

Agent Based Model Examination of Market Dynamics with Varying Information about RMBS Fundamentals

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CANADIAN CENTRE FOR
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Introduction

- CMHC is examining the potential impacts of introducing common mortgage data and description standards, similar to those in the United States.
- The argument is that common data standards on mortgage terms, property characteristics, borrower characteristics, etc. would:
 - eliminate the information asymmetry between the sponsors of mortgage pools and the investors in those pools
 - facilitate Canadian growth in the securitization of mortgages given investors would have greater confidence in the composition of MBS pools.
 - increase secondary market pricing transparency and competition that could ultimately reduce the cost of mortgage credit to Canadians.
- Canadian MBS market overview
 - RMBS in Canada is secured by mortgages that qualify under the National Housing Act (NHA) and the Canada Mortgage Bond (CMB) programs.
 - Over a third of the outstanding mortgage debt is securitized, almost all through public securitization programs reaching over \$496 billion in 2019;
 - Public securitization do not have credit risk beyond that of the government as they are all insured by the government.
 - Financial Institutions (72% Big 6 Banks, 28% other).



Objectives

- 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:
 - Increasing the amount of information available to MBS secondary markets about mortgage pools through introducing common mortgage data standards; and
 - Increasing the number of investor participants in the MBS secondary markets.
- A key hypothesis to be tested is:
 - Increasing the number of market participants and the level of information about insured and uninsured mortgage pools will, for a given level of mortgage pool credit risk, reduce the equilibrium spreads over the government yield curve.
- We will discuss in the context of the findings how greater information and market participation may facilitate an environment in which there would be a reduction in the overall level of guarantees in future securitized mortgage pools.

Approach

General approach: Agent-based modelling

- General approach to study market dynamics: An agent-based model is well suited to model financial markets where the behaviour of individual participants is important. LeBaron, 2002, Markose, Dong & Oluwasegun (2008), Jiang (2011), Lespagnol & Rouchier (2014)
- For each government guarantee assumption of mortgage pools, the emergent properties of the spreads can be generally estimated.
- The result of the analysis will be a matrix of relative spread outcomes and spread volatility and depth outcomes (indications of confidence) for a market of a specific duration for different combinations of information availability and market participant size and number.
- The results will be able to be interpreted as a vector of influence: the direction of change expected and its magnitude.

General approach: Initialization

- The study will be limited to MBS and Covered Bond type products in which the primary distinction will be the prepayment risks inherent in MBS.
- The initial characteristics of the markets that will be used include:
 - Average term will be 5 years.
 - 36% of the outstanding mortgage debt is securitized, all through public securitization programs. This is about \$496 billion in 2019;
 - Profile of issuers are taken from MBS-R120 CMHC Securitization Reports
 - In the absence of loss distributions by credit score empirical data, delinquency and arrears rates published by CMHC will be used for credit risk purposes.
- Distribution of investors that purchase and trade securities is assumed to be unknown. This will be tested using scenarios that are set exogenously to the model from (1) many, same sized investors through to (2) few large, same sized investors
- Varying levels of information. This will be tested using:
 - Perfect information about the fundamental value: assumption that all investors are aware of the actual prepayment and default distribution of the mortgage pool
 - No information about the fundamental value: assumption that investors are unaware of the actual prepayment and default distribution of the mortgage pool and instead generate their own estimates. It will be highly unlikely that any two agents will have exactly the same estimates
 - Some information about the fundamental value: the estimates by investors will slowly converge to the perfect information scenario.
- Proportion scenario of government guarantee coverage of underlying mortgage pool will be varied within the confinements of the initial characteristics of the markets

