Corporate Bond Covenants and Market Illiquidity (in progress 2)

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Final Steps - In Progress

1. Develop 2-period model for the Proposal;
2. Add justification for the shareholders' objective function (MBR) to the text;
   - all shareholders invest the same amount W_0;
   - Net cash infusion: $V_0 - D_0$;
   - Shareholders form a coalition to cover the net cash infusion value;
   - Size of the coalition depends on the value of debt/firm leverage/firm type.
3. Work on more realistic covenant: restrictive covenant affecting dividend payout rate?
4. Minor result confirming optimality of standardized debt for risky firms under full information
5. Compute bond spreads

Motivation

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1. Since the 1940s, corporate bonds have been traded primarily over the counter (OTC);
   - Opaque markets
   - Heavily dependent on dealers' market-making abilities (or willingness to commit capital to intermediate trades);
2. In recent years, deteriorating liquidity conditions in OTC secondary debt markets => increase in electronic trading of corporate bonds
   - cut down costs
   - improve the efficiency of trading operations.

Motivation

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4. E-trading has been gaining ground for the past 5 years.
   - Approximately 90% of trades of $100k or less are now done in electronic platforms.
5. Nonetheless, larger ticket size trades ($1MM or more) are still done over-the-counter.
   - These make up over 80% of the notional volume traded daily.
6. How will secondary corporate bond markets change in terms of the type of issuers and the composition of debt instruments traded?

Motivation

Standardization

- In other asset classes, a move to electronic platforms has been accompanied by a push for standardization (futures, CDS, interest rate swaps. . .)
- However, the universe of corporate bonds is considerably more diverse than other asset classes;
- Covenants appear to fulfill an informational role:
  - Debt protective covenants help mitigate asymmetries of information between creditors and issuers and lack of oversight of bond investors over management's choices;
  - Corporate bond investors tend to be buy-and-hold investors and bond characteristics are generally tailored to the specific needs and risk-appetite of creditors.

Objective

- Investigate how firms sort themselves across OTC markets and electronic platforms.
  - focus on non-publicly traded/private equity firms;
  - analyze trade-off between lower intermediation costs and debt protective guarantees (non-standard instruments).

Endogenous covenants

- Structural Model of credit risk
- Heterogeneous types
- Asymmetric Information between creditors and shareholders.

Preliminary Results

- If investors cannot distinguish the riskiness of the issuing firms, risky types may attempt to pool with safer firms.
  - safe firms adjust leverage, either to accommodate a pooling or force separation in equilibrium.
- Covenants can command a premium by acting as a signaling mechanism.
  - depending on (i) the liquidity differential between OTC and electronic markets and (ii) the firm leverage adjustment under asymmetric information, safe types may choose to issue non-standardized debt in OTC.

The Model

I propose a structural model of credit risk with heterogeneous firm types and asymmetric information in which bonds can be traded in competing secondary markets of varying (external) liquidity.

Heterogenous Types

1. Two types of projects: safe and risky;
   - Drawn from a time-invariant Bernoulli distribution;
   - Risky projects are subject to a volatility shock.
2. Each firm invests in a single project;

Volatility Shocks

- Shocks are independent and arrive according to a Poisson process with intensity λ;
- Once hit by a shock, volatility of the firm is permanently increased from σ_l to σ_h.

The Model

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Asymmetric Information

- Creditors do not directly observe a project/firm's type;

Trading Venues

- Competing trading venues: Over-the-Counter (OTC) and Electronic Markets (EP)
  - EP offers lower transaction costs;
  - But only accepts standardized bonds.

The Model

The Value of Unlevered Assets

Under the risk-neutral measure, the value of the unlevered assets of firm i follows a GBM process:

$$\frac{dV_{i,t}}{V_{i,t}} = \left(r - \overline{\delta}\right) dt + \sigma_{i,t} dZ_{i,t}$$

where

$$\sigma_{i,t} = \sigma_l + (\sigma_{i,h} - \sigma_l) \cdot \mathbf{1}_{\{t \geqslant t^{\sigma}\}}$$

where t^{σ} is the first-stopping time of the volatility shock process.

Firms' Capital Structure

- Firms can be financed by a mix of equity (E) and debt (D);
- Debt financing allows firms to benefit from tax-shields, but creates the risk of a costly bankruptcy process.
- Upon entering the market, firms commit to a stationary debt structure.

Firms' Capital Structure - Cont'd

Stationary Capital Structure

- Only one type of credit instrument per firm:
  - Bond Contract: $\boldsymbol{b} \equiv (m, c, p)$
- Debt Profile:
  - continuum of bonds, varying only in their time-to-maturity;
  - Time-to-maturity of outstanding bonds is uniformly spread out over time.
- Measure of bonds outstanding is constant: μ_b;
  - Maturing bonds immediately replaced by newly-issued bonds.
- Capital structure fully characterized by $\omega = (\mu_b, \boldsymbol{b})$.

Cash-Flows

- Cash-flows happen on a continuous basis;
- Net cash-flows immediately accrue to equity holders.

$$NC_t = \overline{\delta} V_t - (1-\pi)\, C + \underbrace{d\left(V_t, m; V^B, \lambda, \omega, \theta\right) - p}_{\text{Debt rollover profit/loss}}$$

where $\theta \equiv \left(r - \overline{\delta}, r + \xi\kappa, \sigma_l, \sigma_h\right)$ and

  - π is the rate of tax-shield,
  - C is the aggregate coupon
  - $d\left(V_t, m; V^B, \lambda, \omega, \theta\right)$ is the price of a newly-issued bond (of maturity m)

- V^B is the firm's default barrier (discussed below).
- Negative net cash-flows lead to equity dilution: losses are paid off via the issuance of more equity at market prices

Illiquidity and Investors' Discount Rate

- Bond investors are exposed to idiosyncratic liquidity shocks;
  - i.i.d Poisson processes with intensity ξ.
- Investors hit by a liquidity shock must immediately liquidate their bond holding in a secondary bond market at a market-dependent, fractional cost κ;
  - for now, consider only one secondary market.
- Investor's effective discount rate is: $r_{disc} = r + \xi\kappa$

Default

- Default is defined as the first time the value of unlevered assets V_t crosses a constant, non-stochastic barrier $V^B < V_0$ (from above);
- Costly bankruptcy: upon default, the firm is liquidated at a cost $(1-\alpha)\,V^B$, $\alpha \in (0,1)$.
- Equal priority rule:

$$d\left(V_t, m; V^B, \lambda, \omega, \theta\right) = \frac{\alpha V^B}{\mu_b \cdot m}, \quad \tau \in [0, m]$$

  where τ denotes time-to-maturity.
- The optimal default barrier is constant, endogenously determined and independent of V_t
  - Derived by imposing the limited liability constraint on equity.

Timing

The timing of events within a period $t \geqslant 0$ for an entrant firm is as follows:

1. Shareholders observe investment opportunities drawn from the time-invariant Bernoulli distribution;
   - measure of safe firms: μ_s
2. For each project shareholders decide to invest in, they set up a firm;
3. Firms commit to a stationary capital structure, $\omega \equiv (\mu_b, \boldsymbol{b})$;
4. Debt and equity shares are issued.

Timing (Cont'd)

And the timing of events within a period $t \geqslant 0$ for non-entrant (established) firms is:

1. All investors observe whether a volatility shock occurred;
2. Cash flows are computed;
3. If the value of equity falls to zero, the firm is declared bankrupt and its assets are liquidated to repay outstanding debt. Else, debt is rolled over and net cash-flows are realized.

The Choice of the Capital Structure

1. Firms are managed by equity holders;
2. Shareholders' rate of return is the market-to-book ratio (MBR) of equity

$$MBR\left(V_0;\lambda,\omega,\theta\right)=\frac{E\left(V_0;V^B\left(\lambda,\omega,\theta\right),\lambda,\omega,\theta\right)}{\underbrace{V_0-D\left(V_0,m;V^B\left(\lambda,\omega,\theta\right),\lambda,\omega,\theta\right)}_{\text{Equity Infusion at Inception}}}$$

In principle, MBR can be arbitrarily increased by setting the firm's leverage to 1, but creditors' preclude shareholders from doing so.

