The Impact of Varying Information in the Residential Mortgage-Backed Securities Market

Research Report
August 2019

About the Centre for Economic Analysis

The Canadian Centre for Economic Analysis (CANCEA) is a socio-economic research and data firm. CANCEA provides objective, independent and evidence-based analysis and is dedicated to a comprehensive, collaborative, and quantitative understanding of the short- and long-term risks and returns behind market changes, policy decisions and economic behaviour.

CANCEA uses modern techniques in data science, including agent-based modelling, for econometric analysis, risk management assessments, demographic forecasts and epidemiology. CANCEA's work includes market analysis, policy evaluation and risk management, business model optimization, cost-effectiveness and rate of return analysis, macroeconomic analysis, insurance risk evaluation, land use and infrastructure planning, logistics, and labour market analysis. CANCEA also provides comprehensive Canadian data services.

At the centre of CANCEA's analytical capabilities is an agent-based platform called Prosperity at Risk® that is an extensive, data-driven model of 56,000 locations across Canada. Given the systems focus behind all of CANCEA's work, CANCEA has a one-model approach to its analysis which allows various disciplines and stakeholders to be incorporated into a single analysis.

ISBN: 978-1-989077-23-8

CANADIAN CENTRE FOR ECONOMIC ANALYSIS

About This Report

The design and method of research, as well as the content of this study, were determined solely by CANCEA.

Statistics Canada data and relevant literature were used to inform the computer simulation models used to produce the results of this report.

Forecasts and research often involve numerous assumptions and data sources and are subject to inherent risks and uncertainties. This information is not intended as specific investment, accounting, legal, or tax advice.

Citation:

Canadian Centre for Economic Analysis. (2019) *The Impact of Varying Information in the Residential Mortgage-Backed Securities Market*.

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

CMHC is examining the potential impacts of introducing common mortgage data and description standards similar to those in the United States. The argument for doing so is that common data standards on mortgage terms, property characteristics, borrower characteristics etc. would (1) eliminate the information asymmetry between the sponsors of mortgage pools and the investors in those pools; (2) facilitate Canadian growth in the securitization of mortgages, given that investors would have greater confidence in the composition of mortgage-backed securities (MBS) pools; and (3) increase secondary market pricing transparency and competition that could ultimately reduce the cost of mortgage credit to Canadians.

Residential mortgage-backed securities (RMBS) are secured by mortgages that qualify under the National Housing Act (NHA) and the Canadian Mortgage Bond (CMB) programs. Over a third of the outstanding mortgage debt is securitized, almost all of which through public securitization programs reaching over $496 billion in 2019. Public securitization does not have credit risk beyond that of the government, as they are all insured by the government.

Using different government guarantee assumptions of mortgage pools that support the current public MBS market, the objective of this research is to quantitatively examine how MBS spreads over the Canadian government yield curve could be influenced by:

1. Increasing the amount of information available to MBS secondary markets about mortgage pools through the introduction of mortgage data standards; and
2. Increasing the number of investor participants in the MBS secondary markets.

The key hypothesis to be tested is whether increasing the number of market participants and/or the level of information about the underlying mortgages in an MBS for a given level of mortgage pool credit risk could reduce the equilibrium spreads over the government yield curve.

The analysis is neither an attempt to model the full intricacies of the Canadian MBS and bond market nor to price MBSs. Instead, it is designed to simulate how volume, volatility and spreads are expected to change as more information is revealed to the market and as the number of investors in the market change.

2.0 METHODOLOGY

The spread in a market arises from the decisions made by individual investors in the market. Therefore, in order to model how information and investor participation would affect the market as a whole, the decisions made by individuals must be simulated. A natural framework for such an analysis is an agent-based model where individual people and their decisions can be modelled.

2.1 WHAT IS AGENT-BASED MODELLING

Agent-based modelling has been used extensively in economics and finance to understand market structures (LeBaron, 2006) as it can capture information heterogeneity to reproduce actual behaviours (Bao, Sheng, & Zheng Zhou, 2012). Instead of having to assume that all individuals behave according to the population average, each individual has its own behavioural bias. For example, some investors may be more risk-averse than others or have longer investment timeframes. In situations where individual behaviour that is far from the mean can significantly affect the overall system, the use of agent-based models is critical. In dynamic markets, in particular, it is the outliers (highest buy offers) that set the price for the entire market rather than the average price expectation.

