INVESTOR DAY 2023

Modeling's Role in Risk Mitigation

Freddie Mac
SINGLE-FAMILY | Credit Risk Transfer

Today's Speaker

Michael Bradley

Senior Vice President, Single-Family Modeling and Analytics

Michael Bradley is responsible for setting the modeling and analytics strategy and positioning Freddie Mac to become the best credit guarantor. This is a critical role, since Freddie Mac relies on data-driven modeling and analytics to guide functions such as buying loans, valuation and hedging, predicting defaults/severity, and conducting risk management, to name a few. Mr. Bradley holds a Bachelor of Science in economics from the University of Delaware and a Master of Science and a doctorate, both in economics, from the University of Illinois.

Our Agenda

1. **Background**

2. **Overvalued Markets: How to Identify and for How Long**

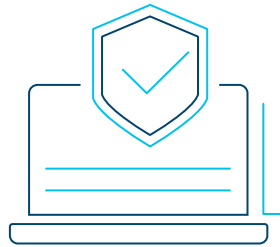3. **Freddie Mac's AI/ML Journey**

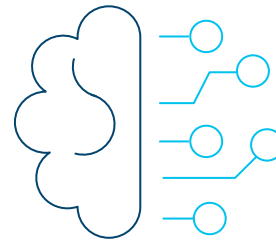4. **Closing Thoughts**

Contextual Background

- **The Three C's**

- **Four Lines of Defense**

- **Formal Theories of Default**

Contextual Background
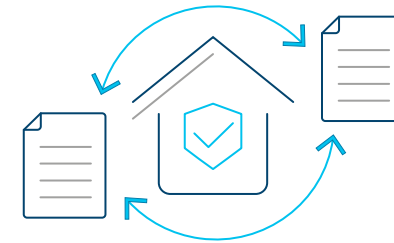
The Three C's of Mortgage Performance

Credit

Capacity

Collateral

Contextual Background

Four Lines of Defense

Borrower

Collateral

Mortgage Insurance

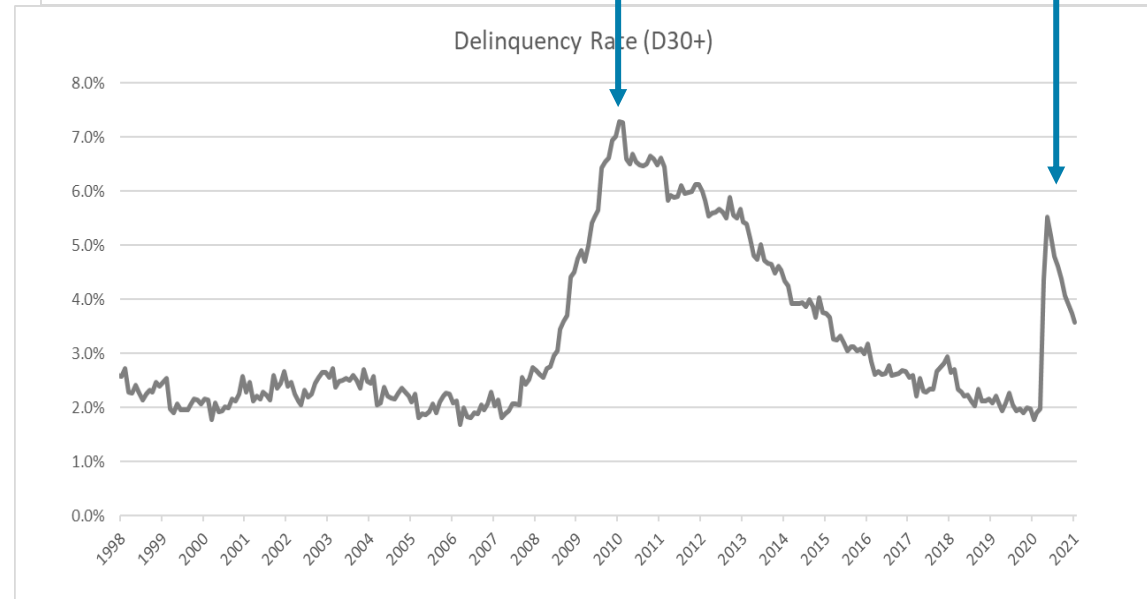Capital
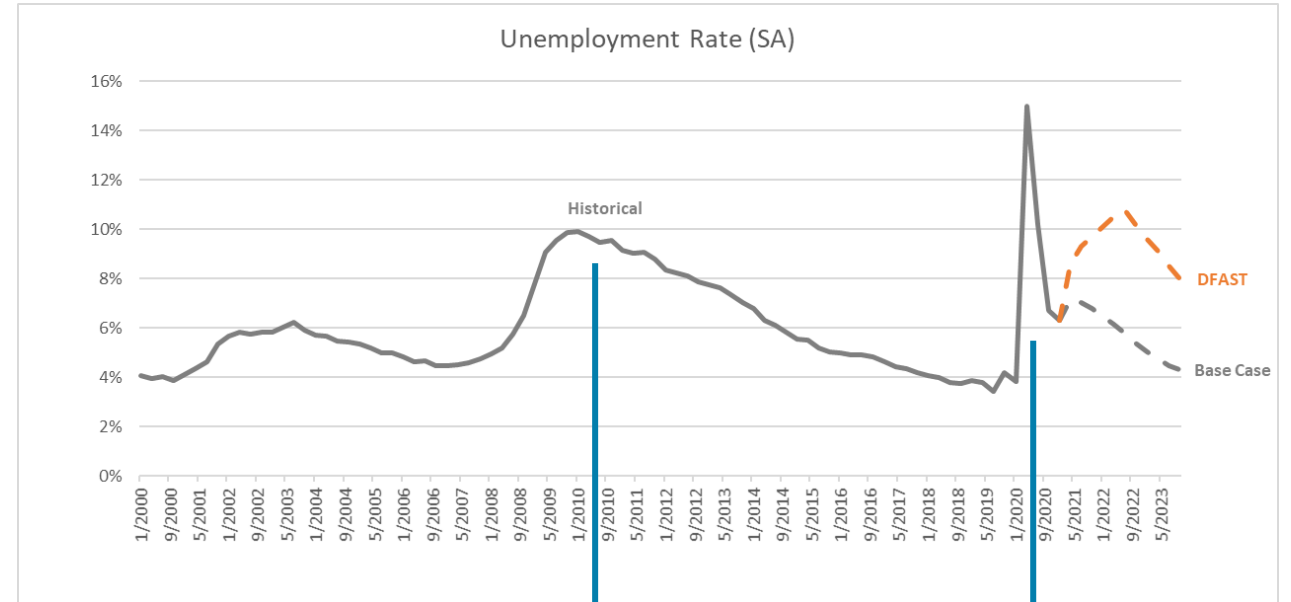
Contextual Background