The Choice of the Capital Structure

Creditors' Funding Condition

When creditors' fully observe a firm's type, they require that the choice of capital structure be made to maximize the total firm value (debt + equity).

$$\omega^{\star}(\lambda,\theta) \in arg \max_{\omega \in \mathbb{R}_{+}^{4}} \left\{ D\Big(V_0; V^B(\lambda,\omega,\theta), \omega, \theta\Big) + E\Big(V_0; V^B(\lambda,\omega,\theta), \lambda, \omega, \theta\Big) \right\}$$

Optimal payoffs: payoffs obtained when the capital structure is set to $\omega^{\star}(\lambda,\theta)$.

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Optimal payoffs: payoffs obtained when the capital structure is set to $\omega^{\star}(\lambda,\theta)$.

Asymmetric Information

Suppose now that

1. creditors cannot observe a firm type;
2. there is no aggregate uncertainty: the distribution of firm types is publicly known.

Creditors' Funding Condition Violation

1. Creditors can preclude arbitrary deviations by refusing to fund firms whose choices of capital structure are clearly sub-optimal;
2. But knowledge of the aggregate firm-type distribution alone does not preclude misrepresentation.

Misrepresentation Analysis

Misrepresentation can increase risky firm's MBR:

- raises the price of outstanding bonds in secondary markets;
- decreases debt rollover costs.

Steps

1. Compute firm's payoffs under full information;
2. Check if risky firm has an incentive to misrepresent itself:
   - Calculate MBR if debt investors believe risky firm is safe.
   - Bond prices are those of safe firms.

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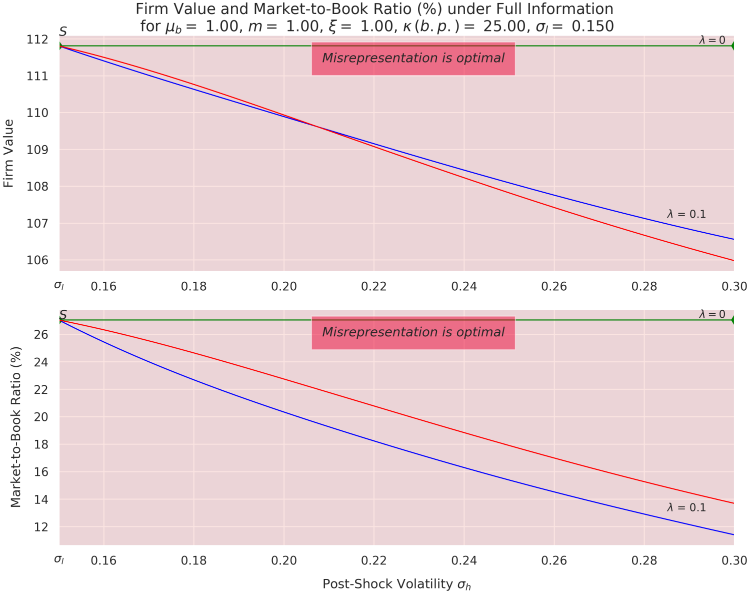
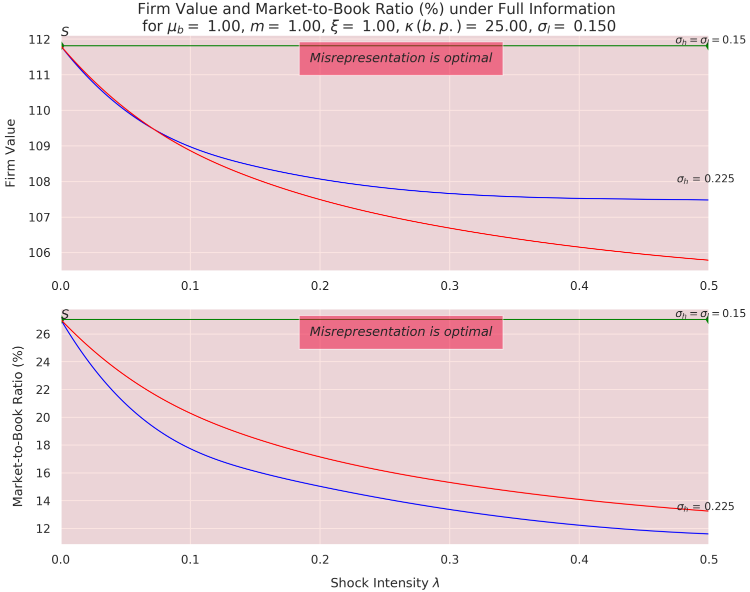
Misrepresentation



Misrepresentation



Secondary Bond Markets

Now consider two types of secondary bond markets:
over-the-counter (OTC) and electronic platforms (EP).

Electronic Plataforms

- higher (external) liquidity/lower transaction costs: $\kappa^{EP} < \kappa^{OTC}$
- only accept standardized (covenant-free) bonds

Note

$\boldsymbol{b}^{EP}$ is derived from the safe-type's bond contract in a full information setting by approximating the coupon ratio to the nearest half-integer.

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Debt Standardization

Firm's Choice of Debt Type

standardized →

Covenant-Free Bonds

Contract Menu $\boldsymbol{b}^{EP} \equiv \left(m^{EP}, c^{EP}, p^{EP}\right)$ + Leverage μ_b (bond units)

→ **Electronic Platform**
$\kappa^{EP} < \kappa^{OTC}$
(more liquidity)

non-standardized →

Optimal Capital Structure

1. Normalize number of bonds: m units
2. Debt issued at par: $P = D\left(V_0; V_l^B, \lambda, \omega, \theta\right)$
3. Endogenous Bankruptcy Barrier: V_l^B chosen so as to satisfy
   - Limited Liability: $E\left(V_l^B; V_l^B, \lambda, \omega, \theta\right) = 0$
   - Smooth-Pasting: $\frac{\partial}{\partial V} E\left(V_l^B; V_l^B, \lambda, \omega, \theta\right) = 0$
4. Choose C to maximize $D\left(V_0; V_l^B, \lambda, \omega, \theta\right) + E\left(V_0; V_l^B, \lambda, \omega, \theta\right)$

→ **Over-the-Counter**
$\kappa^{OTC} > \kappa^{EP}$
(higher transaction costs)

Standardized Bond Issuance

Choice of Debt Instrument when Firm Types are Known

If creditors observe firms' types:

- Creditors enforce funding condition: maximization of total economic value of the firm;
- Safe firms will always issue standardized bonds;
- Risky firms will issue standardized bonds provided that the liquidity differential more than compensates them for the (potentially) sub-optimal coupon ratio, $\frac{c^{EP}}{p^{EP}}$.

To compute the Market Equilibrium, I proceed as follows:

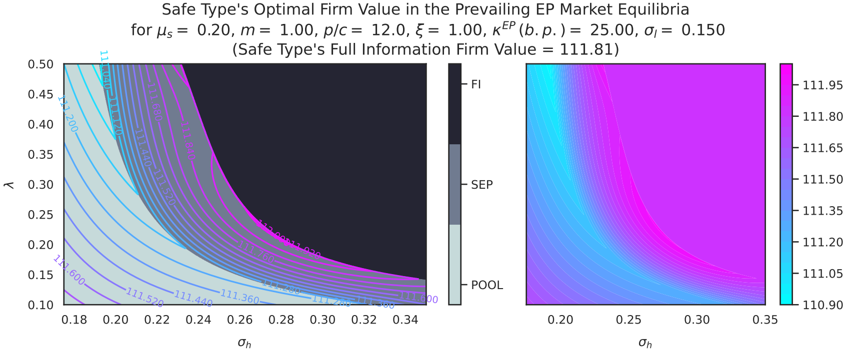
1. Identify the safe type's outstanding bond measure values μ_b for which:
   - **Pooling interval**: it is optimal for the risky type to pool with the safe type;
   - **Separating interval**: truth-telling is optimal for risky type.
2. In each case, search for μ_b that maximizes the safe type's firm value;
3. Determine if safe firm is better off by pooling with the risky type or by adjusting its leverage to force separation: FINISH
4. Compare safe's type firm value to its payoff in OTC markets.

