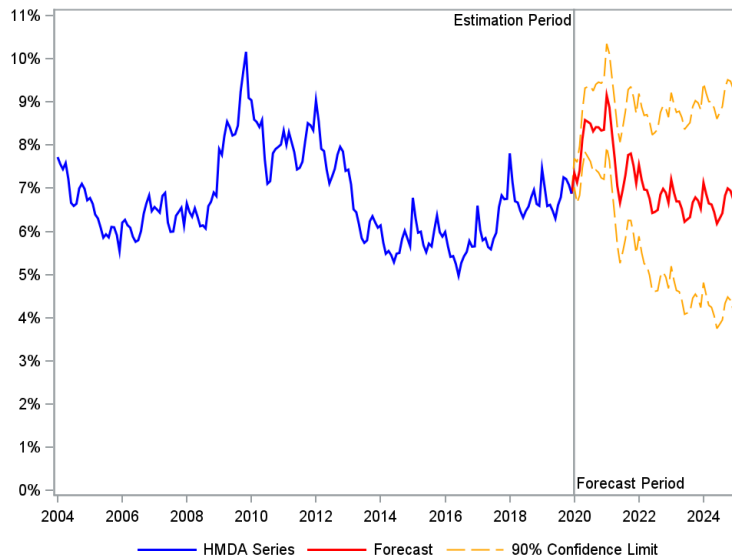


Exhibit 15 presents a summary of the annual forecasts (and their confidence intervals), together with the historical market shares (HMDA) and the benchmark levels that FHFA set for the Enterprises in the past. As a reference, the graph also shows the model forecasts for the 2016-2020 period that FHFA published in the Federal Register for the 2018 Final Rule. Forecasts from the new model are shown in the last row: 6.8 percent for 2022, 6.6 percent for 2023, and 6.6 percent for 2024. The average annual forecast across the 2022-2024 period is 6.7 percent.

**Exhibit 15: Historical Performance and Model Forecast for the Very Low-Income Purchase Goal**

|                        | Historical Performance |      |      |      |      |      |      |      |      |      | Projected Performance |      |      |      |      |
|------------------------|------------------------|------|------|------|------|------|------|------|------|------|-----------------------|------|------|------|------|
|                        | 2010                   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020                  | 2021 | 2022 | 2023 | 2024 |
| <b>Actual Market</b>   | 8.1                    | 8.0  | 7.7  | 6.3  | 5.7  | 5.8  | 5.4  | 5.9  | 6.5  | 6.7  | 7                     |      |      |      |      |
| <b>Benchmark</b>       | 8                      | 8    | 7    | 7    | 7    | 6    | 6    | 6    | 6    | 6    | 6                     | 6    |      |      |      |
| <b>2018 Final Rule</b> |                        |      |      |      |      |      | 5.3  | 5.1  | 5.3  | 5.9  | 5.9                   |      |      |      |      |
| <b>Market Forecast</b> |                        |      |      |      |      |      | +/-  | +/-  | +/-  | +/-  | +/-                   |      |      |      |      |
|                        |                        |      |      |      |      |      | .30  | 0.9  | 1.5  | 1.9  | 2.2                   |      |      |      |      |
| <b>Current Market</b>  |                        |      |      |      |      |      |      |      |      |      | 8.2                   | 7.6  | 6.8  | 6.6  | 6.6  |
| <b>Forecast</b>        |                        |      |      |      |      |      |      |      |      |      | +/-                   | +/-  | +/-  | +/-  | +/-  |
|                        |                        |      |      |      |      |      |      |      |      |      | 1.0                   | 1.4  | 1.8  | 2.1  | 2.4  |

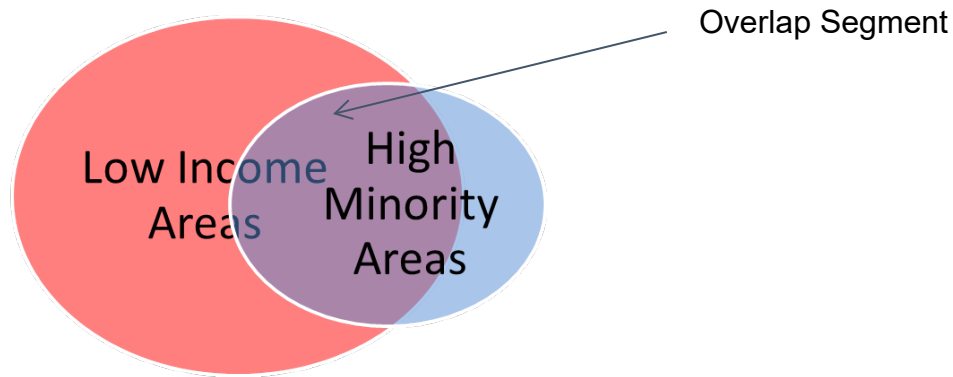
*Market Forecast for Low-Income Areas Home Purchase Subgoal (LIAS)*

This report provides the market model that FHFA has been using to monitor the performance of the current LIAS segment. FHFA’s Proposed Rule for 2022-2024 proposes a different structure for public comments. FHFA will provide the updated market forecast model for the new structure in the Final Rule.

While the definition of goal-qualifying mortgages for the low-income and very low-income goals involves the borrower's income affordability alone, the definition of goal-qualifying mortgages for the low-income area subgoal involves both the borrower's income affordability and the (census tract) location of the borrower's residence. Specifically, the subgoal is intended to measure the share of home purchase mortgage originations associated with:

- (A) Borrowers living in census tracts where the median census tract income is no greater than 80 percent of AMI; and
- (B) Borrowers with incomes no greater than 100 percent of AMI living in census tracts with a minority population of 30 percent or more and median census tract income of less than 100 percent of AMI.