Trigger Theory

- A mortgage can be viewed as a collection of financial options.

- Think of a default as similar to a put option.

- Default requires the combination of negative equity and a 'life event', (e.g., job loss, divorce, illness, death).
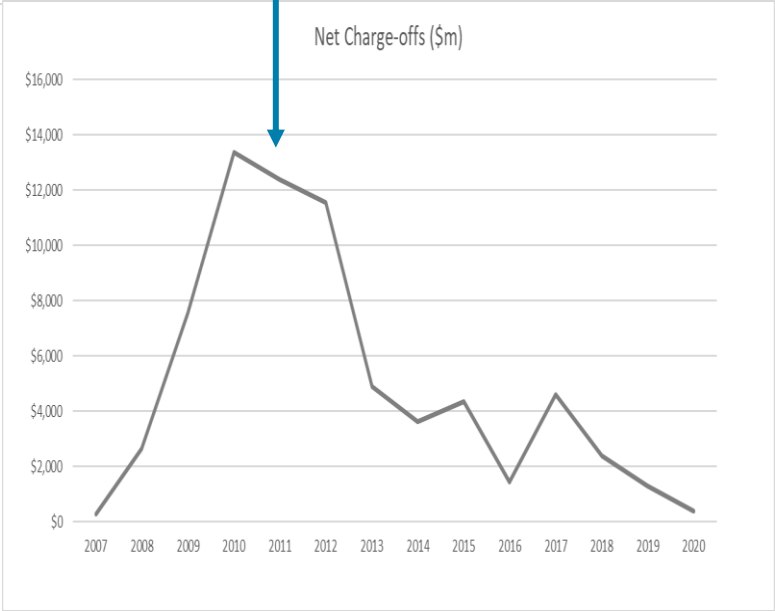
Borrowers with negative equity