Market Equilibria Iso-Curves - fixed μ_s

- The next slides show the safe- and risky-types' firm value and market-to-book ratio iso-curves for varying $(\sigma_{\mathrm{h}}, \lambda)$ pairs.
- The measure of entrant firms is kept constant at $\mu_s = 0.2$.

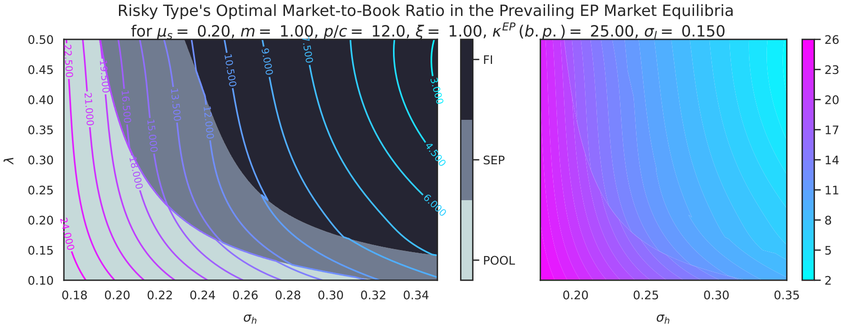
Electronic Market Equilibria

Safe Type's Firm Value - fixed μ_s



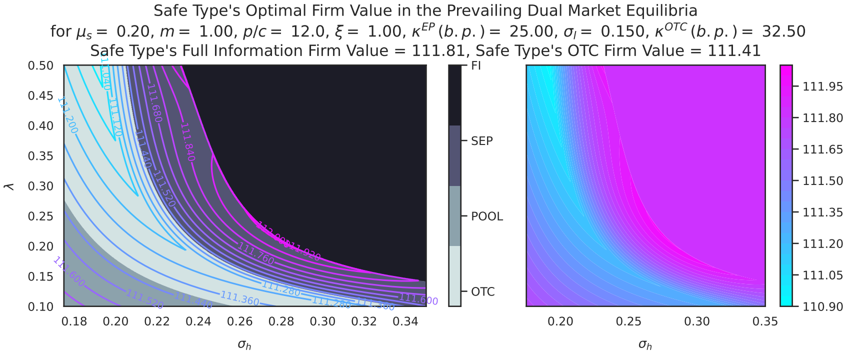
Electronic Market Equilibria

Risky Type's Market-to-Book Ratio - fixed μ_s



Dual Market Equilibria - Electronic Platforms vs. Over-the-Counter

Safe Type's Firm Value - fixed μ_s

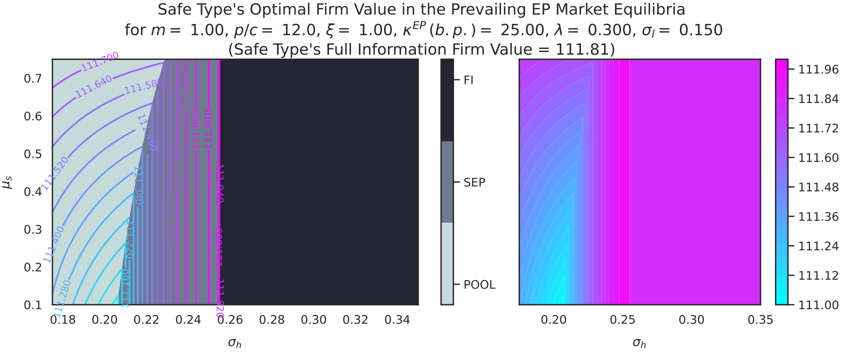


Market Equilibria Iso-Curves - fixed λ

- The next slides show the safe- and risky-types' firm value and market-to-book ratio iso-curves for varying volatility shock sizes, σ_{h}, and measures of safe firms, μ_{s}.
- The intensity of the volatility shock is kept constant at $\lambda = 0.3$.

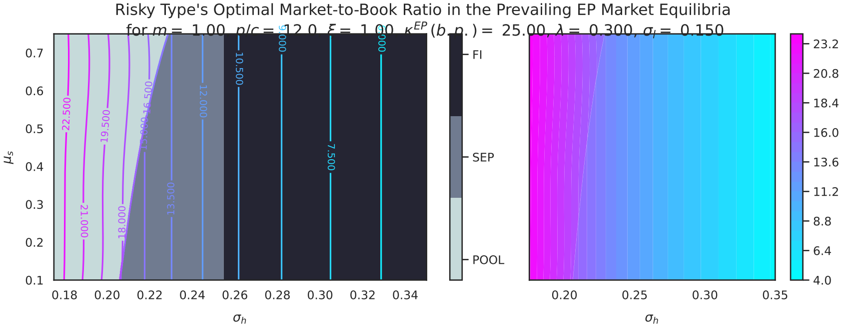
Electronic Market Equilibria

Safe Type's Firm Value - fixed λ



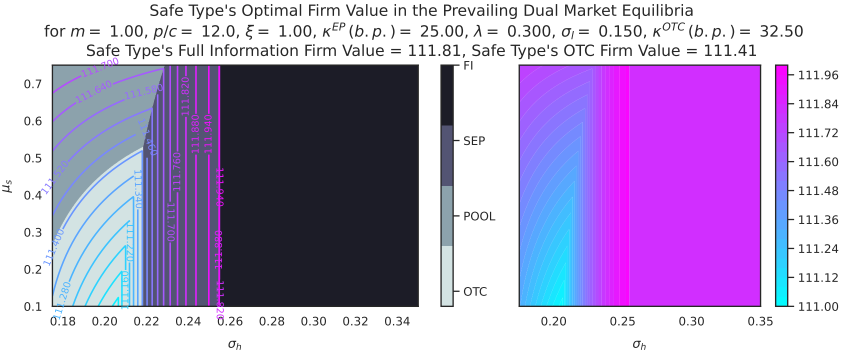
Electronic Market Equilibria

Risky Type's Market-to-Book Ratio - fixed λ



Dual Market Equilibria - Electronic Platforms vs. Over-the-Counter

Safe Type's Firm Value - fixed λ



Informational v.s. Illiquidity Costs

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The Gains from Electronic Trading

- Informational cost: $INFC = FV_s^{FI,EP} - FV_s^{AI,EP}$
- Liquidity Differential: $LQD = FV_s^{FI,EP} - FV_s^{FI,OTC}$
- Gains: $\Delta FV = LQD - INFC$

- Implications for exchange revenue/profitability.

Payoffs

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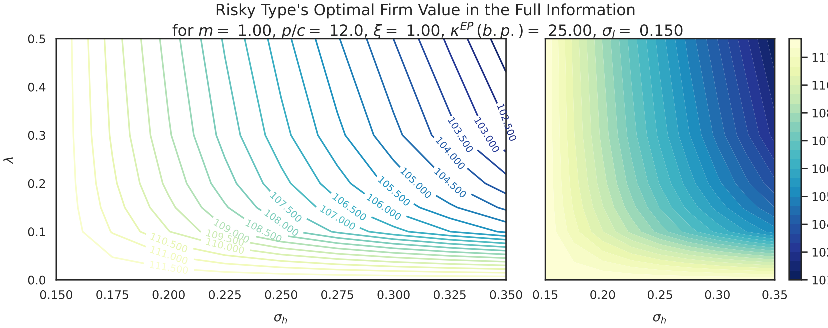
- The market equilibria results were derived from the safe- and risky-type's payoffs in the full information, misrepresentation, pooling and separating cases;
- These payoffs are shown in the next slides for completeness.