Thus, borrowers could qualify under both conditions. For example, in 2019, mortgages satisfying condition (A) above were roughly 1.5 times the share of mortgages satisfying condition (B): 15.0 percent of mortgages met condition (A) in 2019 and 10.2 percent met condition (B) and 6.4 percent of mortgages met both conditions (i.e., the “overlap” segment).



From an economic modeling perspective, it is necessary to generate non-intersecting populations as that is a pre-requisite for accurate modeling.

Prior to the 2018-2020 goal period, this overlap issue was essentially avoided by design: one model was run for the combined population after ensuring that there was no double counting of the loans. This in effect implied that the drivers for the two populations were assumed to be the same variables. For the 2018-2020 goal period and beyond, the modeling team developed different models (with different drivers) for the non-intersecting subpopulations and found that this approach generated more accurate forecasts than the old practice. Thus, the modeling team constructed and ran models two ways: by grouping the overlap with the low-income areas and by grouping the overlap with the high minority area components. If the overlap population of mortgages has more characteristics in common with the low-income areas, we would expect the models that grouped the overlap with low income areas to perform better than the models that group the overlap with the high minority group. Indeed, this is what the modeling team found: aligning the overlapping portion with the low-income area component yields forecast estimates that are more precise (in terms of a narrower confidence interval) than aligning the overlap with the high minority area.

Therefore, we have two components to the LIAS model: the low-income area component and high-minority area component that add up to the overall LAS share. The driver variables and regression coefficient estimates for the low-income area component model are shown in Exhibit 16.

The driver variables that were found to be statistically significant are:

- 30-Year Fixed Mortgage Rate
- Unemployment Rate
- Labor force participation rate
- Consumer confidence
- Underwriting standards
- Sale of existing homes

The variables and coefficient estimates for the high-minority area component model are reported in Exhibit 17.



## Exhibit 16: Regression Coefficients of Market Forecast Model for the Low-Income Area Purchase Goal: Low-Income Area Component

| <b>Outcome Variable (First Difference)</b>  |                             |
|---|-----------------------------|
| Share of Borrowers Residing in Low-Income Areas   |                             |
| <b>Driver Variable (First Difference)</b>   | <i>Coefficient Estimate</i> |
| <i>Demand Side Factors</i>  |                             |
| Household Debt Service Ratio (% of Disposable Income) <sub>t-2</sub>                                      | 0.0059<br>(0.0055)          |
| Per Capita Income <sub>t-1</sub>  | 0.0002<br>(0.0011)          |
| <i>Interest Rate Environment</i>  |                             |
| 30-Year Fixed Mortgage Rate   | 0.0051 **<br>(0.0026)       |
| <i>Expectations Factors &amp; Health of Economy</i>   |                             |
| Unemployment Rate   | -0.0038 ***<br>(0.0014)     |
| Labor Force Participation Rate (Working Age)  | -0.0064 **<br>(0.0026)      |
| Consumer Confidence <sub>t-2</sub>  | 0.0002 ***<br>(0.0001)      |
| Consumer Price Index (CPI) <sub>t-1</sub>   | -0.0004<br>(0.0004)         |
| <i>House Price Levels</i>   |                             |
| Housing Affordability Index   | 0.0001<br>(0.0001)          |
| <i>Supply Side Factors</i>  |                             |
| Sale of Existing Homes <sub>t-6</sub>   | 0.0028<br>(0.0018)          |
| <i>Underwriting Standards</i>   |                             |
| Senior Loan Officer Opinion Survey: Percent of lenders reported tightening of underwriting <sub>t-4</sub> | -0.0125 **<br>(0.0053)      |
| <i>Other</i>  |                             |
| Share of Government-Insured or Guaranteed Mortgages   | 0.0350 *<br>(0.0198)        |
| AR(1)   | -0.1947 **<br>(0.0804)      |
| AR(2)   | -0.1593 **<br>(0.0811)      |
| AR(3)   | 0.1605 **<br>(0.0812)       |
| <i>Model Diagnostics</i>  |                             |
| $\chi^2$  | 1.35                        |
| Prob(> $\chi^2$ )   | 0.72                        |
| AIC   | -1695.64                    |
| SBC   | -1614.33                    |

**Notes:**

All variables are in first-difference format. Model includes monthly dummy variables that control for seasonal variations.

Standard Errors are reported in paratheses. Significance levels: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

## Exhibit 17: Regression Coefficients of Market Forecast Model for the Low-Income Area Purchase Goal: High-Minority Area Component

| <b>Outcome Variable (First Difference)</b>  |                             |
|---|-----------------------------|
| Share of Borrowers Residing in High-Minority Areas  |                             |
|   | <i>Coefficient Estimate</i> |
| <b>Driver Variable (First Difference)</b>   |                             |
| <i>Demand Side Factors</i>  |                             |
| Household Debt Service Ratio (% of Disposable Income) <sub>t-3</sub>                                    | 0.0021<br>(0.0022)          |
| Per Capita Income <sub>t-1</sub>  | -0.0001<br>(0.0005)         |
| <i>Interest Rate Environment</i>  |                             |
| 30-Year Fixed Mortgage Rate   | -0.0002<br>(0.0010)         |
| <i>Expectations Factors &amp; Health of Economy</i>   |                             |
| Unemployment Rate <sub>t-1</sub>  | -0.0011<br>(0.0007)         |
| Labor Force Participation Rate (Working Age)  | -0.0027 **<br>(0.0012)      |
| Consumer Confidence <sub>t-1</sub>  | 0.0000<br>(0.0000)          |
| Consumer Price Index (CPI) <sub>t-6</sub>   | 0.0000<br>(0.0002)          |
| <i>House Price Levels</i>   |                             |
| Housing Affordability Index   | 0.0000<br>(0.0001)          |
| <i>Supply Side Factors</i>  |                             |
| Sale of Existing Homes <sub>t-6</sub>   | 0.0008<br>(0.0008)          |
| <i>Underwriting Standards</i>   |                             |
| Senior Loan Officer Opinion Survey: Percent of lenders reported tightening of underwriting <sub>t</sub> | 0.0002<br>(0.0022)          |
| <i>Other</i>  |                             |
| Share of Government-Insured or Guaranteed Mortgages <sub>t-4</sub>                                      | 0.0183 **<br>(0.0084)       |
| AR(1)   | -0.3294<br>(0.0744)         |
| <i>Model Diagnostics</i>  |                             |
| $\chi^2$  | 4.59                        |
| Prob(> $\chi^2$ )   | 0.47                        |
| AIC   | -1995.41                    |
| SBC   | -1920.60                    |