Market Model

- Main goal is to focus on heterogeneous knowledge about fundamentals and its impact on price dynamics in a financial market.
- Market model follows the prescriptions in Yamamoto (2011), Lespagnol & Rouchier (2014)
- Assumptions about the agents used in the system
 - Usual for Agent-based Computational Economics (ACE) financial models that are related to the present issue regarding the impact of information on prices.
 - Information heterogeneity and bounded rationality are important features to reproduce actual behaviours (Bao et al., 2012).
 - Within a typology of agents that is usual, agents begin as pure fundamentalists who have different risk aversion and investment horizons
 - Several features of bounded rationality that are relevant to this type of modeling.
- The agents types affect the quality of the price signal.
 - modellers distinguish two types of agents that are fundamentalists and chartists (Hommes, 2006)

Market Model: Traders

- Generally, modellers distinguish two types of agents (Chiarella et al., 2007; Jacob-Leal, 2012):
 - **Fundamentalists**
 - trade in order to make the market converge to investor's estimate of the fundamental value
 - assumed to be the most risk averse agents and have longer term investment horizons
 - a pure fundamentalist market should be efficient in the sense of Fama (trading price close to fundamental price - Fama, 1970).
 - An efficient market populated by pure fundamentalists is illiquid until a new information arise
 - **Chartists**
 - trade according to expectations of short term trends
 - speculators that try to predict price evolution so as to exploit the market trends to make profit.
 - revise their expectation frequently and prefer short time investments
 - Can have a destabilizing effect (Giardina and Bouchaud, 2003; Hommes et al., 2005; Lux and Marchesi, 1998))
- Traders are heterogeneous in their fundamentalist and chartist components, their investment horizon and their risk aversion, and are bounded rational.

Market Model: Investment Decisions

- Traders try to maximize their utility function under Constant Absolute Risk Aversion (CARA)
 - Increase or decrease holding of risky-asset vs risk-free asset
- An investor's price expectations are based on:
 - Trends in the last traded prices (chartist component)
 - Information about the fundamental price (fundamentalist component)
 - This information can vary between no knowledge, and full knowledge of the fundamental price
 - Risk aversion
 - Investor mood (a random degree of optimism/pessimism). Lux & Marchesi (1998)