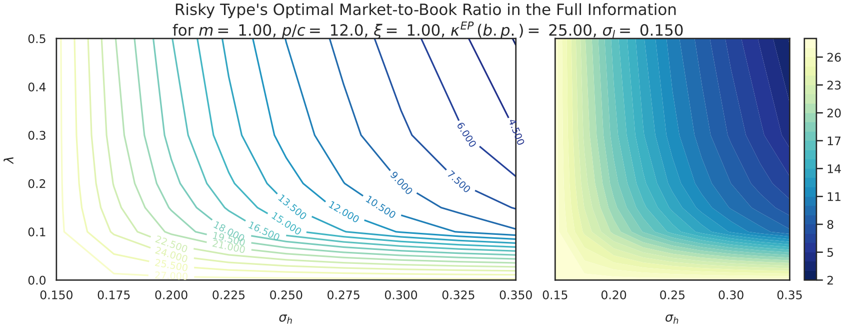
Full Information

Firm Value - fixed μ_s



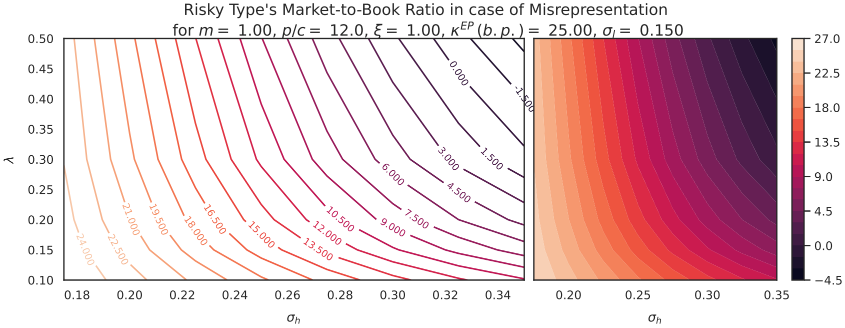
Full Information

Risky Type's MBR - fixed μ_s



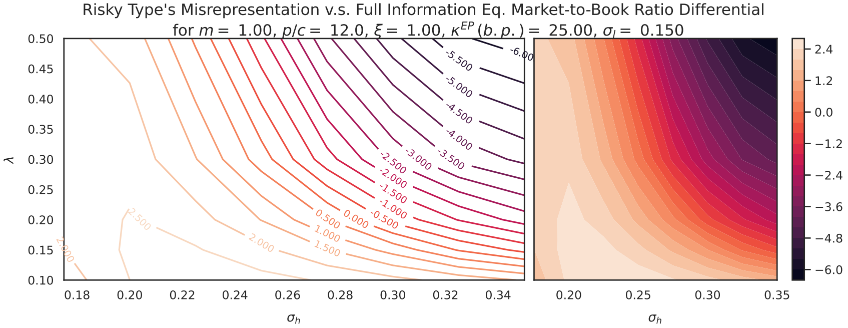
Misrepresentation

Risky Type's MBR - fixed μ_s



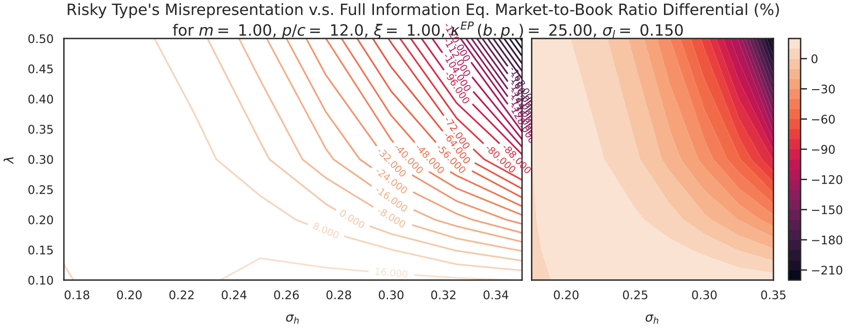
Misrepresentation

Risky Type's MBR Differential - fixed μ_s



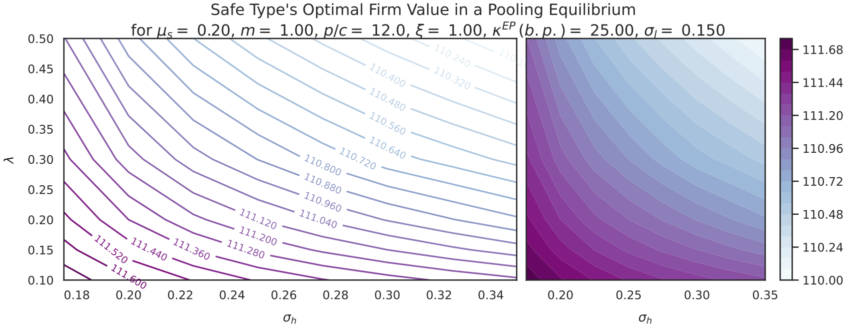
Misrepresentation

Risky Type's MBR Percentage Differential - fixed μ_s



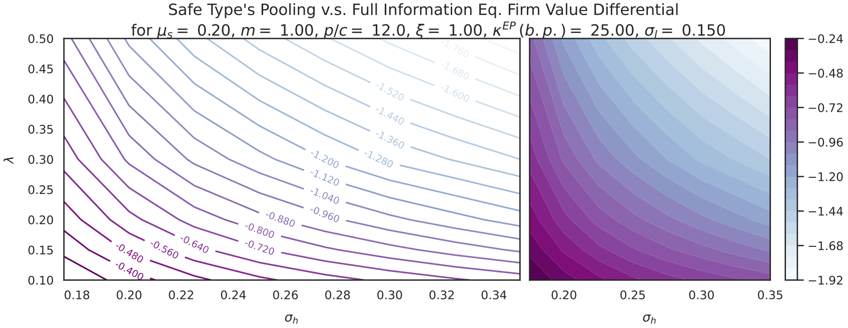
Pooling Payoffs

Safe Type's Firm Value - fixed μ_s



Pooling Payoffs

Safe Type's Firm Value Differential - fixed μ_s



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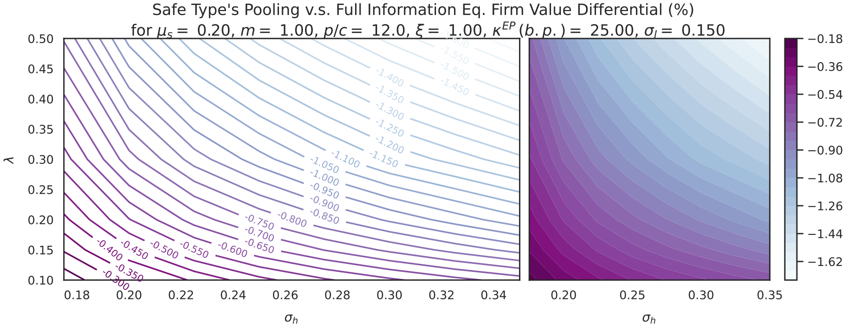
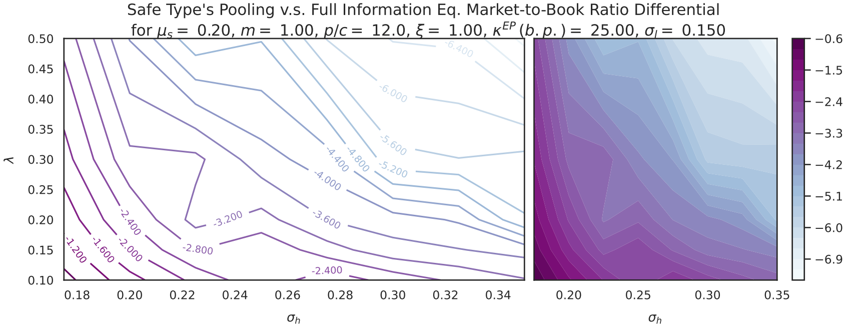