Notes:

All variables are in first-difference format. Model includes monthly dummy variables that control for seasonal variations. Standard Errors are reported in parentheses. Significance levels: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

The driver variables that were found to be statistically significant are:

- Labor force participation rate (working age)
- Share of government insured or guaranteed mortgages

The Chi-square statistics reported at the bottom of both tables indicate that, after including the relevant driver variables in the model, the regression residuals are distributed randomly (following a white noise distribution).

Results of the out-of-sample forecast robustness tests are reported in Exhibit 18, separately for the two component models and for the overall LIAS measure. Once again, the blue line represents the historical HMDA series, while the red line represents the model forecast. In each of the three cases, the red line tracks the blue line closely for the 2019 out-of-sample period, showing the robustness of the model estimates.

**Exhibit 18: Robustness Test of Market Forecast Model for the Low-Income Areas Subgoal**

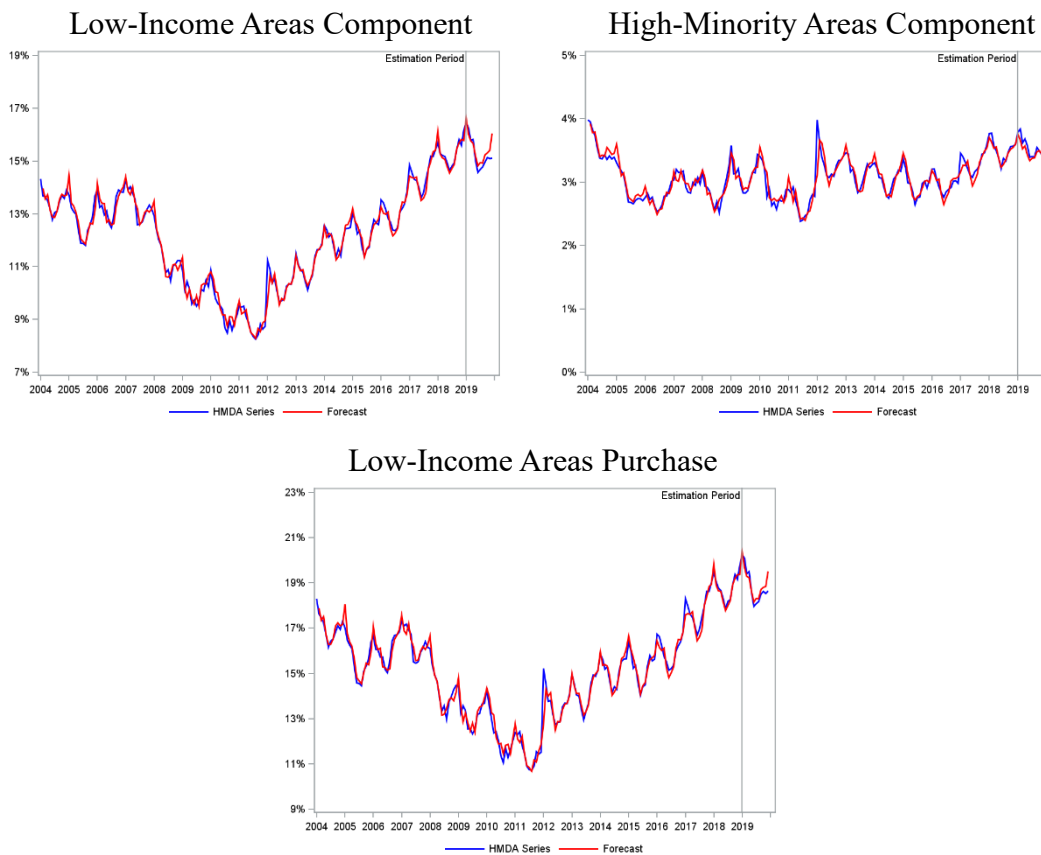


Exhibit 19 plots the monthly forecasts. This is done separately for the two component models and then combined to generate the LIAS outcome measure. The red lines represent the forecasts, while the yellow lines are the corresponding confidence intervals. The forecasts exhibit noticeably seasonal and cyclical patterns. Over the 2022-2024 period, the share for the low-income area component is forecast to be approximately at the pre-pandemic level while for the high-minority component is forecast to decline slightly. These two trends offset each other as we combine them to obtain the overall LIAS forecasts. As a result, the overall trend for the LIAS market share is expected to be a slight decline for the 2022-2024 forecast period, notwithstanding the seasonal/cyclical patterns.