Market Model: Order Book

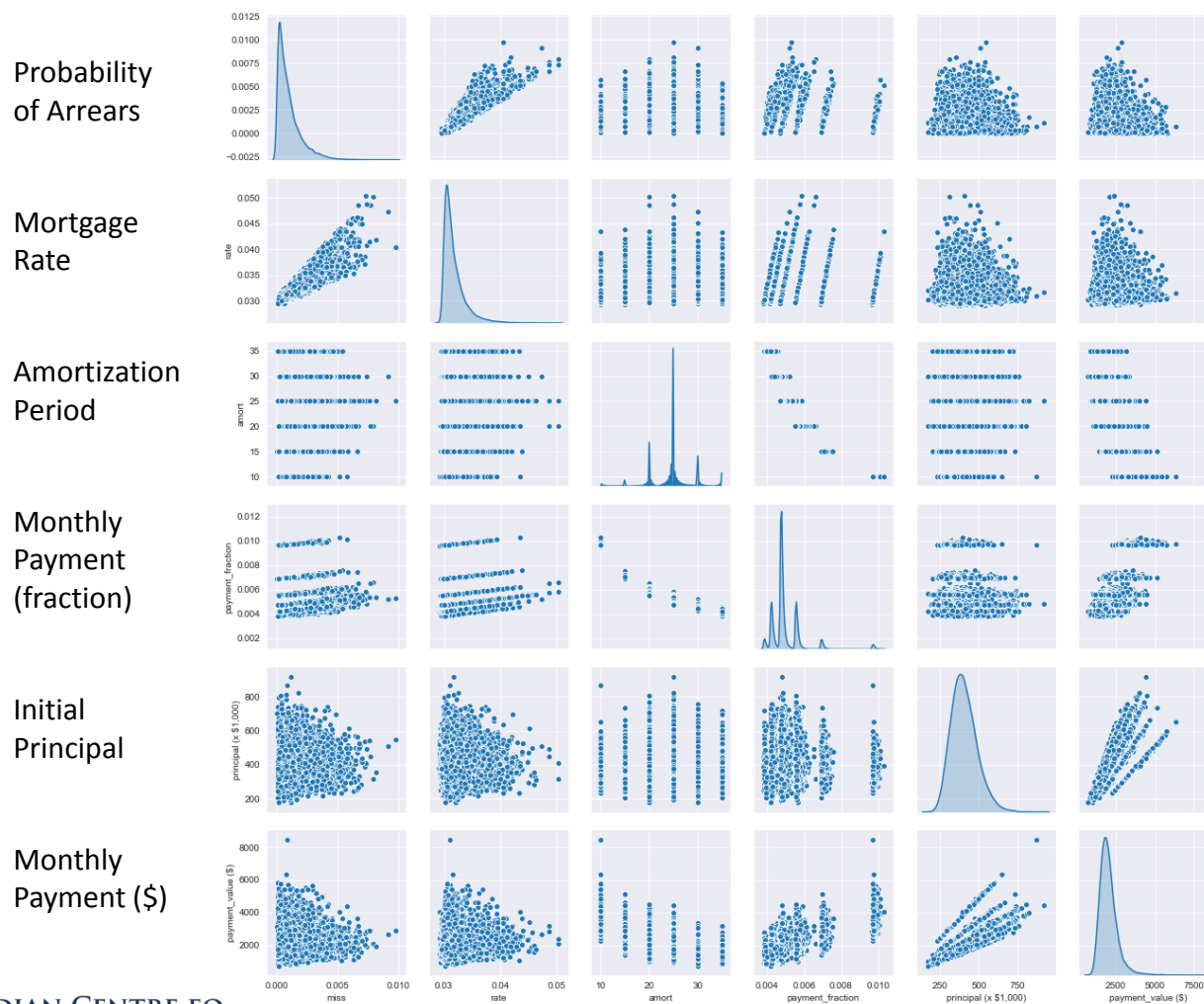
- Order book market structure: LeBaron, 2006
- At each step, an agent is chosen at random to make an investment decision
 - Any pending orders for the selected agent are cancelled
 - For each asset, target change in position is calculated based on risk-adjusted price expectations
 - Buy or sell offers are placed accordingly (market or limit price depending on current best bid/offer)
 - Any orders which can be fulfilled are, including any partial orders

Market Model: Mortgage-Backed Securities

- Mortgage back securities are modelled as the aggregate of a portfolio of Canadian mortgages which vary by:
 - Principal value
 - Interest rates
 - Amortization period
 - Probability of pre-payment
 - Probability of arrears and default
- Mortgage terms are taken to be 5 years
- The probability of arrears and default vary depending upon the level of government guarantee in the pool
 - Probability is 0 for fully insured mortgages
 - Arrears probability increases to recent CMHC reported rates (~0.3%)
 - Default probability is 1/3 the arrears rate
- Probability of pre-payment is based on Public Securities Association Standard Prepayment Model
- Risk-adjusted fundamental value of the pool is estimated by running many simulations of the mortgages within the pool to calculate average and std of PV

Mortgages Characteristics

- Selection of mortgages used to generate a MBS pool



- Scenarios are modelled by varying:
 - the number of investor participants from few to many
 - the level of information about the fundamental price on the asset
 - the level of government guaranteed mortgages with the pool
 - Note that the probabilities of prepayment are significantly higher than the probabilities of default, even in uninsured mortgages
- Each combination of variable is run many times to calculate the average outcomes

Credit Risk Scenarios

- In addition to varying information and participants, two credit risk scenarios are considered:
 - **Low Credit Risk:** Based on the current mortgage low arrears and default rates
 - **High Credit Risk:** A hypothetical scenario where probability of arrears and defaults are 10 times higher and only 70% of principal is recovered on defaulted mortgages