Borrowers who suffered a life event

Default
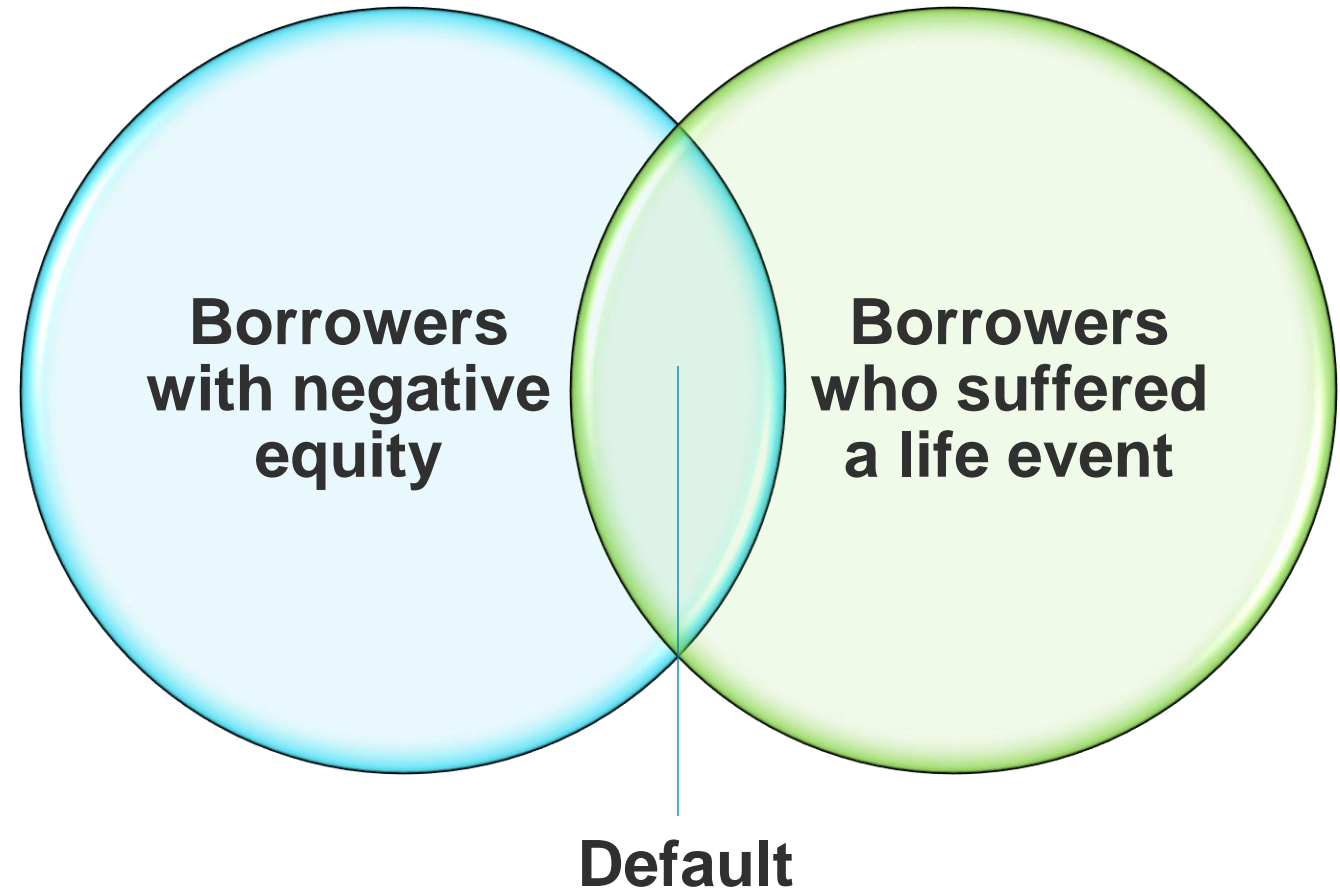
Contextual Background

A variety of life events help drive delinquencies

Unemployment Rate (SA)

Delinquency Rate (D30+)

Contextual Background

Adding home price drop drives credit losses

House Price Index (Jan 2000 = 100)

- Base Case (+12%)
- DFAST (-25%)
- Internal Capital (10/2019) (-27%)
- Historical

Net Charge-offs ($m)
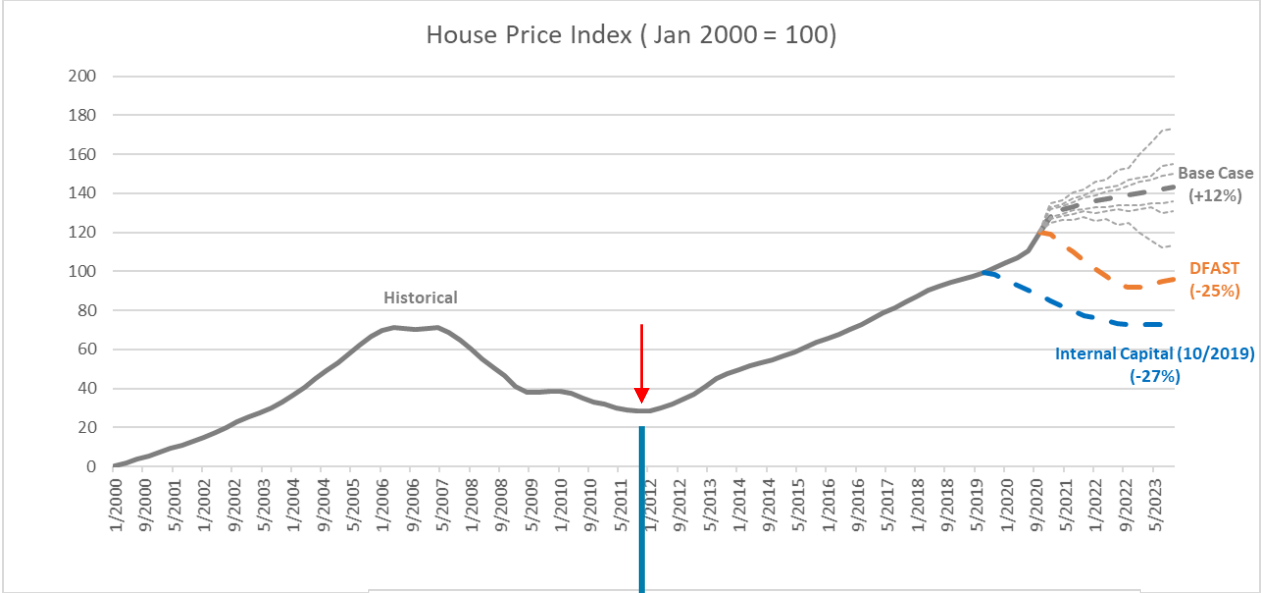
Overvalued Markets: How to Identify & for How Long