Other advantages of agent-based models include:

- The ability to discover emergent group properties which arise from individual decisions;
- The direct connection between the cause of an outcome and the effect; and
- The fact that they are easily expandable to add additional nuances to behaviours.

Naturally, agent-based models also have some drawbacks. In particular,

- Agent-based models can be more computationally intensive to run.
- Since participants in the model make decisions stochastically, the result of the analysis is a distribution of outcomes rather than a single value, which can be more difficult to interpret.
- Models frequently have greater data requirements, as detailed knowledge about the range of individual behaviours is needed

2.2 MARKET AND TRADER MODEL

The model used in this analysis is based on traders trying to maximize their portfolio returns in a two-asset model which consists of one risky asset and one risk-free asset (Orito, Kambayashi, Tsujimura, & Yamamoto, 2011; Lespagnol & Roucher, 2014). Under a constant risk aversion assumption, traders in the simulation place buy or sell orders in the market in an attempt to maximize their returns based on their individual estimates of the future value and return of each asset.

There are two fundamental ways that a trader can estimate the value of an asset (Hommes, 2006; Jacob Leal, 2012). Over the short term, traders can simply follow the trend of recent prices – a 'chartist' approach. On the other hand, traders may also formulate an estimate of price based on their knowledge of the fundamental value of the asset – a 'fundamentalist' approach. In the market, chartists have a

destabilizing effect as they can amplify short term trends. A market consisting only of chartists would either crash to zero or have run-away growth as trends reinforce themselves. In contrast, fundamentalists have a stabilizing effect by drawing prices towards their individual estimates of the fundamental price. In practice, each trader has a mix of chartist and fundamentalist behaviour with both aspects contributing to their estimates of future returns.

As more information becomes available, two effects occur:

- Investors shift their bias towards a more fundamentalist approach.
- Fundamentalist traders obtain a better estimate of the true fundamental price of the risky asset.

Finally, each investor has a random degree of optimism and pessimism which slightly adjusts their expectations (Lux & Marchesi, 1998).

At each step of the simulation, a trader is chosen at random to make an investment decision. Based upon the available information and the trader's intrinsic characteristics, the trader calculates their target change in position in order to maximise their portfolio's return. If the trader would benefit from buying or selling an asset, an order is submitted to the order book.

After each order is submitted to the order book, any matched orders (buy offer is greater or equal to the sell offer) are processed and the transactions are logged. Orders which cannot be fulfilled remain in the order book.

2.3 Mortgage-Backed Securities

The market and trader model can be used for any risky asset. The differences between assets arise in the calculation of the fundamental price of the risky asset. In this analysis, the risky asset is a mortgage-backed security, which is made up of a pool of mortgages with similar terms. Payments by the mortgagors are passed through to the MBS shareholders. The expected returns from an MBS are determined by the characteristics of the underlying mortgages. In this analysis, the distribution of mortgages used in the analysis to generate an MBS pool is designed to reflect the current mortgage markets in Canada. The key parameters which were permitted to vary include:

- Principal value;
- Interest rate;
- Amortization period;
- Probability of pre-payment; and
- Probability of arrears and default.

The mortgages in the pool can be either be government-backed (CMHC insured) or not. In the case of uninsured mortgages, the probabilities of arrears and defaults depend upon the level of credit risk in the market. In order to investigate the sensitivity of the results to the credit risk environment, two credit risk scenarios are considered:

- A low-risk (or status quo) scenario based on current trends
- A high-risk scenario in which prices fall and defaults increase

In the low credit risk scenario, the probability of a mortgage being in arrears is taken to be 0.3%[1]. In addition, the probability of a mortgagor defaulting is assumed to be 1/3 of the arrears rate, with 90% of the principal value of the mortgage recovered. In the high credit risk scenario, the probabilities of arrears and default are assumed to be 10 times larger, with only 70% of the principal value of a defaulted mortgage recovered.