### Exhibit 19: Model Forecast for the Low-Income Areas Purchase Subgoal

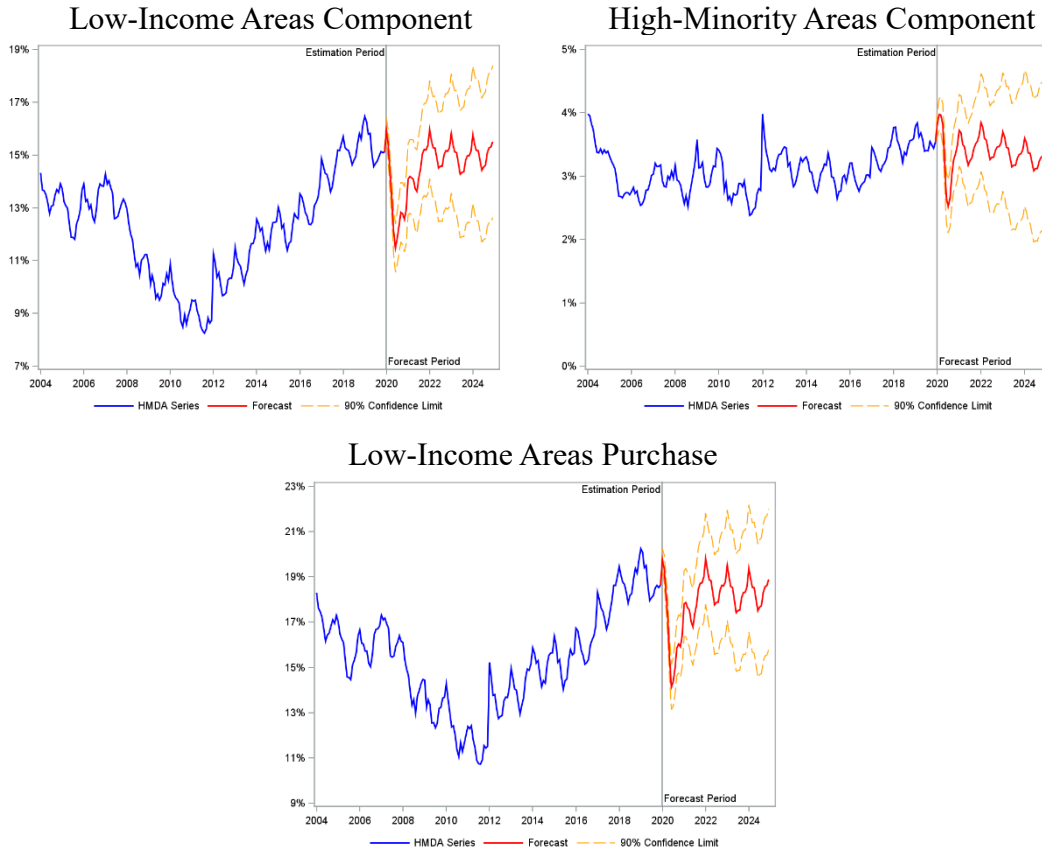


Exhibit 20 summarizes the annual forecasts (and their confidence intervals), together with the historical market shares (HMDA) and the benchmark levels that FHFA set for the Enterprises in the past. As a reference, it also shows the model forecasts for the 2016-2020 period that FHFA published in the Federal Register for the 2018 Final Rule. Forecasts from the new model are shown in the last row: 18.9 percent for 2022, 18.8 percent for 2023, and 18.9 percent for 2024. The average annual forecast across the 2022-2024 period is 18.9 percent.

### Exhibit 20: Historical Performance and Model Forecast for the Low-Income Areas Purchase Subgoal

|                        | Historical Performance |      |      |      |      |      |      |      |      |      | Projected Performance |      |      |      |      |
|------------------------|------------------------|------|------|------|------|------|------|------|------|------|-----------------------|------|------|------|------|
|                        | 2010                   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020                  | 2021 | 2022 | 2023 | 2024 |
| <b>Actual Market</b>   | 12.1                   | 11.4 | 13.6 | 14.2 | 15.0 | 15.2 | 15.9 | 17.1 | 18.0 | 18.3 | 17.6                  |      |      |      |      |
| <b>Benchmark</b>       | 13                     | 13   | 11   | 11   | 11   | 14   | 14   | 14   | 14   | 14   | 14                    |      |      |      |      |
| <b>2018 Final Rule</b> |                        |      |      |      |      |      | 15.8 | 16.5 | 16.6 | 16.8 | 16.4                  |      |      |      |      |
| <b>Market Forecast</b> |                        |      |      |      |      |      | +/-  | +/-  | +/-  | +/-  | +/-                   |      |      |      |      |
|                        |                        |      |      |      |      |      | 0.6  | 1.22 | 2.0  | 2.5  | 3.0                   |      |      |      |      |
| <b>Current Market</b>  |                        |      |      |      |      |      |      |      |      |      | 16.1                  | 17.8 | 18.9 | 18.8 | 18.9 |
| <b>Forecast</b>        |                        |      |      |      |      |      |      |      |      |      | +/-                   | +/-  | +/-  | +/-  | +/-  |
|                        |                        |      |      |      |      |      |      |      |      |      | 1.2                   | 1.7  | 2.2  | 2.6  | 3.0  |

## Market Forecast for Low-Income Refinance Goal (LIR)

The model for forecasting the share of low-income refinances is shown in Exhibit 21. As expected, the driver variables are quite different from those for the home purchase goal models because different factors determine a borrower's refinance decisions.