Standard Industry House Price Forecasting Model

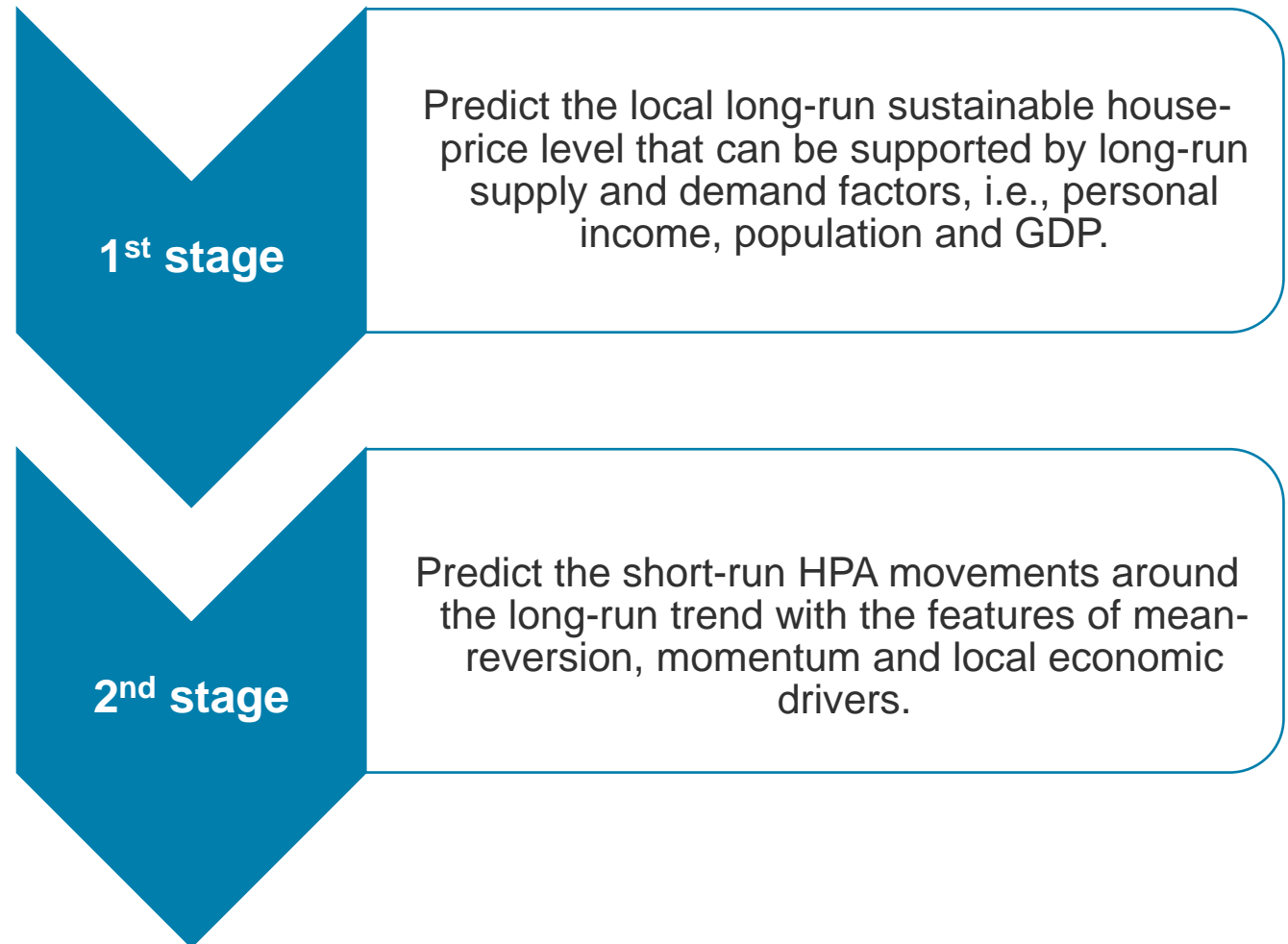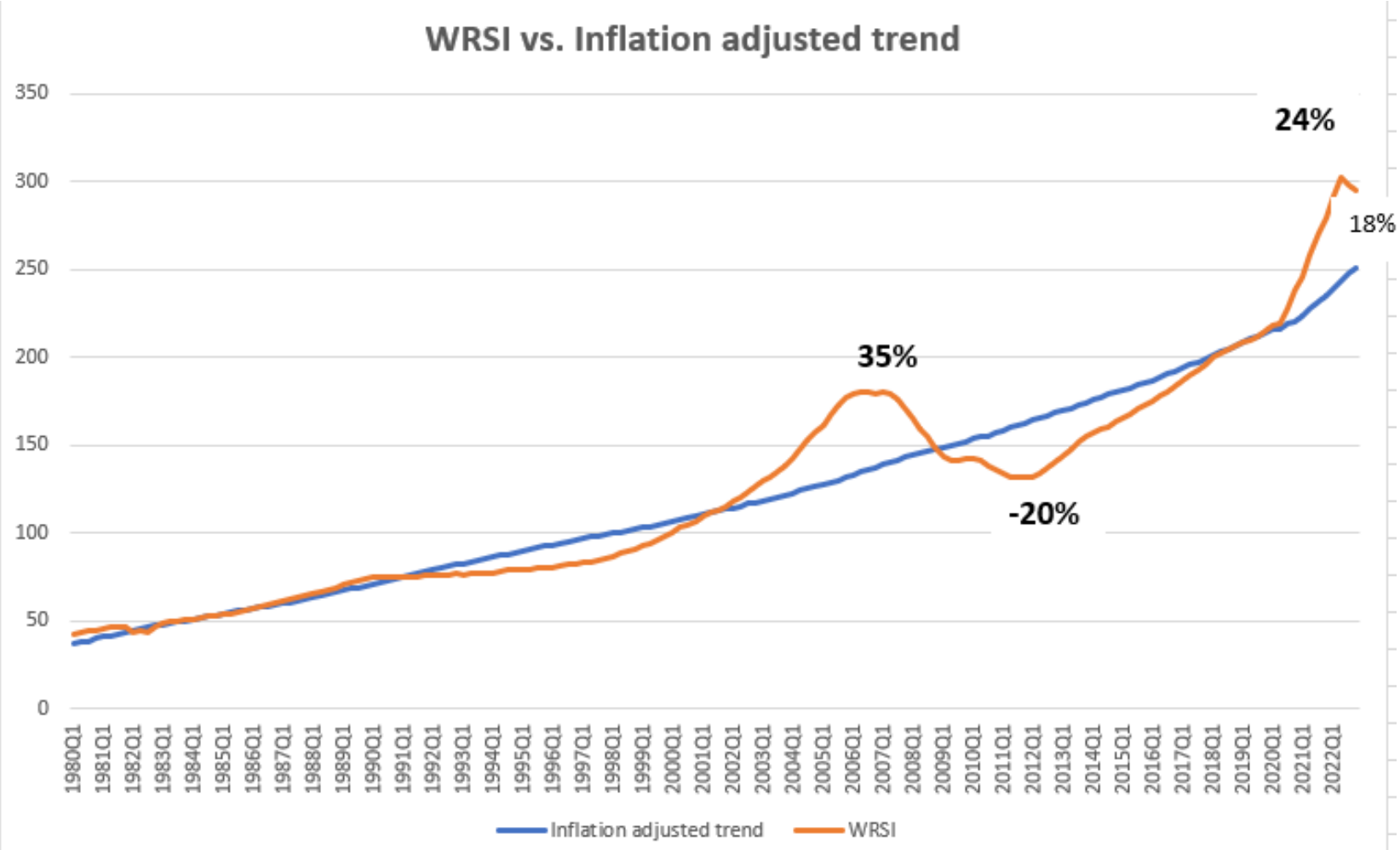- **Standard House Price Forecasting Model in the industry is a two-stage error-correction model that:**
  - Uses **local house-price drivers** to predict both short-term HPA fluctuations and long-run fundamental level, supported by housing supply and demand;
  - Allows for **mean reversion** (to the fundamental price level);
  - Captures the **momentum effect** in local housing markets.