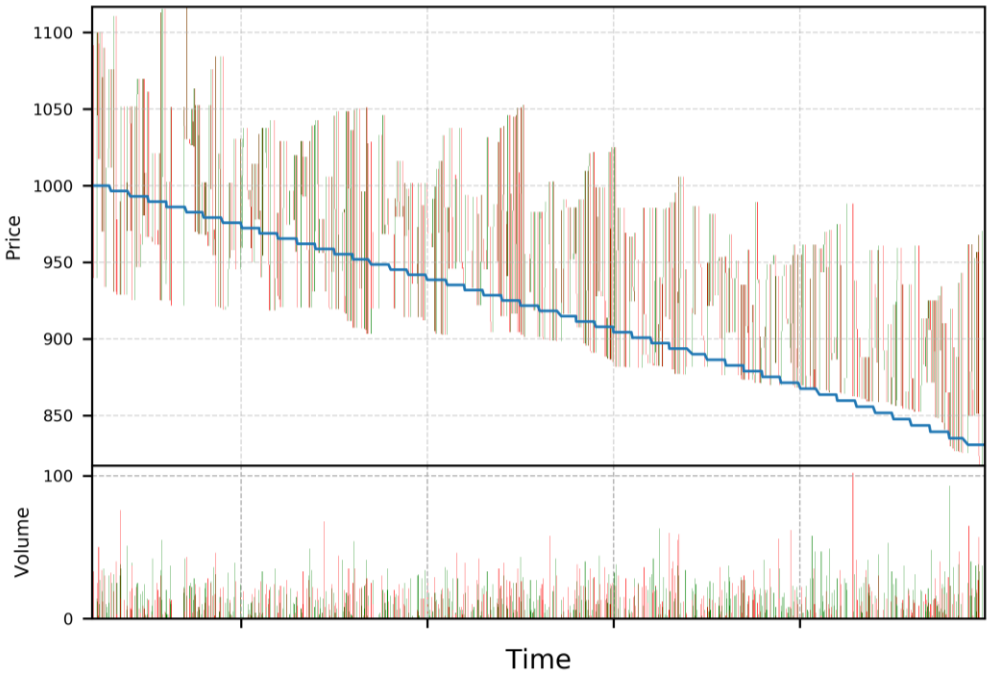
The fundamental value of the MBS is the expected present value of the future payments received by the MBS plus any remaining mortgage balances at the end of the MBS term. The primary risk to investors is the early prepayment of mortgages which removes all associated future cash flows from the present value but does result in the immediate payment of the principal. Similarly, mortgage defaults affect future cash flows, with the additional impact that the entire principal of the mortgage may not be recovered. Note that as mortgagors repay the principal on their mortgage, which is passed through to shareholders, the fundamental value of the mortgage pool decreases. Full information about the default and prepayment probabilities in the pool allows investors to better estimate the future cash flows from the MBS.

[1] Based on data from CMHC.

3.0 RESULTS

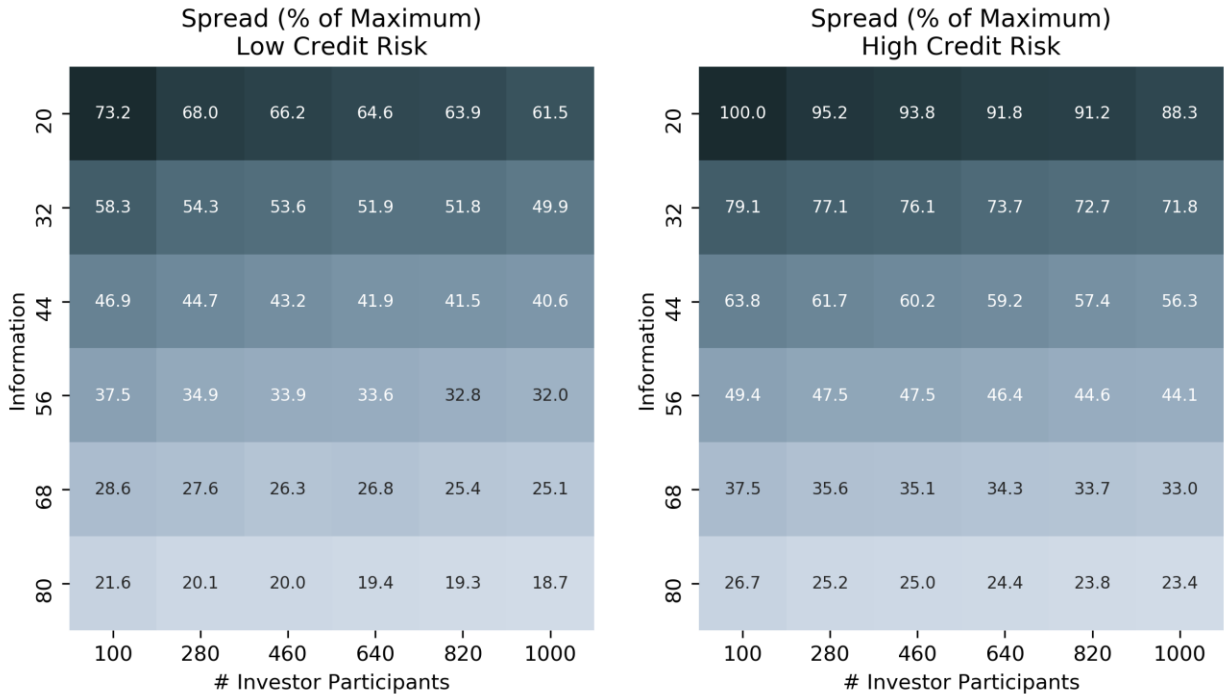
Implementing a full order book with multiple traders and varying behaviours results in market behaviour that is representative of real markets. Figure 1 shows the results of a typical simulation. The red and green lines show the market trading activity, while the solid blue line is the fundamental price of the MBS. Such simulations are repeated thousands of times, varying the number of traders and the level of information to estimate the expected outcomes. The information level varies from 20% to 80% confidence in estimates of the fundamental value of the MBS. (Values below 20% and above 80% were excluded since zero information and complete information are unrealistic limits.)