### Exhibit 21: Regression Coefficients of Market Forecast Model for the Low-Income Refinance Goal

| <b>Outcome Variable (First Difference)</b>   |                         |
|--|-------------------------|
| Share of Refinance Borrowers with Low Income   |                         |
|  | <i>Coefficient</i>      |
| <b>Driver Variable (First Difference)</b>  |                         |
|  | <i>Estimate</i>         |
| <i>Demand Side Factors</i>   |                         |
| Household Debt Service Ratio (% of Disposable Income) $t_3$                                | -0.0196<br>(0.0148)     |
| Refinance Application Volume Index $t+2$   | -0.0501 ***<br>(0.0187) |
| <i>Interest Rate Environment</i>   |                         |
| Refinance Incentive $t-1$  | 0.0166 **<br>(0.0066)   |
| <i>Expectations Factors &amp; Health of Economy</i>  |                         |
| Unemployment Rate  | 0.0034<br>(0.0036)      |
| Consumer Price Index (CPI) $t-1$   | -0.0003<br>(0.0012)     |
| <i>Underwriting Standards</i>  |                         |
| Senior Loan Officer Opinion Survey: Percent of lenders reported tightening of underwriting | 0.0042<br>(0.0164)      |
| <i>Other</i>   |                         |
| Share of Government-Insured or Guaranteed Refinance Mortgages                              | -0.0237<br>(0.0527)     |
| Refinance Rate   | -0.2370 ***<br>(0.0229) |
| AR(1)  | -0.1953 **<br>(0.0768)  |
| <i>Model Diagnostics</i>   |                         |
| $\chi^2$   | 2.96                    |
| Prob(> $\chi^2$ )  | 0.71                    |
| AIC  | -1290.31                |
| SBC  | -1225.26                |

Notes:

All variables are in first-difference format. Model includes monthly dummy variables that control for seasonal variations. Standard Errors are reported in parentheses. Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

The driver variables that were found to be statistically significant are:

- Refinance application share (MBA's refinance index)
- Refinance incentive, measured as a spread between the prevailing 30-year fixed rate and the moving average of the monthly 30-year fixed rates from previous 3 years

- Refinance share of the mortgage originations

The Chi-square statistics reported at the bottom of the table indicate that, after including the relevant driver variables in the model, the regression residuals are distributed randomly (following a white noise distribution).

Results of the out-of-sample forecast robustness test are presented in Exhibit 22. The blue line represents the historical HMDA series, while the red line represents the model forecast. Focusing on the out-of-sample forecast period (2019), the forecast does a reasonably good job at tracking the actual HMDA observations. In particular, the model is capable of correctly predicting the downturn of the low-income refinance share since the beginning of 2019. This indicates robustness of the model specification.

**Exhibit 22: Robustness Test of Market Forecast Model for the Low-Income Refinance Goal**

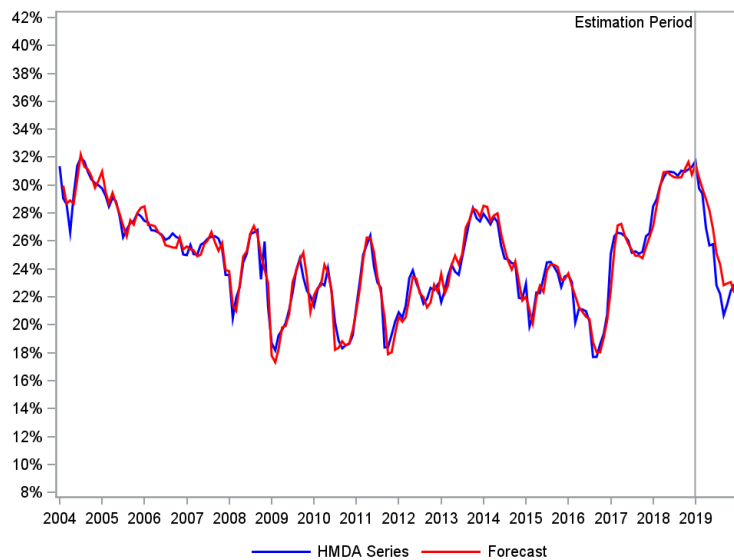
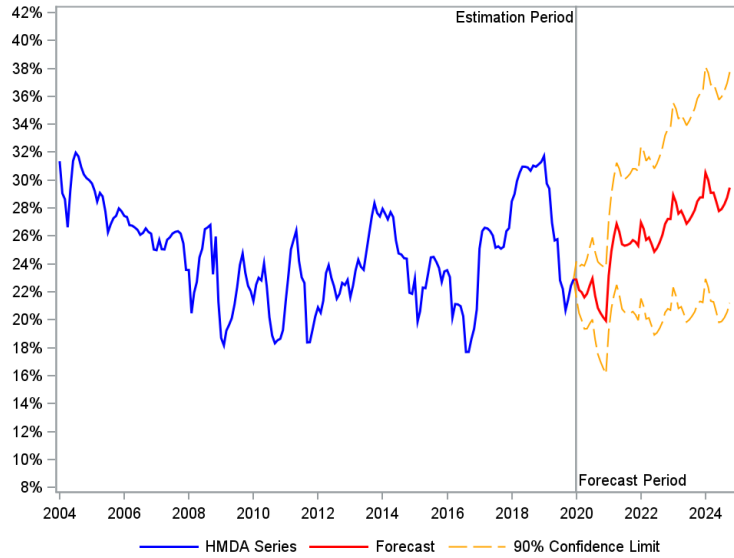


Exhibit 23 plots the monthly forecasts generated by the model for 2020-2024 period. The red line represents the forecast, while the yellow lines are the corresponding confidence intervals. The plot shows that although the affordable share in the refinance market declined substantially in 2020, it is expected that it will recover sharply in 2021 and then gradually rise during the 2022-2024 period.