Results

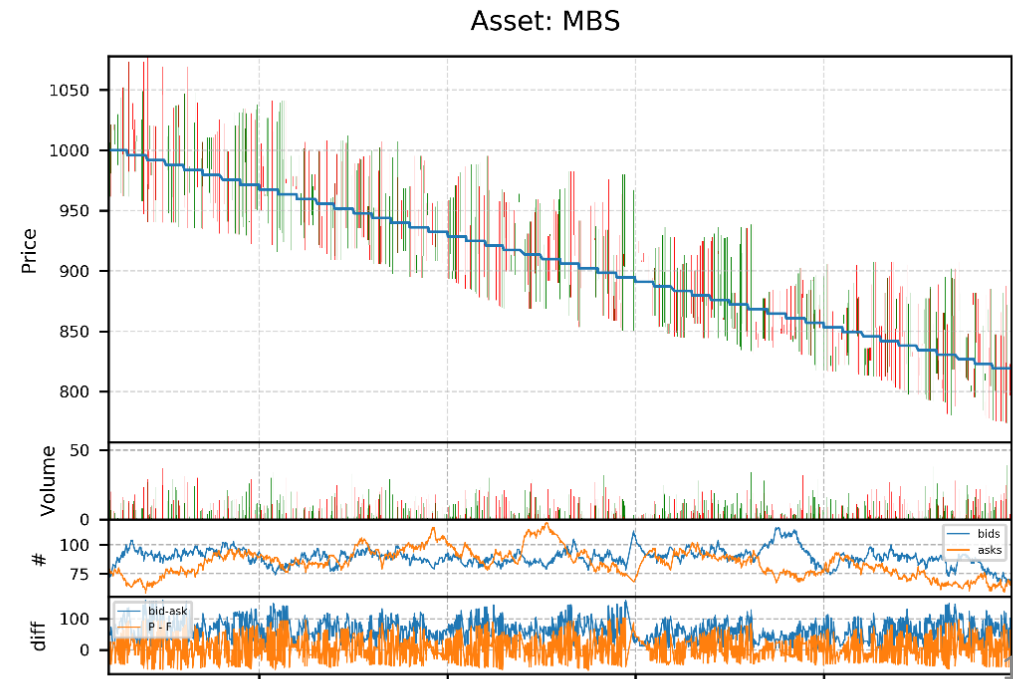
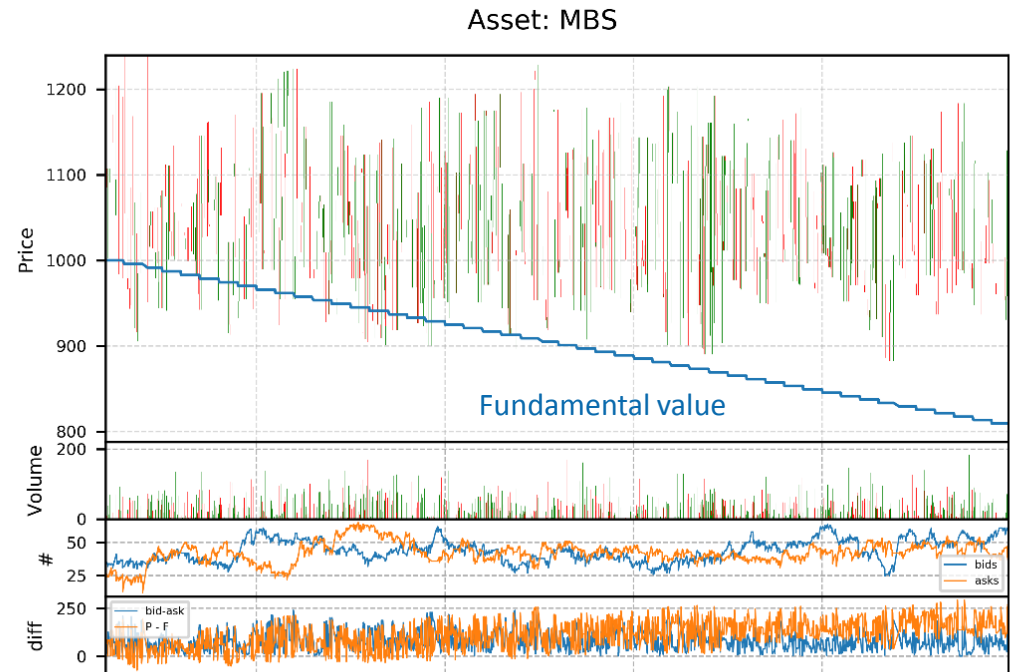
Trading Behaviour