Figure 1 Typical trading profile for single simulation with moderate information (50%) and 1,000 investors



For uninsured mortgages, Figure 2 shows how the spread varies as the level of information and the number of investors in the market increases in the low credit risk and high credit risk scenarios. Since the objectives of the study are to understand the overall trends and not to price MBSs the spreads are presented relative to the largest values seen in the analysis.

Figure 2 Sensitivity of the spread (relative to the maximum) to information and number of investors under the low credit risk (left) and high credit risk (right) scenarios for uninsured mortgages.



As expected, the spreads tend to be higher in the high credit risk scenario since investors are taking on additional risk. However, in both scenarios, as the level of information and the number of traders increase, the spread falls considerably. By introducing more information to the market, traders are better able to estimate the fundamental value of the MBS resulting in both investors taking a more fundamentalist approach and investors trading closer to the true fundamental value of the asset.

As shown in Figure 3, increasing both market participation and information together reduces the spread more significantly than increasing either individually. Importantly, in the high credit risk scenario, increasing information has a greater impact than in the low-risk scenario. Therefore, greater information is more important in high credit risk environments than lower credit risk situations.

Figure 3 Impact of increasing information and number of traders

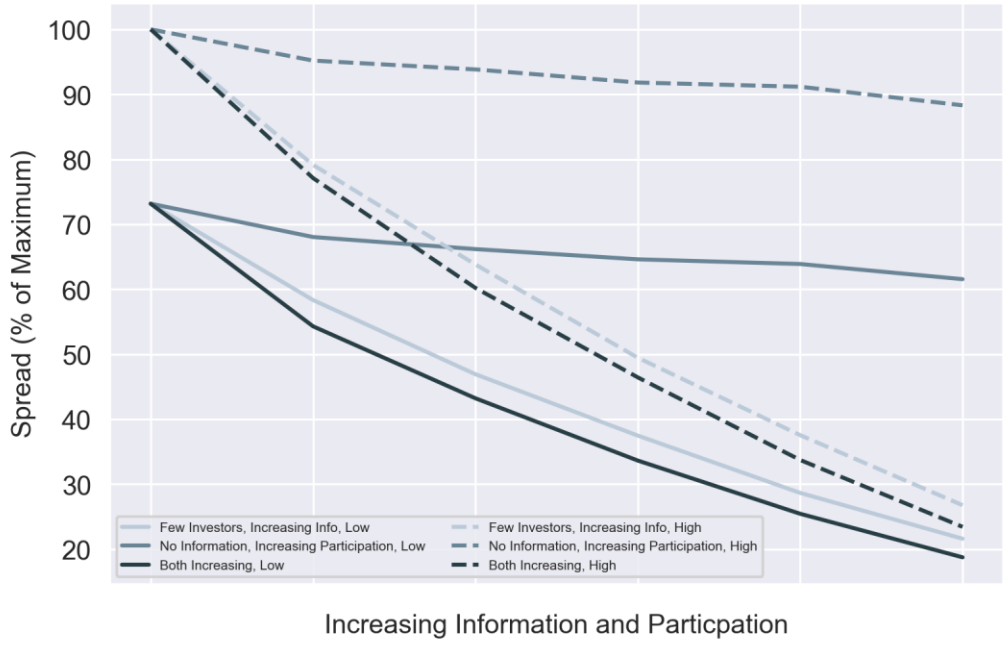
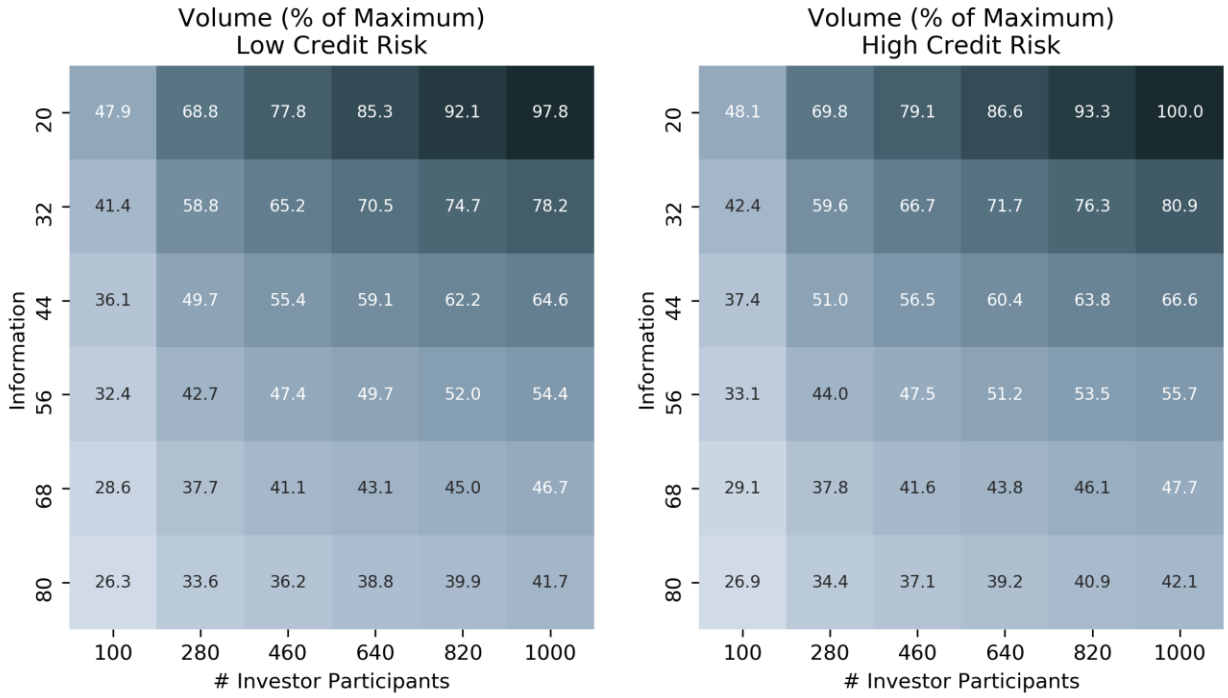