Pooling Payoffs

Safe Type's Market-to-Book Ratio Differential - fixed μ_s



Pooling Payoffs

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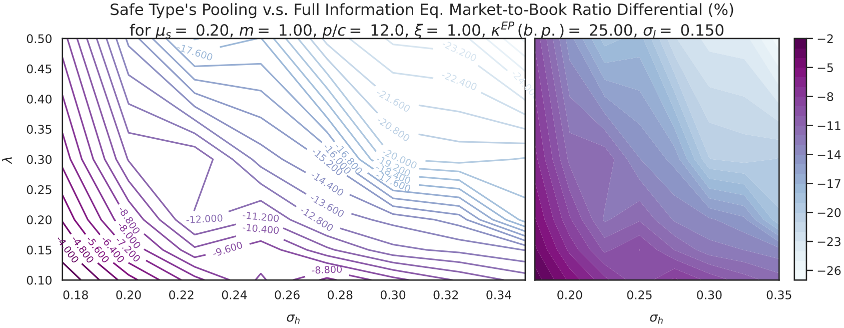
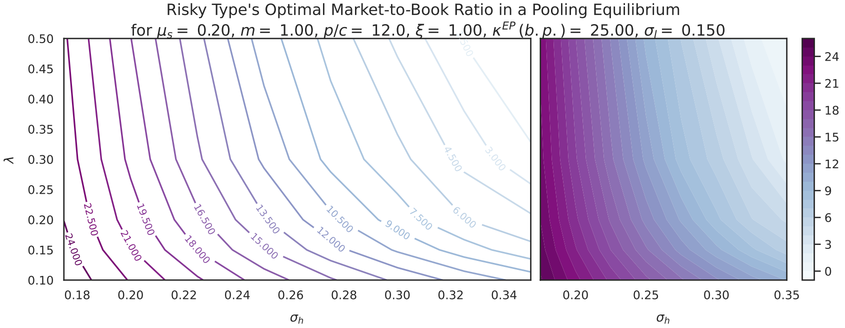


Pooling Payoffs

Risky Type's Market-to-Book Ratio - fixed μ_s



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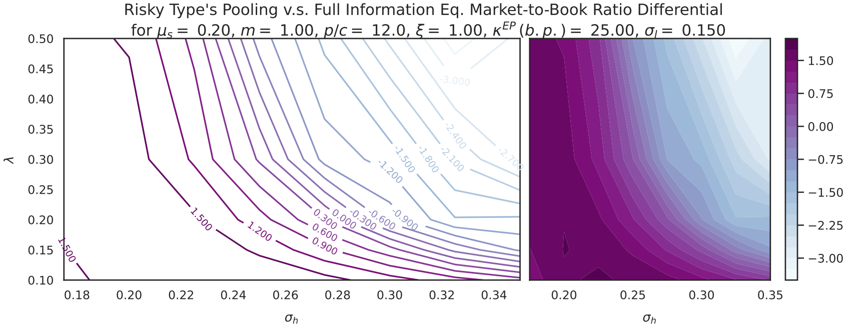

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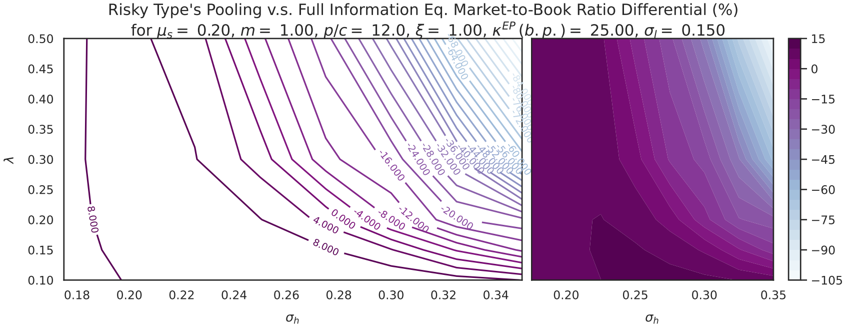
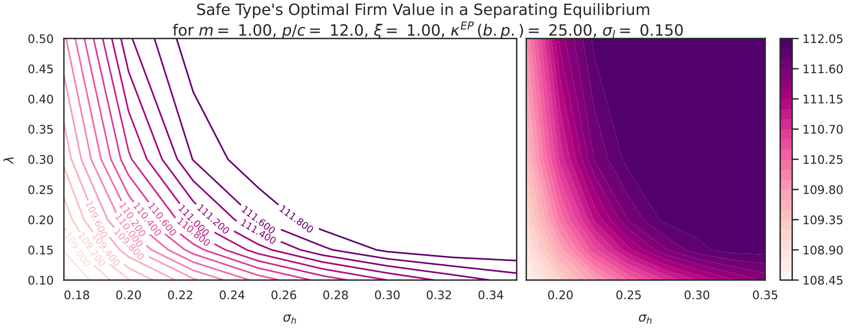


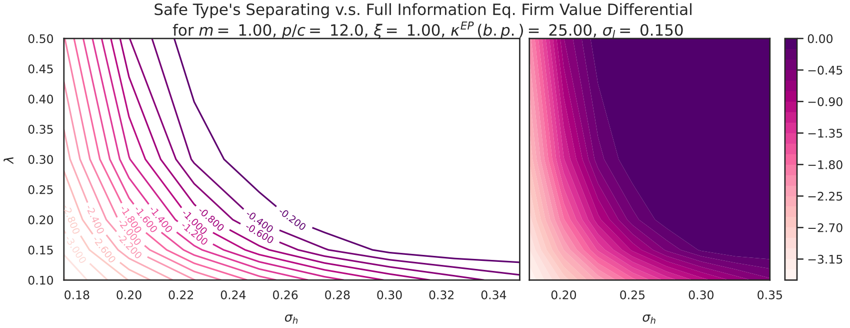
Separating Payoffs

Safe Type's Firm Value - fixed μ_s



Separating Payoffs

Safe Type's Firm Value Differential - fixed μ_s



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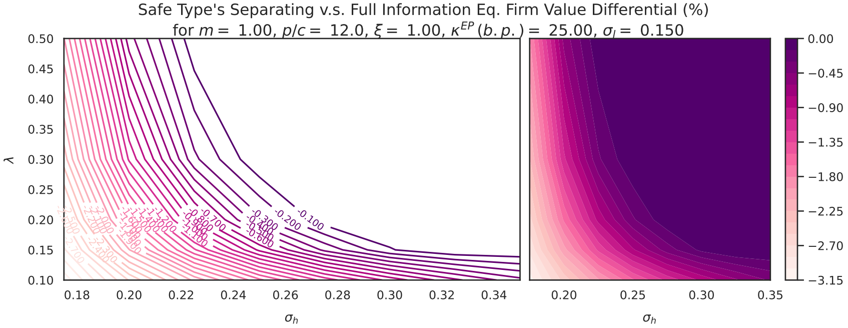

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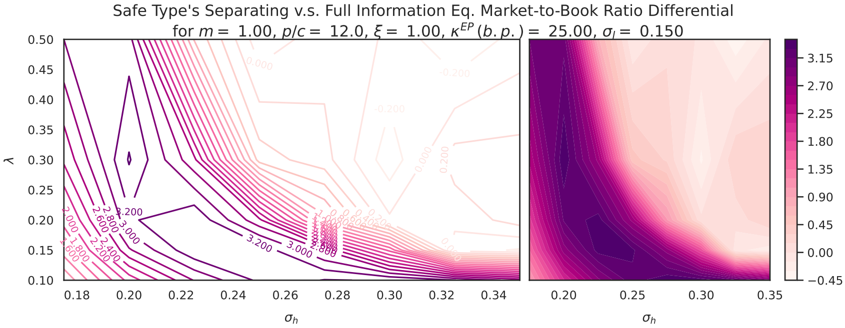