1st stage

Predict the local long-run sustainable house-price level that can be supported by long-run supply and demand factors, i.e., personal income, population and GDP.

2nd stage

Predict the short-run HPA movements around the long-run trend with the features of mean-reversion, momentum and local economic drivers.

One Example for Some MSA

WRSI vs. Inflation adjusted trend

24%

18%

35%

-20%

— Inflation adjusted trend   — WRSI

Challenges of identifying an overvalued market

No definitive, universally accepted measure of market overvaluation; no observed equilibrium level of a market

Different studies consider different factors:

- High price-to-income ratio
- High price-to-rent ratio
- Rapid price appreciation
- Low affordability
- Overbuilding

Even if one can determine the actual drivers of the equilibrium level of certain markets, statistical estimates depend on:

- Underlying house price index (e.g., Case-Shiller vs. FHFA)
- The underlying sample used for model estimation (e.g., with or without bubble years prior to 2007 Great Financial Crisis)
- Specific model specifications (with/without population growth, interaction terms or not)

Significant Variation - Different Model Views on Select MSAs from 2022 Q2

Metro	Model A	Model B	Model C	Model D	Model E	Model F
Atlanta						
Austin						
Baltimore						
Birmingham						
Boston						
Buffalo						
Chicago						
Dallas						
Detroit						
Houston						
Los Angeles						
Miami						
New York						
Phoenix						
San Francisco						
Wash. DC						

Legend:
- 50+%
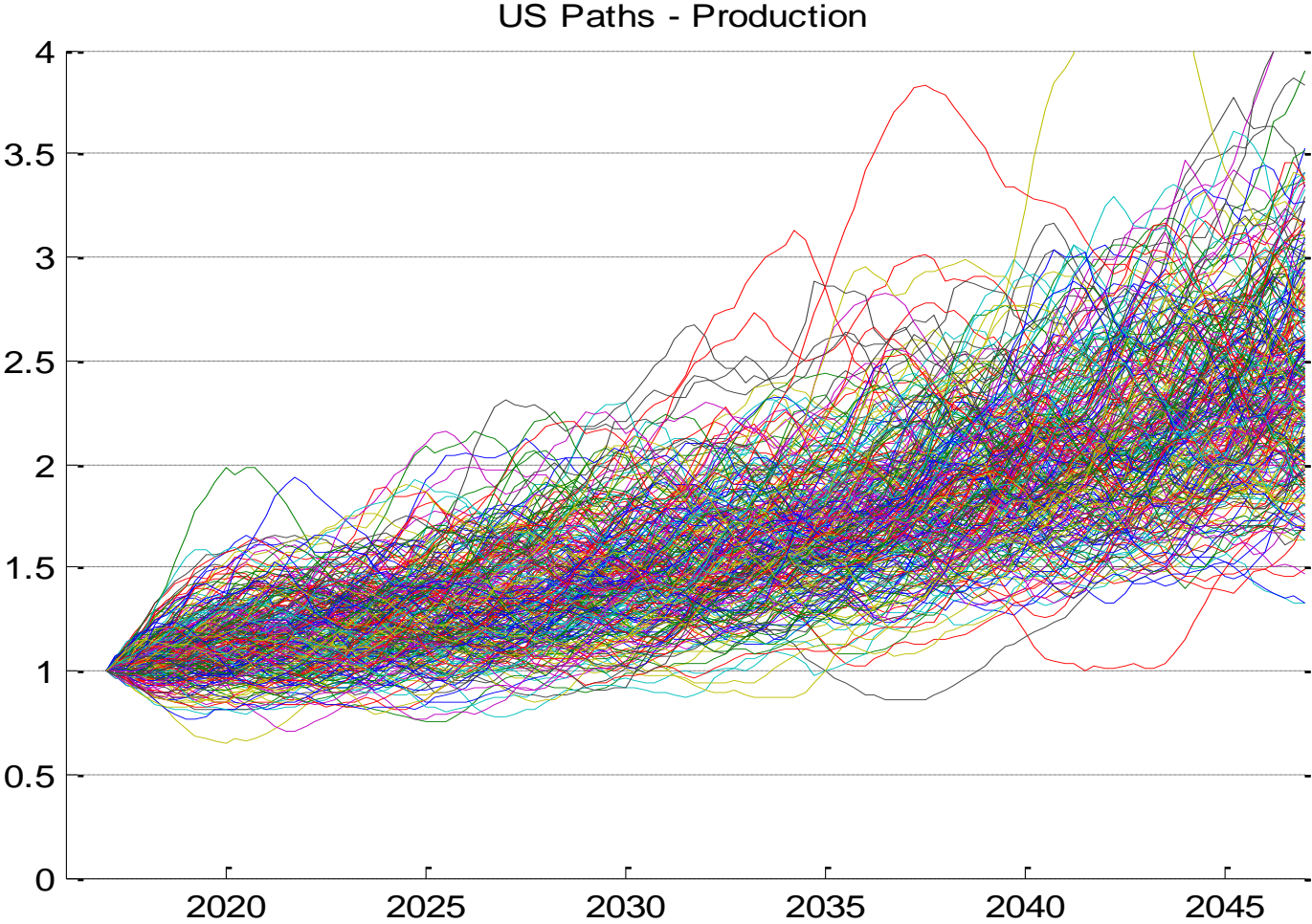- 25%~50%
- 10%~25%
- 0%~10%
- -10%~0%
- -25~10%

Monte Carlo Simulation

US Paths - Production

Determining When an Overvalued Market will Decline is a Challenge

Not all overvalued markets will decline. An "overvalued" market can stay overvalued for extended periods of time. For example,

- Miami had been called 15% overvalued in 2014 Q1 by one of the industry models.