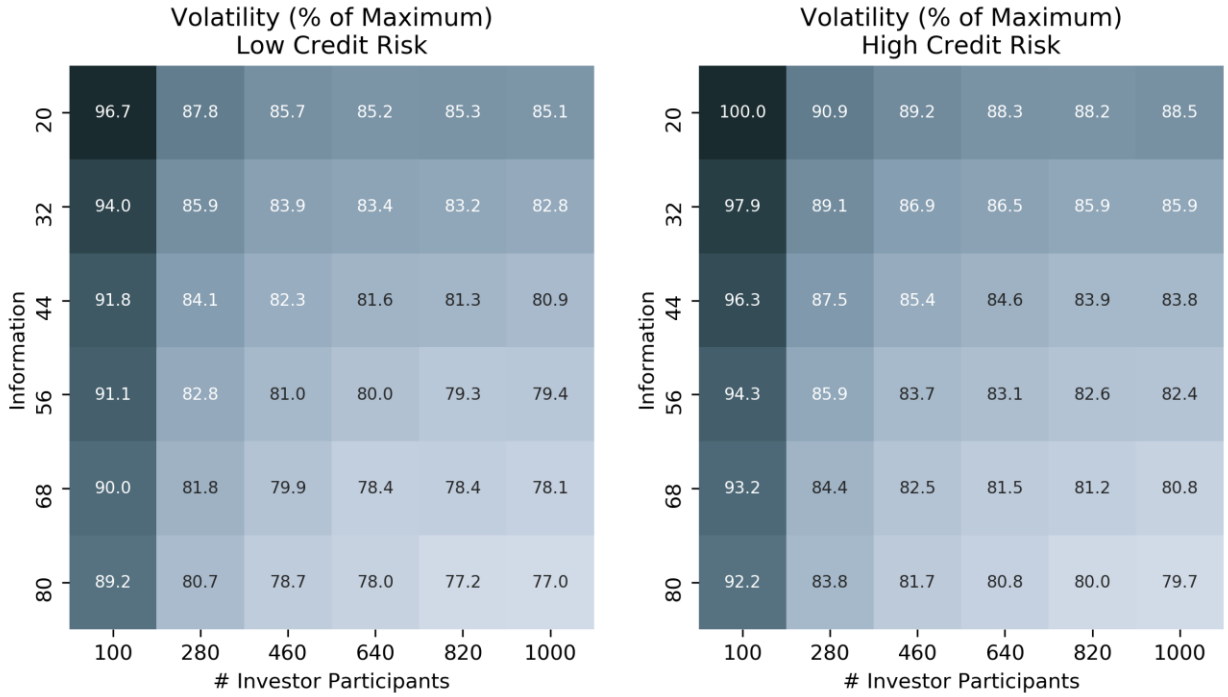
Figure 4 Sensitivity of the volume (relative to the maximum) to information and number of investors under the low credit risk (left) and high credit risk (right) scenarios.



Changing the amount of information and number of investors also impacts the volume of trades in addition to the spread. Unsurprisingly, as the number of participants in the market increases, so does the

volume of trades. However, as shown in Figure 4, increasing information decreases the liquidity of the market. This can be understood by recognizing that transactions only occur when there is a disagreement between a buyer and seller on the value of an asset. If everyone were to exactly agree on the price of an asset, no transactions would occur. This emphasizes that increasing information without encouraging additional market participation could result in a more illiquid market despite reduced spreads.

Figure 5 Sensitivity of the trading volatility (relative to the maximum) to information and number of investors under the low credit risk (left) and high credit risk (right) scenarios.