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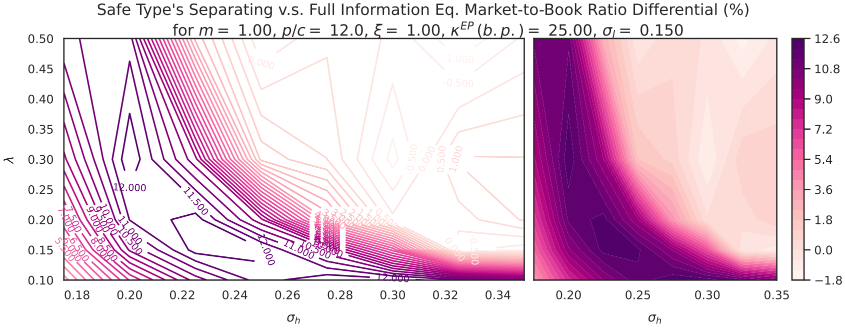

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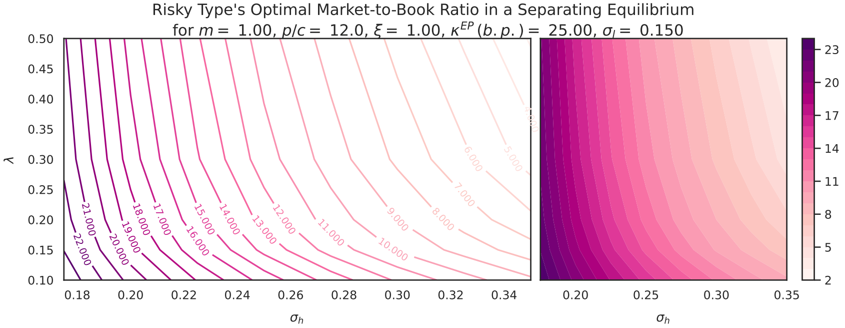

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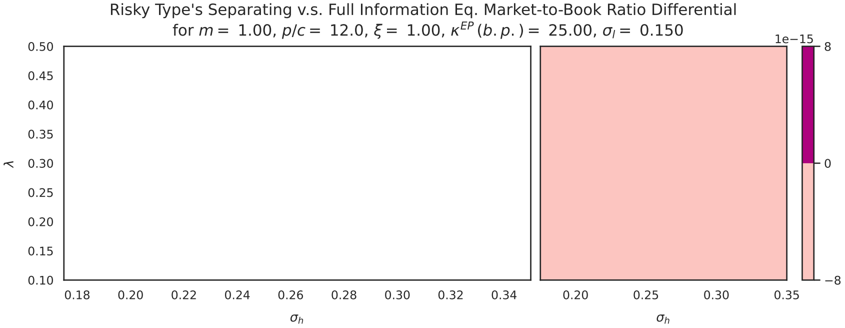

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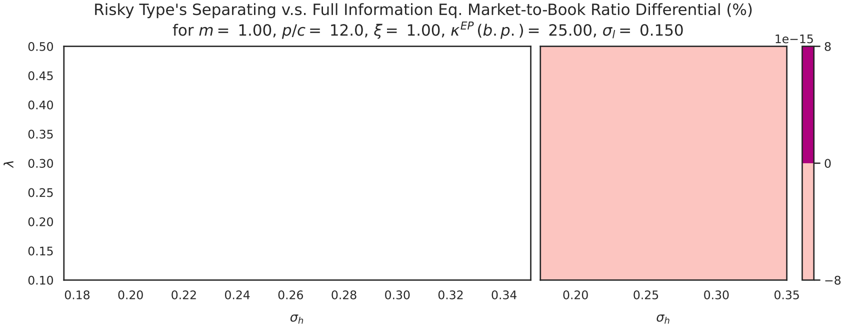
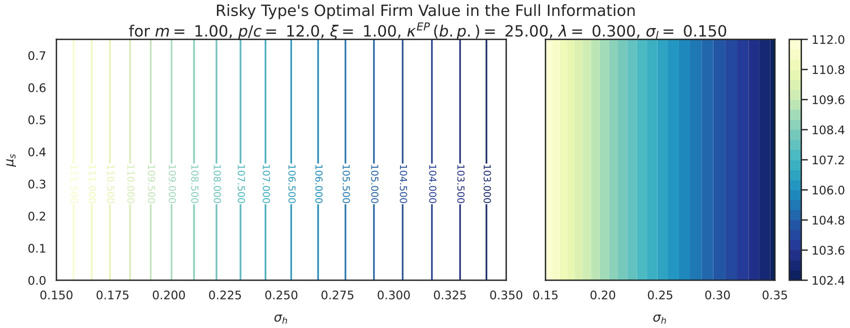