Exhibit 24 presents a summary of the annual forecasts (and their confidence intervals), together with the historical market shares (HMDA) and the benchmark levels that FHFA set for the Enterprises in the past. As a reference, it also shows the model forecasts for the 2016-2020 period that FHFA published in the Federal Register for the 2018 Final Rule. Forecasts from the new model are shown in the last row: 26.1 percent for 2022, 28.0 percent for 2023, and 28.9 percent for 2024. The average annual forecast across the 2022-2024 period is 27.7 percent.

**Exhibit 23: Model Forecast for the Low-Income Refinance Goal**



**Exhibit 24: Historical Performance and Model Forecast for the Low-Income Refinance Goal**

|                 | Historical Performance |      |      |      |      |      |      |      |      |      | Projected Performance |      |      |      |      |
|-----------------|------------------------|------|------|------|------|------|------|------|------|------|-----------------------|------|------|------|------|
|                 | 2010                   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020                  | 2021 | 2022 | 2023 | 2024 |
| Actual Market   | 20.2                   | 21.5 | 22.3 | 24.3 | 25.0 | 22.5 | 19.8 | 25.4 | 30.7 | 24.3 | 21                    |      |      |      |      |
| Benchmark       | 21                     | 21   | 20   | 20   | 20   | 21   | 21   | 21   | 21   | 21   | 21                    | 21   |      |      |      |
| 2018 Final Rule |                        |      |      |      |      |      | 19.8 | 23.4 | 23.4 | 20.6 | 18.0                  |      |      |      |      |
| Market Forecast |                        |      |      |      |      |      | +/-  | +/-  | +/-  | +/-  | +/-                   |      |      |      |      |
|                 |                        |      |      |      |      |      | 1.5  | 3.0  | 5.1  | 6.5  | 7.7                   |      |      |      |      |
| Current Market  |                        |      |      |      |      |      |      |      |      |      | 21.4                  | 25.5 | 26.1 | 28.0 | 28.9 |
| Forecast        |                        |      |      |      |      |      |      |      |      |      | +/-                   | +/-  | +/-  | +/-  | +/-  |
|                 |                        |      |      |      |      |      |      |      |      |      | 3.2                   | 4.7  | 6.0  | 7.1  | 7.9  |

**Section 4: Sensitivity of Model Estimates**

The modeling team has also investigated the sensitivity of the model forecasts with respect to our assumption of future macroeconomic scenarios. Results are summarized in Appendix A. Overall, we find that the forecasts are relatively insensitive to the use of alternative scenarios.

**Section 5: Concluding Remarks**

This paper provides the technical details of the econometric models that we have developed to forecast the market share of the goal-qualifying mortgage originations in the mortgage market for

each of the four single-family housing goals. Forecasts for the 2022-2024 period are presented. Model diagnostics and reliability of the forecasts have also been discussed. To examine the sensitivity of the model forecasts, we also provide the model forecasts using driver variables embedded in a number of alternative scenarios published by Moody's.



## Appendix A: Sensitivity of Model Estimates to Alternative Macroeconomic Forecast Scenarios

This section analyzes the extent to which our market share estimates are sensitive to the macroeconomic environments that we have assumed. The market share estimates we have reported so far in the paper are based on forecast values of the driver variables from Moody's Consensus Forecast scenario. This scenario incorporates the central tendency of baseline forecasts from a broad range of reputable institutions and professional economists, including the Congressional Budget Office, Office of Management and Budget, and the Federal Reserve Board. To assess the sensitivity of our market share estimates, we use forecast values of the driver variable from three alternative macroeconomic scenarios from Moody's. They are:

- **Baseline scenario.** This scenario assumes that GDP growth will be very strong in 2021 and 2022 as the pandemic eases and fiscal spending increases. The Federal Reserve is expected to keep Federal Funds Rate in the 0-0.25 percent range until early 2023. The 10-year U.S. Treasury yield is expected to increase steadily over the next few years. In addition, strong demographic tailwind is expected for the housing sector.
- **Stronger Near-Term Growth (S1) scenario.** This scenario assumes that the US economy will show a more robust economic growth in the near term as compared to the Consensus Forecast scenario. It assumes that the pandemic eases earlier than assumed in the Baseline scenario and fiscal spending is even higher, increasing business and travel activity and leading to lower unemployment and an even stronger economy in 2021. Consumer confidence increases, accelerating spending and lifting nonresidential investment which adds to growth in real GDP. Wage rates rise, lifting household incomes and spending. House prices rise by 8.3 percent over the course of 2021, compared with 6.2 percent in the Baseline scenario.
- **Protracted Slump (S4) scenario.** This scenario assumes that pandemic persists or worsens, causing business closures and lower consumer confidence and spending. Unemployment rates rise and recession begins. GDP declines through 2022, unemployment rate exceeds 10 percent in 2023. House prices drop 12 percent from 2021-2022. The recession will be less severe than the 2008-2009 downturn. However, the trough is well above that of the 2011 trough following the Great Recession. The recovery is assumed to begin in the third quarter of 2022. Based on historical experience, we assume that the maximum share of the government mortgages (FHA, VA, and RHS) cannot exceed 55 percent of the overall mortgage market. As this share approaches its maximum, we expect that there would be other policy intervention to address the growing share of government financed mortgages.

The comparison of the driver variables for all scenarios is presented in Exhibit A-1 and as can be seen the differences in many of the variables themselves are more subtle than stark.