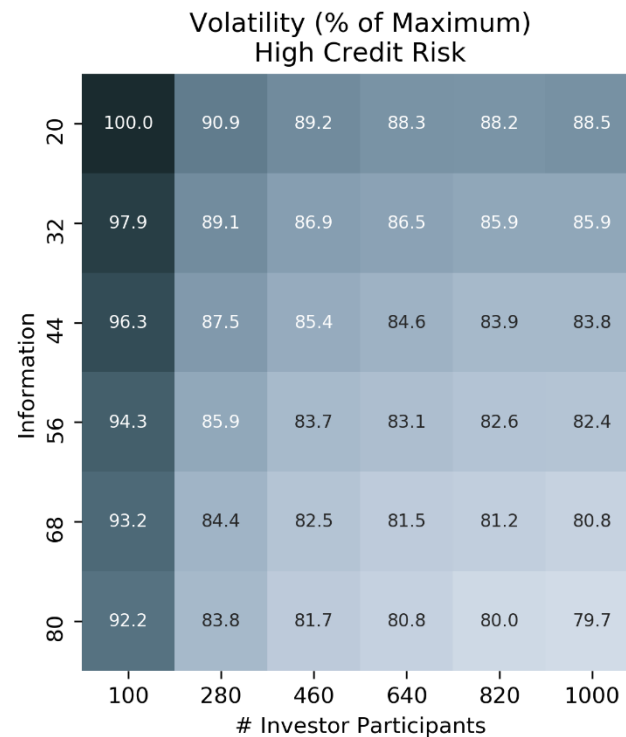
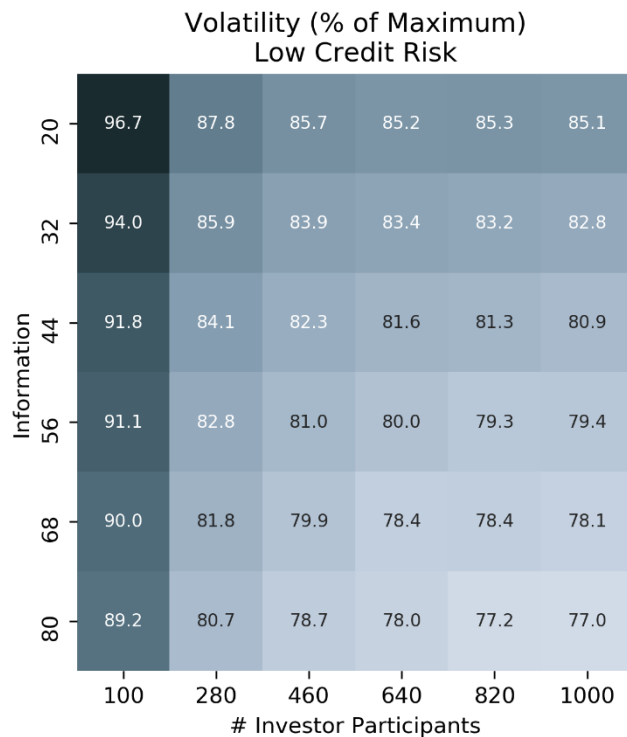
- **No information at all**