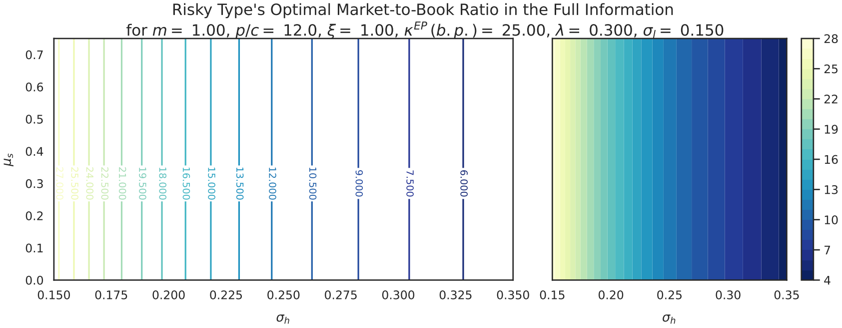
Full Information -

Firm Value - fixed λ



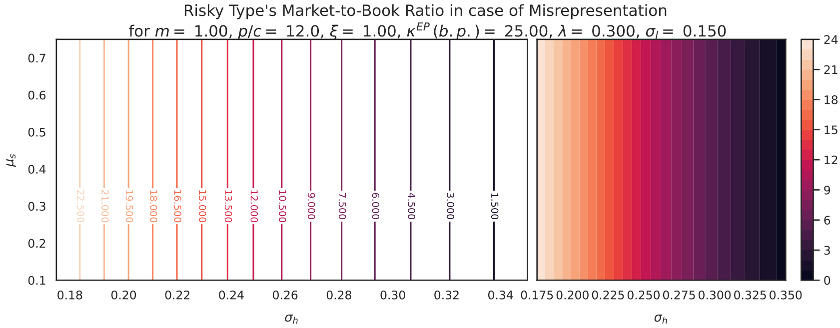
Full Information

Risky Type's MBR - fixed λ



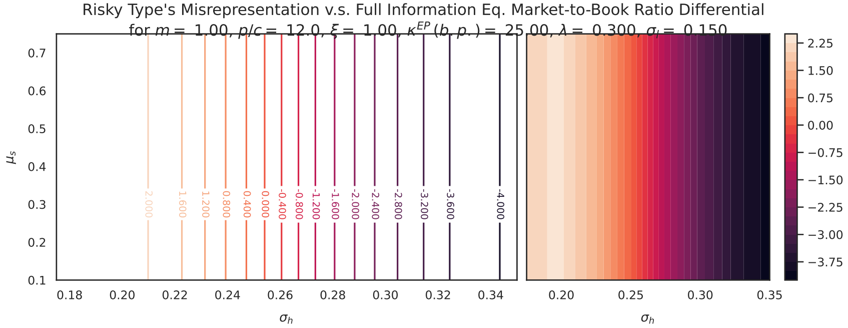
Misrepresentation

Risky Type's MBR - fixed λ



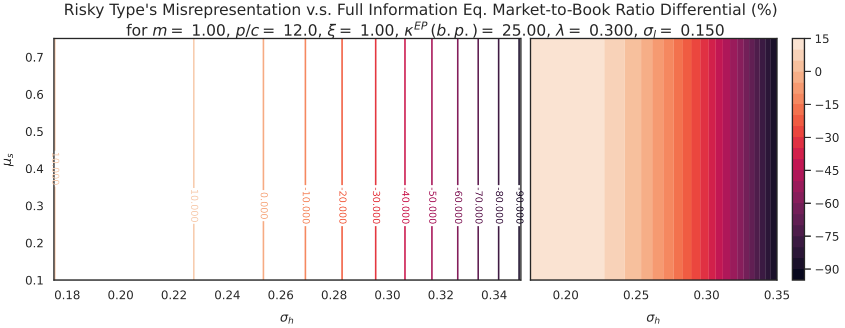
Misrepresentation

Risky Type's MBR Differential - fixed λ



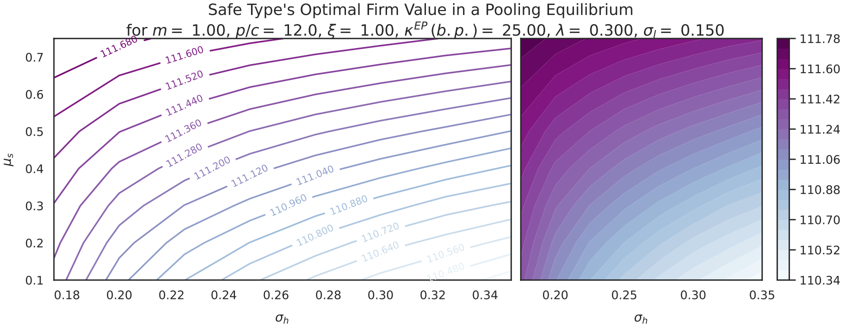
Misrepresentation

Risky Type's MBR Percentage Differential - fixed λ



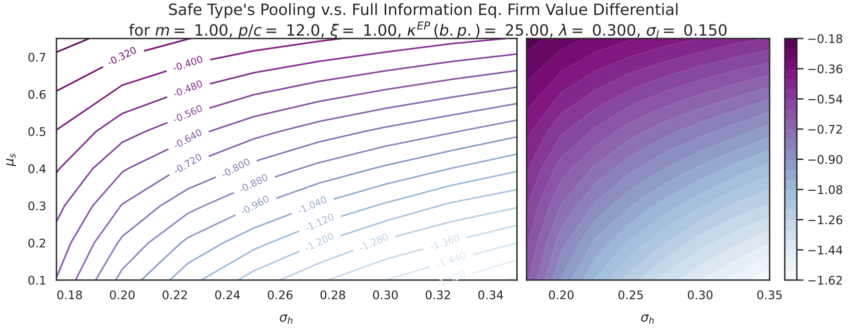
Pooling Payoffs

Safe Type's Firm Value - fixed λ



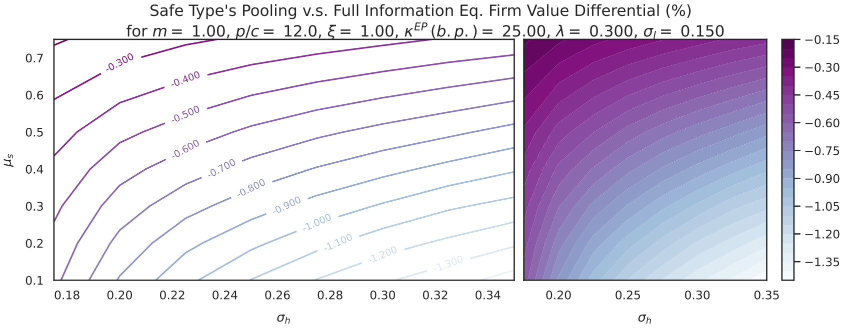
Pooling Payoffs

Safe Type's Firm Value Differential - fixed λ



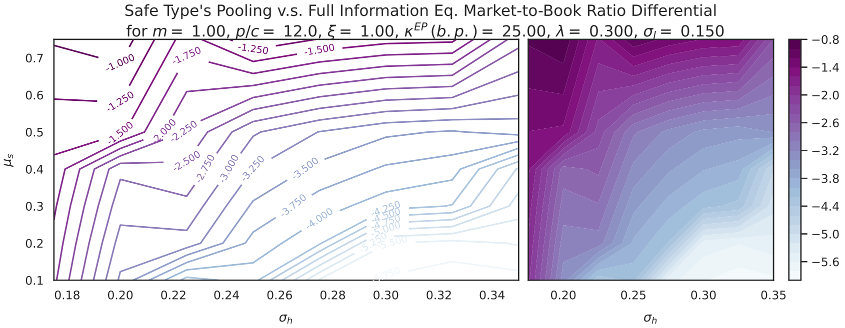
Pooling Payoffs

Safe Type's Firm Value Percentage Differential - fixed λ



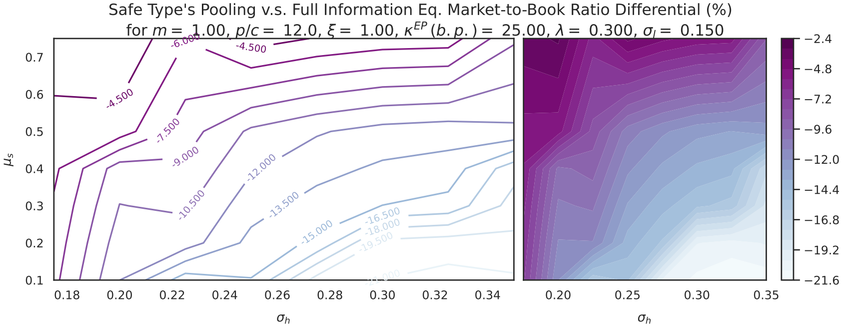
Pooling Payoffs

Safe Type's Market-to-Book Ratio Differential - fixed λ



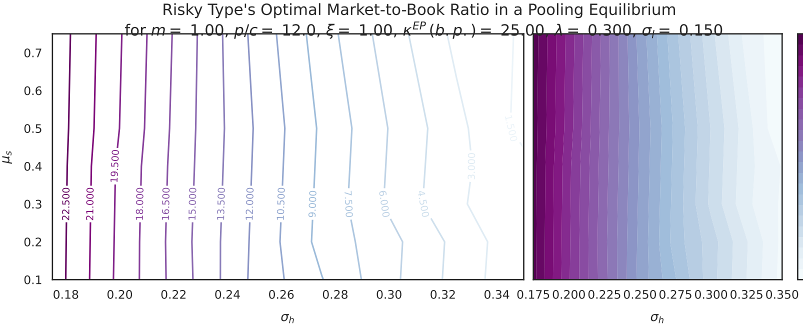
Pooling Payoffs

Safe Type's Market-to-Book Ratio Percentage Differential - fixed λ



Pooling Payoffs

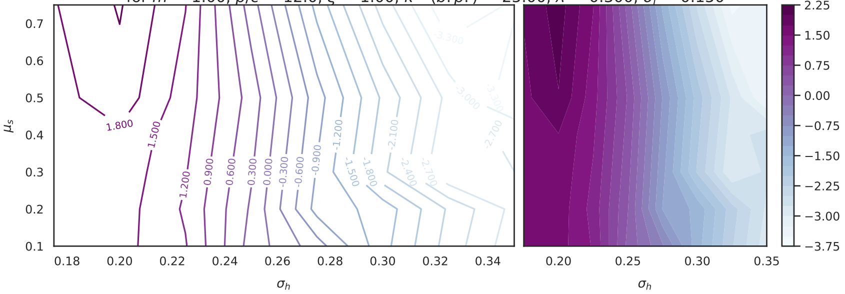
Risky Type's Market-to-Book Ratio - fixed λ



Pooling Payoffs

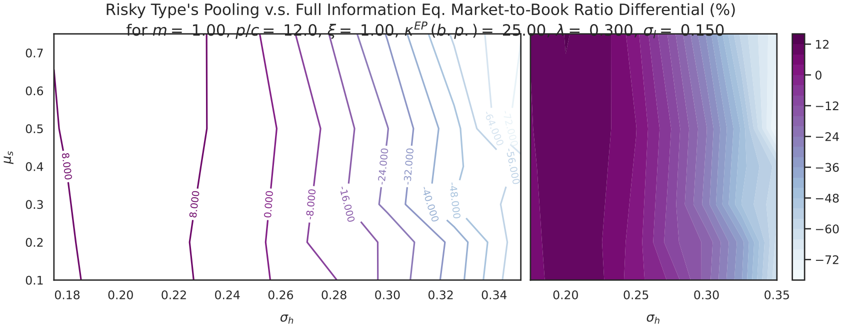
Risky Type's Market-to-Book Ratio Differential - fixed λ