Unlike the spread, the trading volatility, as shown in Figure 5, is more sensitive to the number of investors than the level of information, though the lowest trading volatility still occurs when there is high information and a larger number of investors. As the level of information increases, there is more certainty about the fundamental value of the MBS, but with few investors, there is still significant volatility. As the number of market participants increases, orders farther away from the market price are less likely to be executed since competing offers closer to the market price are more likely to be made. The result is lower price volatility over the course of each simulation.

3.1 Uninsured vs Insured Mortgage Pools

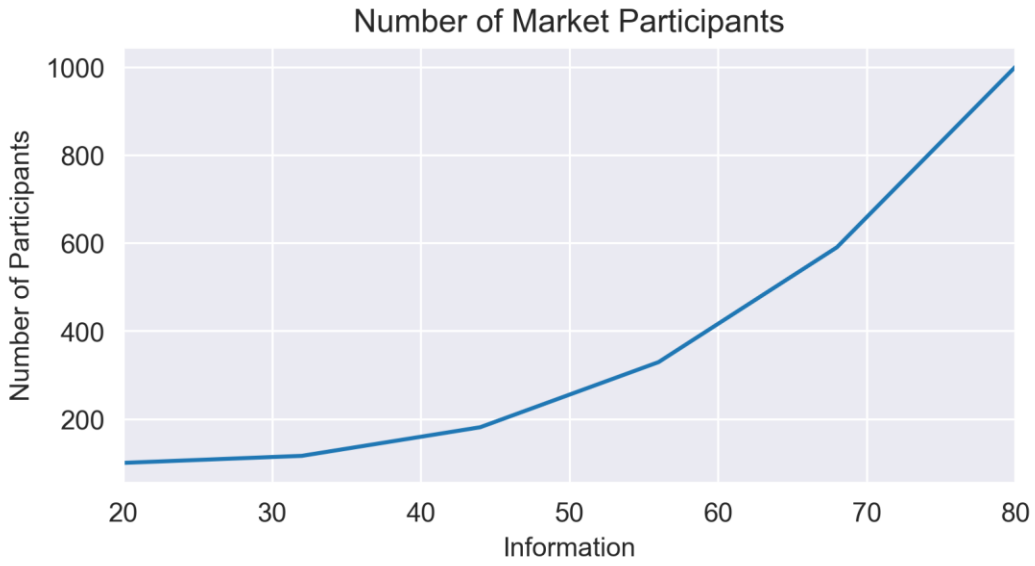
The discussion to this point has focussed on uninsured mortgages. However, in the low credit risk environment, there is little difference between insured and uninsured mortgage pools. The dominant source of the spread is the prepayment risk rather than the credit risk. As a consequence, increasing information and participation, in either case, yields the same results.