- investors continue to follow the initial expectation of the price

- **Full information**

- Fundamentalists with the market move the price in line with the fundamental price

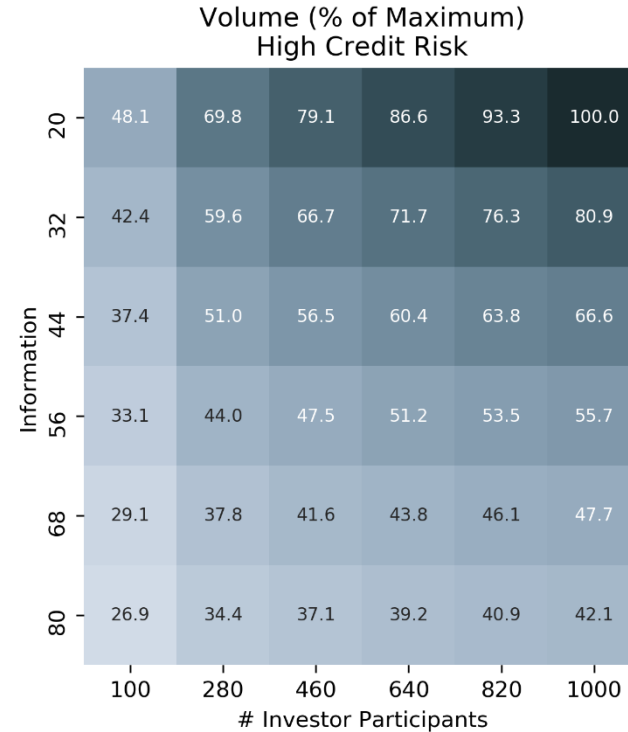
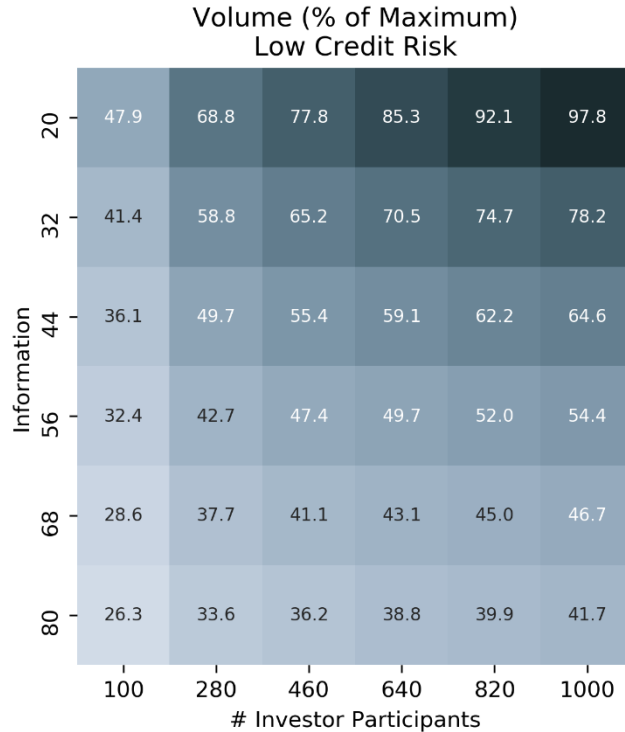