Risky Type's Pooling v.s. Full Information Eq. Market-to-Book Ratio Differential
for $m=$ 1.00, $p/c=$ 12.0, $\xi=$ 1.00, $\kappa^{EP}(b.p.)=$ 25.00, $\lambda=$ 0.300, $\sigma_l=$ 0.150



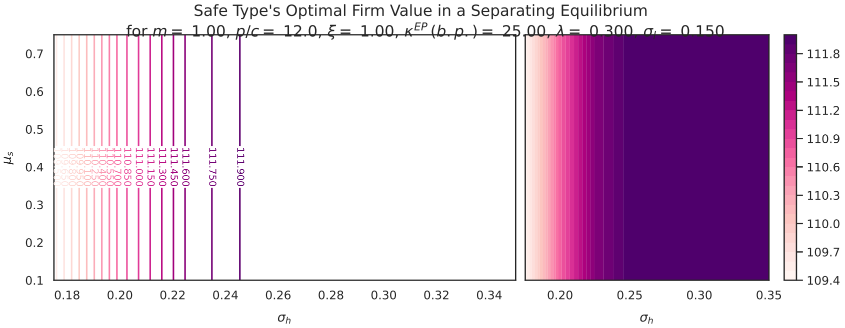
Pooling Payoffs

Risky Type's Market-to-Book Ratio Percentage Differential - fixed λ



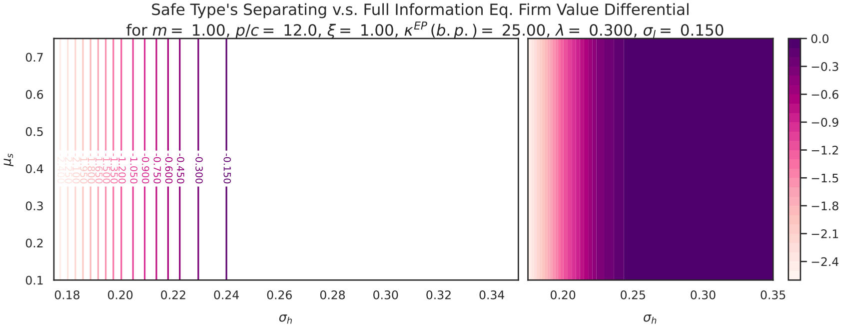
Separating Payoffs

Safe Type's Firm Value - fixed λ



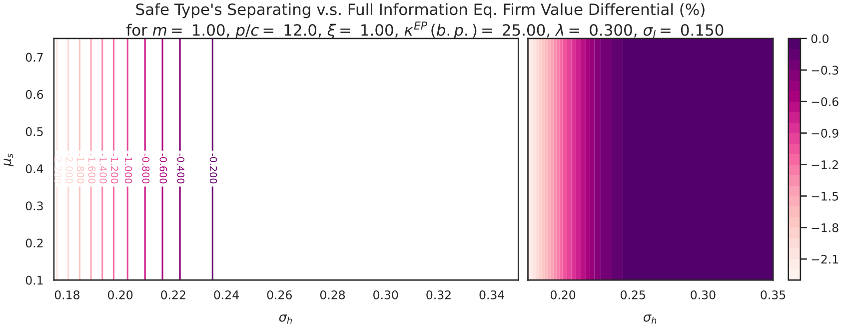
Separating Payoffs

Safe Type's Firm Value Differential - fixed λ



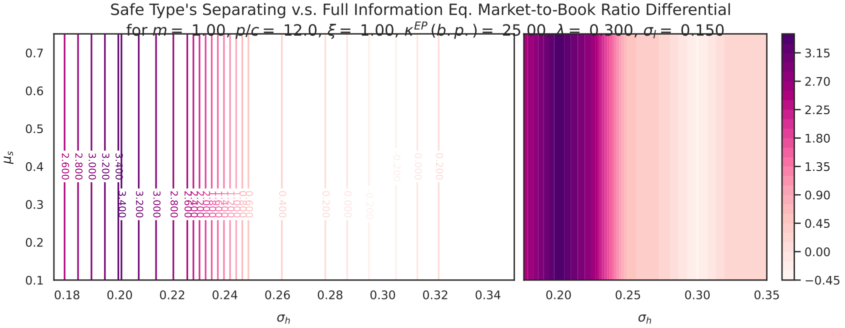
Separating Payoffs

Safe Type's Firm Value Percentage Differential - fixed λ



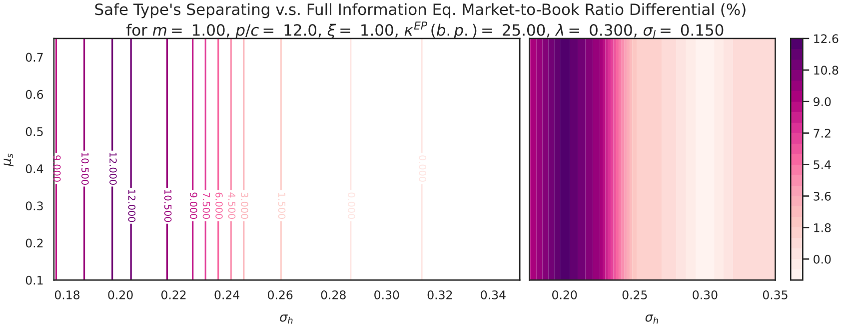
Separating Payoffs

Safe Type's Market-to-Book Ratio Differential - fixed λ



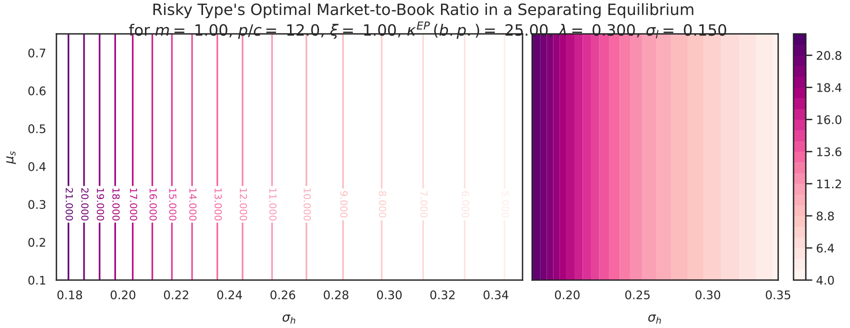
Separating Payoffs

Safe Type's Market-to-Book Ratio Percentage Differential - fixed λ



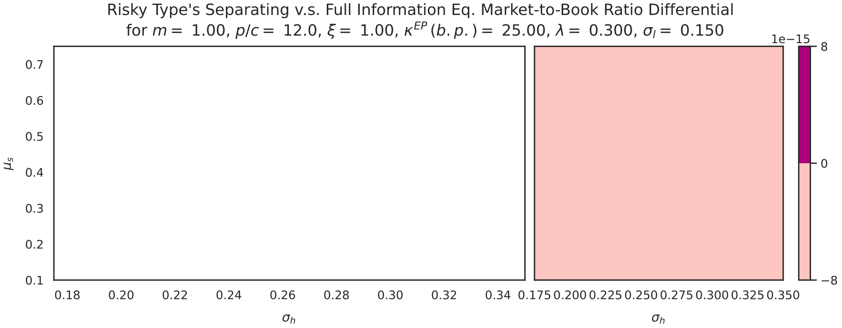
Separating Payoffs

Risky Type's Market-to-Book Ratio - fixed λ



Separating Payoffs

Risky Type's Market-to-Book Ratio Differential - fixed λ



Separating Payoffs

Risky Type's Market-to-Book Ratio Percentage Differential - fixed λ