- However, Miami grew 132+% further over 8 years since 2014 (annualized 11+% per year) and did not show negative monthly growth rates until August 2022.

Miami House Price Index
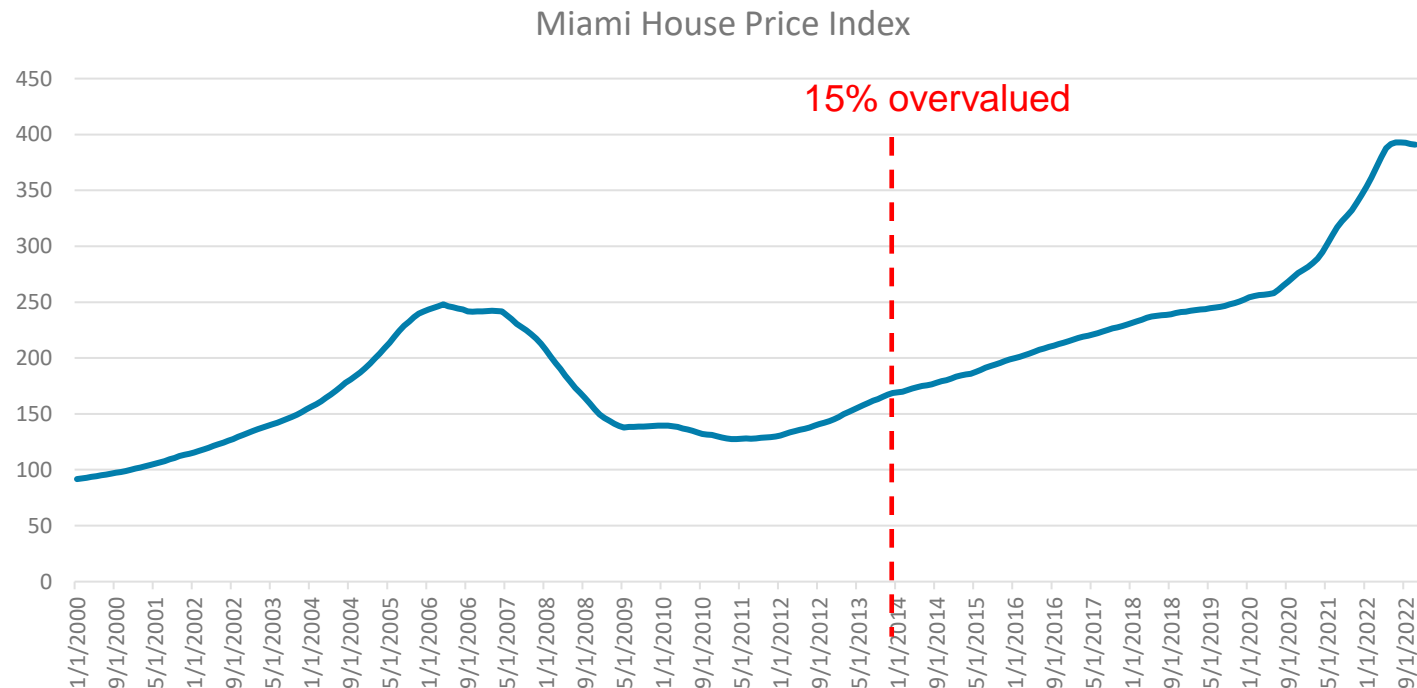
Market Overvaluation: Summary

- Determining whether a housing market is overvalued based on statistical models can be a challenging task.

- It is equally difficult to determine how long a market can remain overvalued.

- Better to monitor key indicators and economic trends to get a sense of where a particular market may be headed, instead of relying on statistical models.

- Despite the challenges, we can and should try our best to predict house prices.
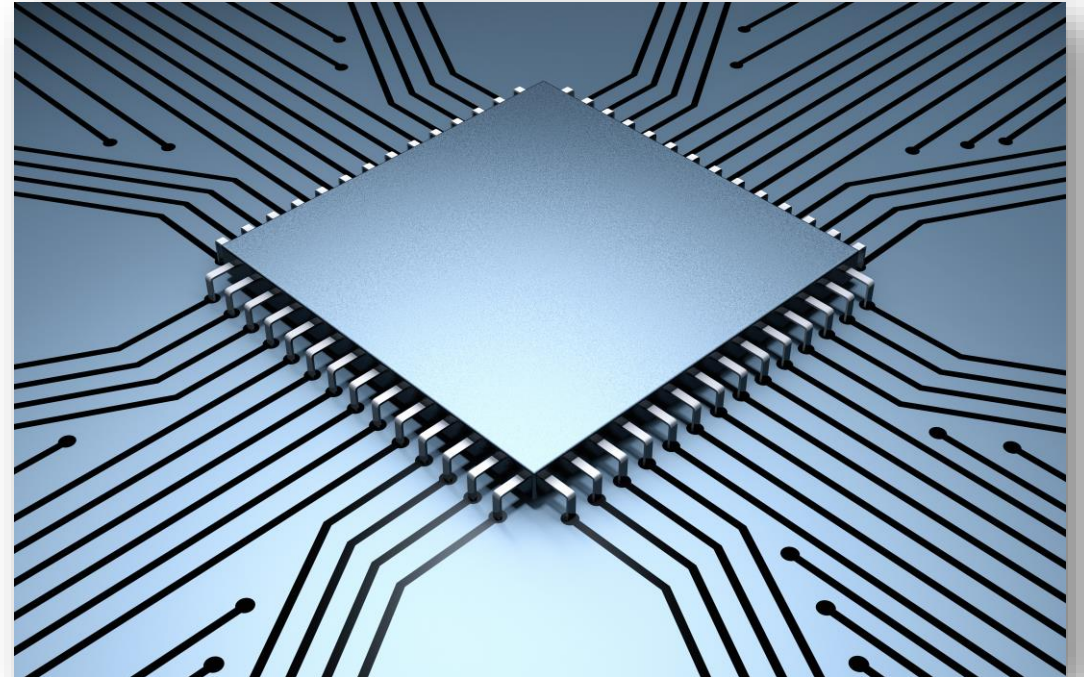
Freddie Mac's AI/ML Journey: The Rationale & Examples

Benefits of Machine Learning

- Our major models allow us to scale massively

- Others are using AI in an attempt to disrupt our business model

- Humans predictably make mistakes – "Thinking Fast and Slow"

Why We Need AI

- Captures nonlinearities and interactions better than traditional methods, which maps to improved business outcomes.