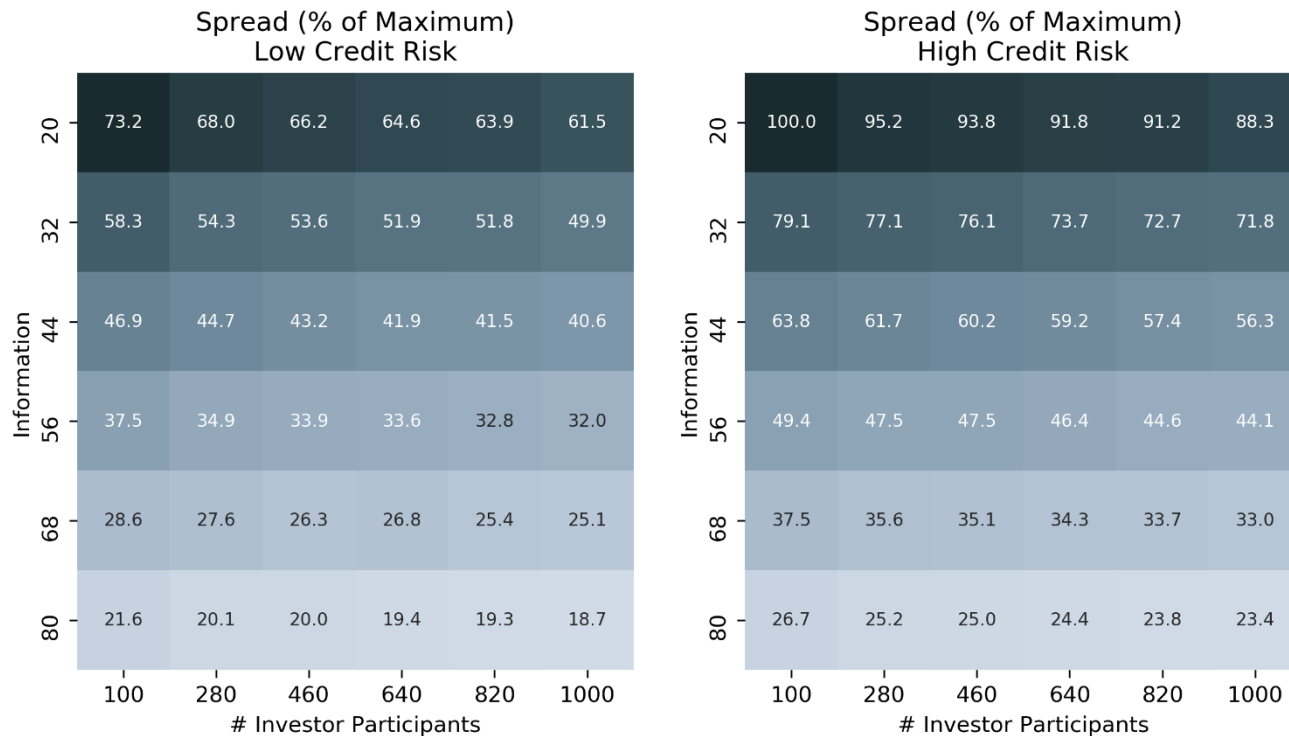
- Volatility decreases in response to either:
 - More information
 - More investor participants

- Both factors compliment each other:
 - Benefits of more information alone results in investors having a better understanding of the fundamental value of the MBS resulting in:
 - more consistent value estimates
 - fundamentalists reining in chartists price divergence
 - Greater number of investors results in more bids & asks being closer to the mean

