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Analyzing the Impact of Prepayment Risk on Duration and Valuation of Mortgage-Backed Securities

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ABSTRACT :

This paper investigates the influence of prepayment risk on the valuation and risk assessment of Mortgage-Backed Securities (MBS). Prepayment risk, arising from early mortgage repayments, disrupts expected cash flows and complicates pricing. By comparing traditional duration measures with option-adjusted duration (OAD), which incorporates the embedded prepayment option, this study highlights the necessity of advanced modeling for accurate risk management. The research employs historical analysis, forecasting models, and option-pricing techniques to provide actionable insights for investors, issuers, and regulators.

1.Introduction

Background

Mortgage-Backed Securities (MBS) are created by pooling home loans and selling the resulting cash flows to investors. This process increases liquidity in the mortgage market but introduces unique risks, most notably prepayment risk. Prepayment occurs when borrowers refinance or pay off loans early, often in response to declining interest rates, making MBS cash flows unpredictable and complicating valuation.

1.2 Prepayment Risk and Duration

Traditional metrics like Macaulay duration fail to capture the embedded prepayment option in MBS. Option-adjusted duration (OAD) provides a more accurate measure by incorporating the probability of prepayment using option-pricing techniques. Understanding OAD is crucial for assessing interest rate sensitivity and making informed investment decisions.

1.3 Purpose and Objectives

This study aims to:

- Quantify the impact of prepayment risk on MBS valuation and duration.
- Compare traditional and option-adjusted duration measures.
- Analyze how prepayment modeling improves risk assessment and pricing accuracy in MBS.

2. Literature Review

Recent studies emphasize the complexity of MBS risk:
Tyhopho (2025):Reveals hidden default risks in both commercial and residential MBS using advanced statistical models.
Li et al. (2024): Propose alternative margin models that better incorporate prepayment and interest rate risks.
Güneş & Apaydın (2024): Use machine learning to show that prepayment and default are influenced by borrower behavior, loan characteristics, and economic conditions.

- He (2022): Discusses how regulatory changes and market perceptions affect MBS pricing.
- Wang (2022): Proposes integrated models that address both prepayment and default risks.

These works collectively underscore the need for sophisticated modeling approaches to accurately assess MBS risks.

Data Analysis & Interpretation

4.1Prepayment Trends

Data shows that prepayment rates are inversely related to interest rates. When rates fall, refinancing activity increases, leading to higher prepayments and greater cash flow uncertainty for investors.

4.2Duration Measures

Traditional Macaulay duration underestimates interest rate risk in MBS because it ignores the prepayment option. OAD, however, adjusts for the likelihood of prepayments, providing a more accurate measure of risk.

4.3Model Results

Prepayment models that incorporate borrower characteristics, loan features, and economic indicators outperform static models. Option-pricing frameworks further refine risk estimates by valuing the embedded call option in mortgage contracts.

4.4Comparative Findings

OAD consistently outperforms traditional duration in predicting price sensitivity and risk exposure under varying interest rate scenarios

5. Discussion

5.1Practical Implications

- For Investors: OAD provides a more realistic assessment of risk, supporting better portfolio management.
- Understanding prepayment dynamics aids in product structuring and risk mitigation.
- Advanced modeling supports market stability and transparency.

5.2 Case Study Example

Consider a period of rapidly falling interest rates: traditional duration models may underestimate MBS price volatility, while OAD will more accurately reflect increased prepayment risk and its effect on valuation.

6. Limitations and Future Research

6.1Limitations

- Data constraints may limit the generalizability of findings.
- Model assumptions (e.g., interest rate paths, borrower rationality) may not hold in all market conditions.

6.2 Future Research

- Explore alternative modeling techniques, such as machine learning, for prepayment prediction.
- Analyze the impact of macroeconomic shocks on prepayment behavior and MBS pricing.

7. Conclusion

Prepayment risk is a defining feature of MBS that complicates valuation and risk management. This study demonstrates that option-adjusted duration provides a more accurate and robust framework for assessing interest rate sensitivity and pricing MBS. Adopting advanced prepayment models and risk measures can improve decision-making for all market participants and enhance the resilience of the mortgage finance system.

REFERENCES:

1. Tyhopho, 2025. "Risk Analysis of CMBS."
2. Li et al., 2024. "Alternative Margin Models for MBS."
3. Güneş & Apaydın, 2024. "Prepayment and Default Risks of MBS."

4. He, 2022. "Agency MBS as Safe Assets."
5. Wang, 2022. "MBS Valuation and Prepayments."
6. Appendix (Optional, if space allows)
7. Glossary: Definitions of Macaulay Duration, Option-Adjusted Duration, Prepayment Risk, etc.
8. Supplementary Tables/Charts: • Key data visualizations supporting the analysis.