- Has potential to greatly improve outcomes (including expanding access to credit) for consumers, businesses and other stakeholders across wide range of applications and industries.

- Helps us reduce "noise" and improve loan manufacturing, leading to superior risk management.
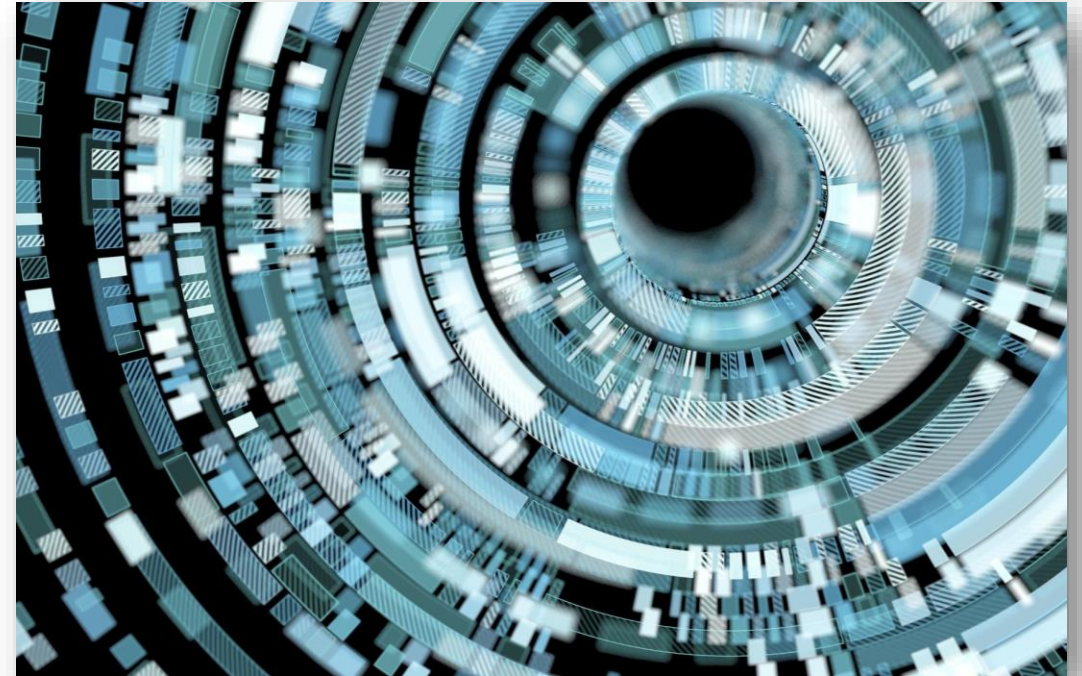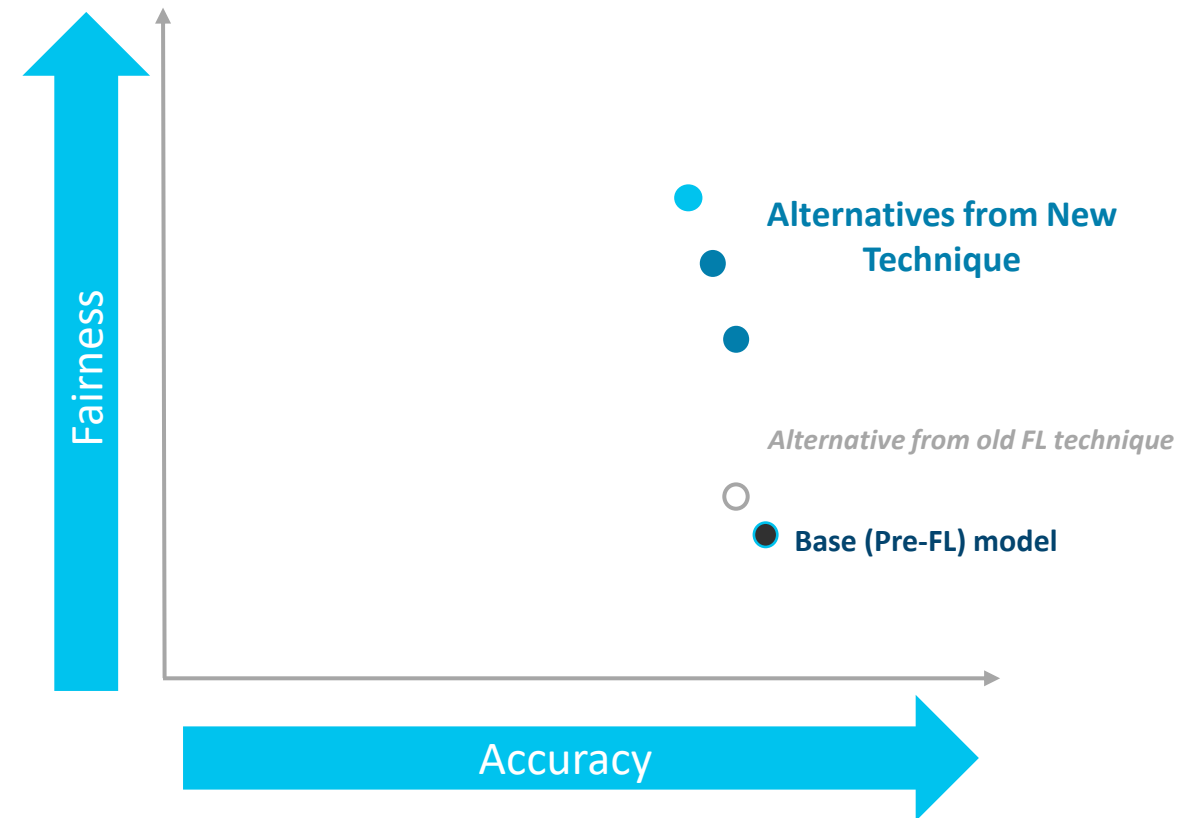
LPA and Fair Lending Testing