In the high credit risk environment, there is a significant difference between the government-backed mortgage pool and the private pools. However, since the risk of default is removed in the insured mortgage pool and the dominant uncertainty remains the prepayment risk, the results again are the same as in the low credit risk scenario.

3.2 Information and Participation

While the quantitative change in investor participation in response to increased information is unknown, it has been shown (Allen & Gale, 1994) that Pareto-preferred states are those with lower volatility and higher participation. As a result, when the amount of information available is increased and consequently the volatility falls, it would be expected that participation rates would increase. Figure 6 presents an example of investor participation increasing with more information based on the volatility results from Figure 5.

Figure 6 Change in the number of market participants with increasing information



Initially, when the number of investors is low, the volatility slowly diminishes as information increases. As a result, the number of investors moving into the market only increases slightly. For greater amounts of information, the volatility diminishes more significantly, which attracts additional investors. Additionally, the larger number of investors further diminishes volatility, resulting in even greater participation. Therefore, there is a feedback loop whereby increasing information attracts additional investors, which then attracts more investors, though with decreasing benefits for a given level of information. Therefore, while the magnitude of the feedback effect is unknown, qualitatively, one would expect participation to increase as information increases.

4.0 CONCLUSIONS

The analysis has shown that increasing the information about mortgages included in a mortgage-backed security can act to reduce the spread and lessen market volatility at the cost of lower market liquidity. Increasing the number of investors in the market can result in similar outcomes, but with increased liquidity. The spread and volatility are minimized when both additional information and more participants are introduced to the market. Finally, if investors favour lower-volatility assets, increasing information could result in increased market participation.

A. REFERENCES

Allen, F., & Gale, D. (1994). Limited market participation and volatility of asset prices. *The American Economic Review*, 933-955.

Bao, Y., Sheng, S., & Zheng Zhou, K. (2012). Network-based market knowledge and product innovativeness. *Marketing Letters, 32*(1), 309-324.

Hommes, C. H. (2006). Heterogeneous agent models in economics and finance. In L. Tesfatsion, & K. Judd, *Handbook of Computational Economics* (Vol. 2, pp. 11009-1186).

Jacob Leal, S. (2012). Momentum Effect in Individual Stocks and Heterogeneous Beliefs among Fundamentalists. *Cahier de Recherche no 2012-03*. CEREFIGE, Université de Lorraine.

LeBaron, B. (2006). Agent-based computational finance. In L. Tesfatsion, & K. L. Judd, *Handbook of Computational economics* (1 ed., Vol. 2, pp. 1187-1233). Elsevier.

Lespagnol, V., & Roucher, J. (2014). What is the Impact of Heterogeneous Knowledge about Fundamentals on Market Liquidity and Efficiency: An ABM Approach. *2014 IEEE 38th International Computer Software and Applications Conference Workshops*, (pp. 420-425). Vasteras.

Lux, T., & Marchesi, M. (1998). Volatility clustering in financial markets: A micro-simulation of interacting agents. *IFAC Proceedings Volumes, 31*(16), 7-10.

Orito, Y., Kambayashi, Y., Tsujimura, Y., & Yamamoto, H. (2011). An Agent-Based Model for portfolio Optimization Using Seach Space Splitting. In S.-H. Chen, Y. Kambayashi, & H. Sato, *Multi-Agent Applications with Evolutionary Computation and Biologically Inspired Technologies: Intelligent Techniques for Ubiquity and Optimization* (pp. 19-34). IGI Global.