To generate the alternative market share forecasts, we input the forecast values of the driver variables from each of the alternative scenarios into the regression equations. Monthly forecast results are then aggregated into yearly forecasts. We compare these to the market share forecasts based on the Consensus scenario. Exhibit A-2 provides a summary of the results by year, while Exhibit A-3 presents the monthly forecast results. Results for the low-income purchase share are

shown in the first panel of Exhibit A-2. The first row of each panel highlights the results based on the Baseline scenario, while the following rows show results from using the alternative scenarios. Average annual market performance over the 2022-2024 period are presented in the last column. The results show that the share forecasts for the low-income home purchase goal change slightly in response to alternative macroeconomic environments. The scenarios themselves are close in terms of assumptions (despite the names assigned by Moody's) and this closeness translates into the closeness of the results across different scenarios. Average forecast for the low-income purchase (LIP) share in the 2022-2024 period according to the Stronger Near-Term Growth scenario deviates from the one based on the Consensus Forecast scenario by 0.8 percentage points. If the Protracted Slump scenario is assumed, the differential is 0.2 percentage point only. These are small differences. The same is true for the share forecasts for the very-low income home purchase goal and the low-income areas home purchase subgoal in general. The only exception is that, for the low-income areas subgoal, if the Protracted Slump scenario is assumed, the share forecast will drop by 2.6 percentage points.

Comparisons for the low-income refinance goal are presented in the bottom panel of Exhibit A-3. Under the Stronger Near-Term Growth scenario, market share is forecast to be 31.3 percent for the 2022-2024 period, as compared to 27.7 percent under the Consensus scenario. This represents an increase of 3.6 percentage points. If the Protracted Slump scenario is assumed, the market share is forecast to be 24.6 percent, representing a decrease of 3.1 percentage points.

Overall, we find that the share forecasts are reasonably robust across alternative macroeconomic scenarios.

### Exhibit A-1: Comparison of Forecast Scenarios

|                             |                           | 2021 | 2022 | 2023 | 2024 |
|-----------------------------|---------------------------|------|------|------|------|
| <b>GDP Growth Rate</b>      | Baseline                  | 6.7  | 5.0  | 2.3  | 2.7  |
|                             | Consensus                 | 6.7  | 4.1  | 2.5  | 2.1  |
|                             | Stronger Near-Term Growth | 7.2  | 6.6  | 1.3  | 2.2  |
|                             | Protracted Slump          | 4.5  | -2.2 | 1.2  | 3.8  |
| <b>Unemployment Rate</b>    | Baseline                  | 5.5  | 3.8  | 3.5  | 3.7  |
|                             | Consensus                 | 5.4  | 4.1  | 4.0  | 4.0  |
|                             | Stronger Near-Term Growth | 5.3  | 3.1  | 3.0  | 3.2  |
|                             | Protracted Slump          | 7.0  | 9.6  | 10.3 | 8.6  |
| <b>30-Yr Fixed Rate</b>     | Baseline                  | 3.3  | 4.1  | 4.5  | 4.9  |
|                             | Consensus                 | 3.3  | 3.9  | 4.1  | 4.3  |
|                             | Stronger Near-Term Growth | 3.4  | 4.3  | 4.8  | 5.0  |
|                             | Protracted Slump          | 3.2  | 3.2  | 3.2  | 3.4  |
| <b>FHFA HPI Growth Rate</b> | Baseline                  | 6.2  | 1.9  | 1.3  | 1.2  |
|                             | Consensus                 | 7.9  | 4.0  | 3.7  | 1.5  |
|                             | Stronger Near-Term Growth | 8.3  | 3.8  | 1.3  | 1.2  |
|                             | Protracted Slump          | -4.4 | -2.3 | 0.5  | 2.7  |

|  |                           |       |       |       |       |
|--|---------------------------|-------|-------|-------|-------|
| <b>Housing Affordability Index</b>           | Baseline                  | 144.9 | 142.6 | 140.1 | 139.3 |
|  | Consensus                 | 143.6 | 138.5 | 134.9 | 135.4 |
|  | Stronger Near-Term Growth | 141.7 | 135.7 | 134.3 | 135.1 |
|  | Protracted Slump          | 155.8 | 161.4 | 163.0 | 164.0 |
| <b>Refinance Share Mortgage Applications</b> | Baseline                  | 52.8  | 43.5  | 33.6  | 24.8  |
|  | Consensus                 | 54.3  | 49.9  | 41.7  | 34.0  |
|  | Stronger Near-Term Growth | 52.1  | 40.4  | 28.2  | 19.1  |
|  | Protracted Slump          | 57.0  | 60.4  | 52.8  | 43.7  |

**Exhibit A-2: Summary of Market Model Forecasts Based on Different Scenarios**

|             |                           | 2022  | 2023  | 2024  | 2022-2024<br>Average |
|-------------|---------------------------|-------|-------|-------|----------------------|
| <b>LIP</b>  | Baseline Forecast         | 27.4% | 27.3% | 27.6% | 27.4%                |
|             | Consensus Forecast        | 26.9% | 26.2% | 26.4% | 26.5%                |
|             | Stronger Near-Term Growth | 27.4% | 27.2% | 27.4% | 27.3%                |
|             | Protracted Slump          | 24.6% | 27.1% | 28.3% | 26.7%                |
| <b>VLIP</b> | Baseline Forecast         | 6.9%  | 6.9%  | 6.9%  | 6.9%                 |
|             | Consensus Forecast        | 6.8%  | 6.6%  | 6.6%  | 6.7%                 |
|             | Stronger Near-Term Growth | 6.8%  | 6.8%  | 6.8%  | 6.8%                 |
|             | Protracted Slump          | 6.7%  | 7.6%  | 7.9%  | 7.4%                 |
| <b>LIAS</b> | Baseline Forecast         | 18.9% | 18.4% | 18.5% | 18.6%                |
|             | Consensus Forecast        | 18.8% | 18.2% | 18.3% | 18.4%                |
|             | Stronger Near-Term Growth | 18.9% | 19.4% | 19.1% | 19.2%                |
|             | Protracted Slump          | 14.9% | 15.4% | 17.2% | 15.8%                |
| <b>LIR</b>  | Baseline Forecast         | 28.5% | 30.7% | 32.0% | 30.4%                |
|             | Consensus Forecast        | 26.1% | 28.0% | 28.9% | 27.7%                |
|             | Stronger Near-Term Growth | 29.6% | 32.1% | 32.0% | 31.3%                |
|             | Protracted Slump          | 22.6% | 24.7% | 26.5% | 24.6%                |