## Fair Lending testing of LPA uses innovative techniques to identify Less Discriminatory Alternatives

Less Discriminatory Alternatives (LDA):

- Alternative model specifications that lower impact on protected classes without a material degradation in performance. If found, such alternatives are called LDAs.

- LPA relies on an innovative adversarial debiasing technique, the **Generative Adversarial Network (GAN),** that smartly searches for alternative model specifications.

- By greatly expanding the search relative to previous methods, the GAN allows us to find much **larger improvements in fairness** than were possible before.

Alternatives from New Technique

Alternative from old FL technique

Base (Pre-FL) model

Fairness

Accuracy

Results are hypothetical. Actual results are not shown.

LDA Search Results from GAN – An Example

Hypothetical Example – Actual Results Not Shown
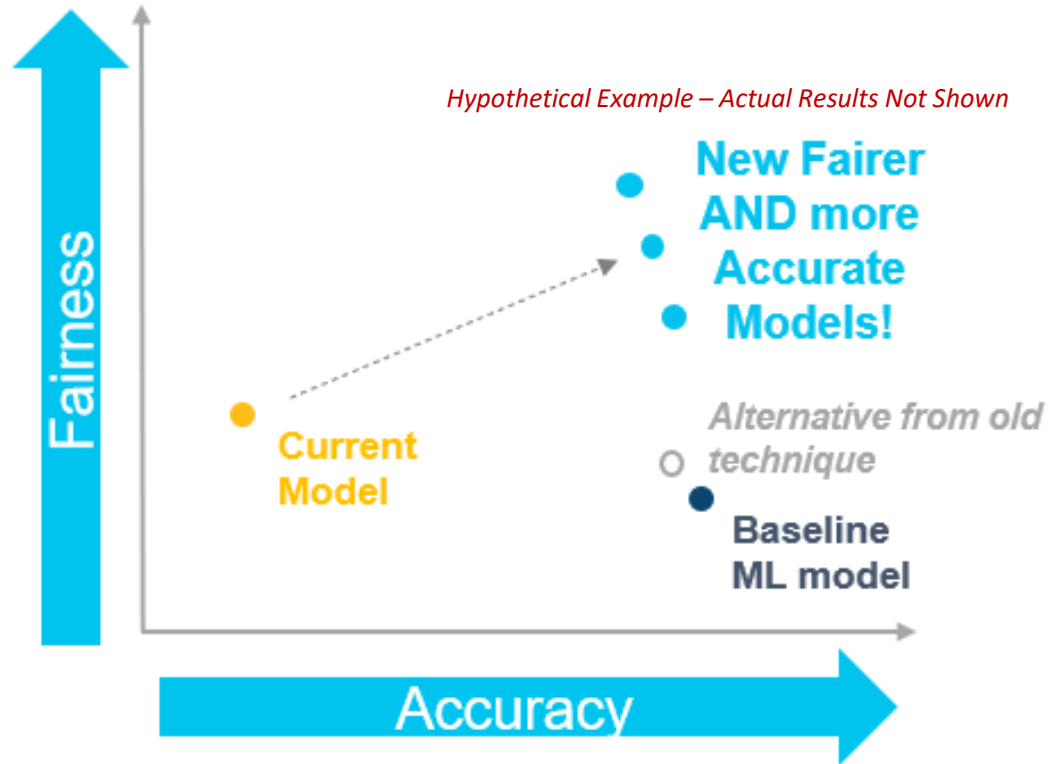
- The graph shows impact/accuracy tradeoff for alternatives created from the GAN process.

- Currently in use for LPA fair lending testing.

By greatly expanding the search relative to previous methods, the GAN allowed us to find much larger improvements in fairness than were possible before.

Asset Income Modeler (AIM) Helps Manage Risks

Using new auto-labeling techniques to build future versions of our models increases accuracy and speed.

Continually Managing Risk:

- Removes subjectivity & manual errors by applying consistent rules to all loans.

- Receives data directly from the source via trusted third parties, thereby reducing fraud associated with traditional documentation.

- Moves QC review "up front" on all loans and eliminates highest frequency defects.

Condition & Quality Analysis

Applying AI/MI algorithms to develop solution for property condition and quality assessment

Understanding the type of **characteristics** to determine the **overall property quality** and **condition** are needed to understand **market expectations** and how that influences **value**.

Condition Assessment

A Tale of Two Kitchens

- Updated / Not Updated

- Damaged / Not damaged

- Upgraded / Not Upgraded

Score: 30 (Q5, C4)
No damage but no update

Score: 80 (Q4,C3)
No damage and updated

Investor Day – April 20, 2023

Conclusion

- Freddie Mac is harnessing the power of AI and ML to drive faster, more accurate decisioning, manage risk effectively and create value, liquidity and stability within the housing ecosystem.

- Freddie Mac's investment in AI/ML and research of new applications is enhancing our understanding of loan performance and strengthening risk management.

- From improving and optimizing credit scoring, to determining overvalued markets, to ensuring accuracy, fairness and equity in lending, AI and ML are a driving force in Freddie Mac's pursuit of its mission and objectives.

Questions?

Thank You