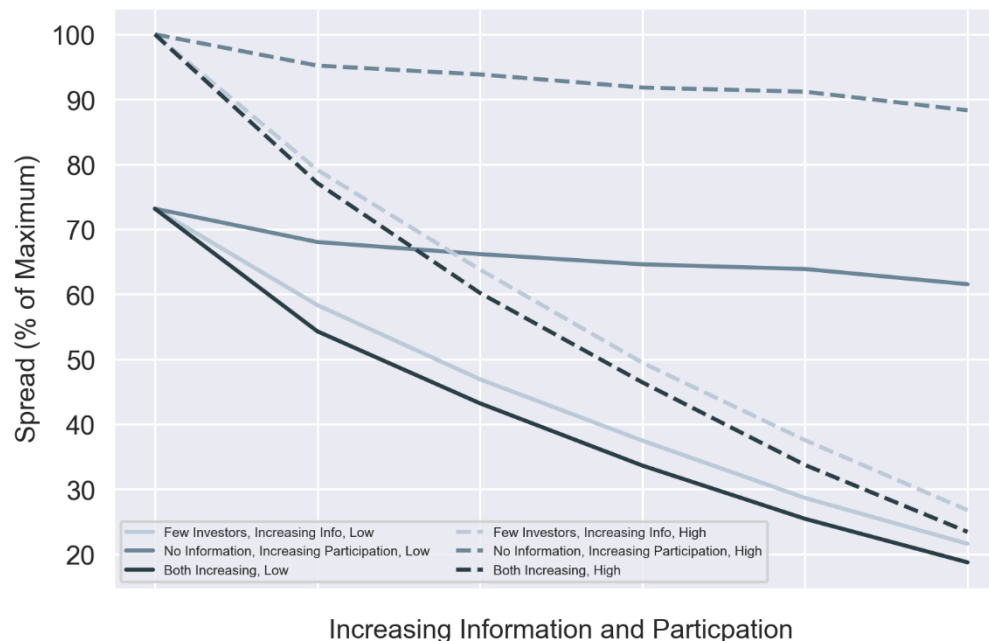
Volume (Liquidity)



- Highest volume of trades for:
 - Low information,
 - More investors

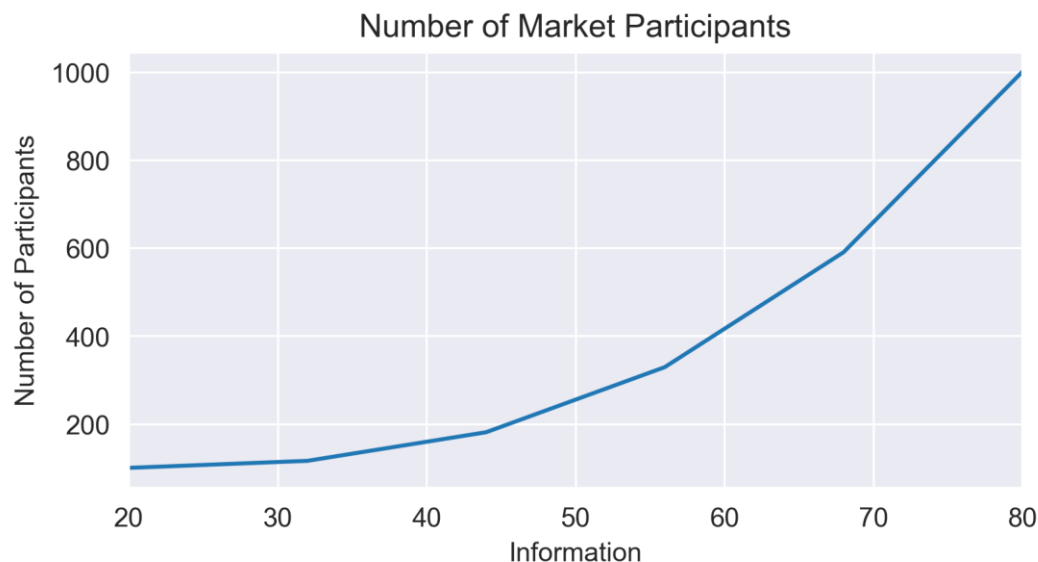


- More information and more market participants results in smaller differences between the traded and fundamental prices
- The spread is highest for:
 - Low information
 - Low number of investors



- As information and participation increase, the spread falls.
- The spread is most sensitive to information rather than the number of participants

Information and Participation



- Literature suggest Pareto-preferred equilibria exist for higher participation and lower volatility (see for example Allen and Gale, 1994)
- Exact response is unknown, but figure show illustrative response based on volatility results
 - Low increases in information only decrease volatility slightly, resulting in small participation increase
 - Higher increases in information decrease volatility more, attracting additional participants which further reduces volatility.

Conclusions

- The addition of more information and market participants to the MBS market results in a smaller spread and less market volatility
- Information is the largest factor at work