LIP = Low-Income Purchase Goal

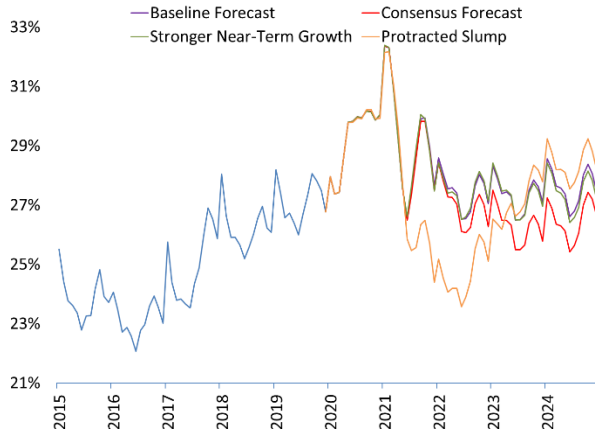
VLIP = Very Low-Income Purchase Goal

LIAS = Low-Income Areas Purchase Subgoal

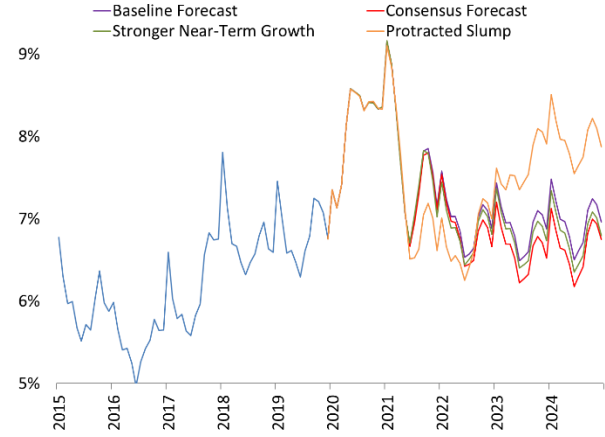
LIR = Low-Income Refinance Goal

## Exhibit A-3: Market Model Forecasts Based on Alternative Scenarios

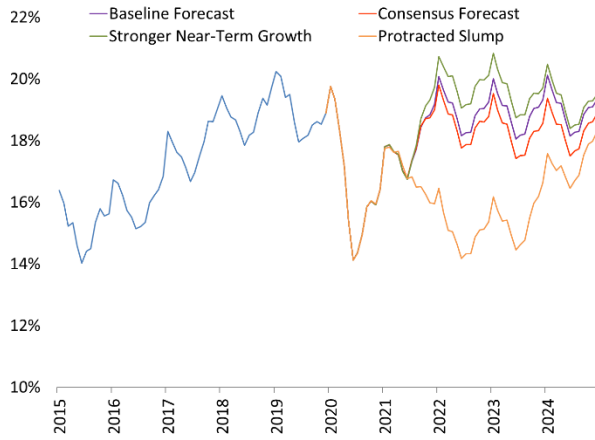
### Low-Income Home Purchase Goal



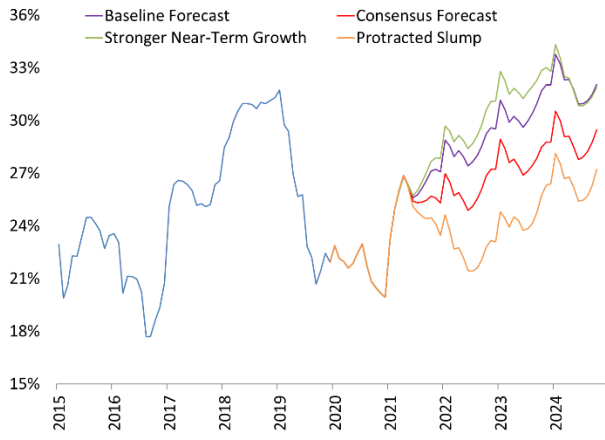
### Very Low-Income Home Purchase Goal



### Low-Income Areas Purchase Subgoal



### Low-Income Refinance Goal



## Appendix B: List of Data Sources

Moody's Analytics

<https://www.economy.com/products/tools/data-buffet>

Federal Housing Finance Agency: House Price Index

<http://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx>

Mortgage Bankers Association

<http://www.mortgagebankers.org/ResearchAndForecasts/ForecastsAndCommentary>

Freddie Mac

<http://www.freddiemac.com/finance/ehforecast.html>

Fannie Mae

<http://www.fanniemae.com/portal/research-and-analysis/emma.html>

Wells Fargo

<https://www.wellsfargo.com/com/insights/economics/monthly-outlook>

PNC Financial

<https://www.pnc.com/webapp/unsec/NCAboutMicrositeNav.do?siteArea=/pnccorp/PNC/Home/About+PNC/Media+Room/Economic+Reports>

National Association of Home Builders

[http://www.nahb.org/reference\\_list.aspx?sectionID=138](http://www.nahb.org/reference_list.aspx?sectionID=138)

Wall Street Journal Survey

<http://projects.wsj.com/econforecast>