Iceberg Orders

Optimal Hiding of Limit Orders

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Deutsche Bank

dbqpl quantitative products laboratory

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Trader's Question

- What is the optimal display size Δ^*?
- How much transaction costs can be saved?

Section 1

Outline

Section 2

Model

Model Set-Up

At $t_0 = 0$ trader places his Iceberg (N, Δ) at the best bid price B_0, observing initial depth D_{bid} (and imbalance I_0).

The Optimal Display Size

$$\Delta^* = \arg\min_{0 \le \Delta \le N} W(\Delta) \quad . \tag{1}$$

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- Absolute Execution Price $\widetilde{P} = V_T B_0 + (N - V_T) A_T$
- Execution volume V_T ; Terminal Best Ask A_T

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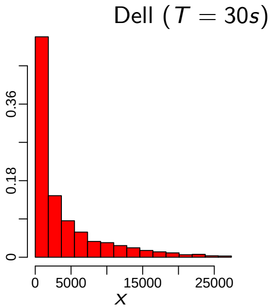
"Evidence" ⟶ Empirical Distributions



Subsection 3

Some Analytical Insights

Proposition (Execution Volume)

If $p \cdot \alpha, N > 0$, then

$$E[V_T \mid \Delta] = \alpha p(1 - \hat{\beta}_r) e^{-\frac{D(1-c)}{\alpha}} \left\{ \left(1 - e^{-\frac{\Delta}{\alpha}}\right) + (1 - \beta_r)(1 - \gamma_r)\left(e^{-\frac{\Delta}{\alpha}} - e^{-\frac{N}{\alpha}}\right) \right\} \tag{2}$$

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- $W(\Delta, \beta_r, \beta, A, \ldots) \stackrel{!}{=} (N - E[V_T \mid \Delta])(E[A_T \mid \Delta] - B_0)$
- $\alpha, \hat{\beta}_r, \ldots$ depend on the trader's Δ-choice.

Hiding and Display Thresholds

Proposition

Assume $A' > 0$. There are bounds $k, m > 0$, such that

$$N \geq k(\hat{\beta}_r, \beta_r, A, p, \ldots) \quad \Longrightarrow \quad \Delta_W^* = 0 \tag{3}$$

$$N \leq m(\hat{\beta}_r, \beta_r, A, p, \ldots) \quad \Longrightarrow \quad \Delta_W^* = N \tag{4}$$

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- When N sufficiently large, hide them all
- When N sufficiently small, show them all

Results on Optimal Display Sizes

Corollary

Assume $N, \alpha p > 0$.

$$\lim_{\frac{D}{\alpha}\to\infty} \Delta^* = \begin{cases} 0 & \textit{for} \quad \mathbf{A}' \geq 0 \\ N & \textit{else} \end{cases} \tag{5}$$

Corollary (Execution Price vs Execution Volume)

Let $\Delta^*_{\mathbf{V}}$, Δ^*_W *denote the optimal display size w.r.t. transaction price and volume. Assume* $\mathbf{A}' \geq \mathbf{0}$, *then*

$$\Delta^*_W \leq \Delta^*_{\mathbf{V}}. \tag{6}$$

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- Consistent with empirical literature (Bessembinder (2009)).

Market vs Priority Impact

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- Market term may **lower or increase** costs W depending on signs of $A', \beta_r', \hat{\beta}_r, p'$ ($\mathbf{A}(\Delta) := E[A_T \mid \Delta]$).

Absence of Market Penalty?

Corollary (Full Exposure)

Assume $A', \beta_r', \hat{\beta}_r, -\alpha', -p' < 0$ *("Absence of Market Penalty"). Then*

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- Check next slide.

Section 3

Model Calibration

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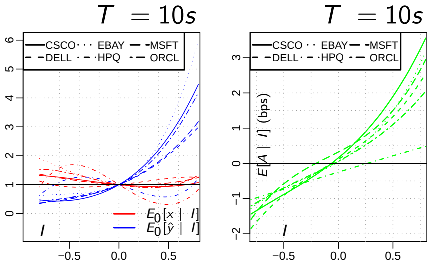

Figure: Imbalance-based Flow - and Price Impact

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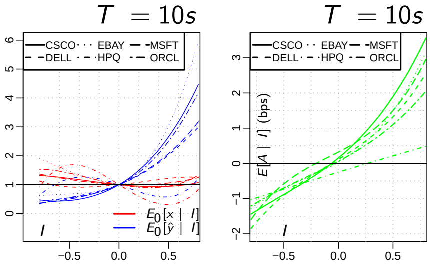

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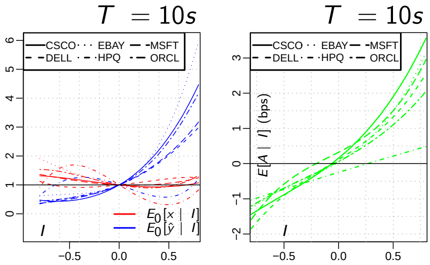

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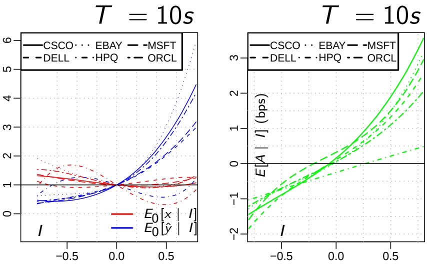

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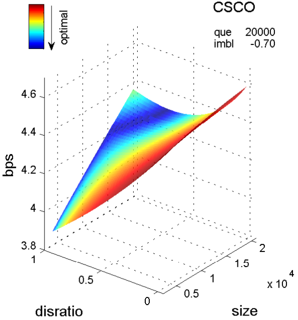
- $I(\Delta) = \frac{D_{bid}+\Delta-D_{ask}}{D_{bid}+\Delta+D_{ask}}$
- Harris' scenario: Presence of *Parasitic* trader's (1996)
- Use this to compute real market optimal display strategies.

Calibration Results: The Optimal Display Strategy



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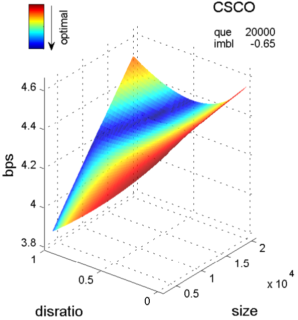

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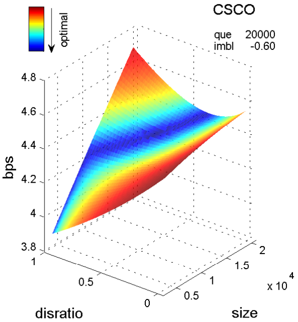

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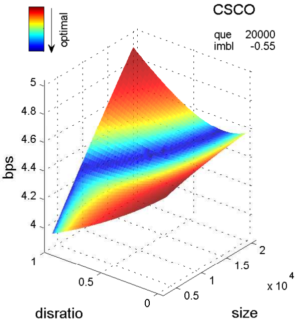

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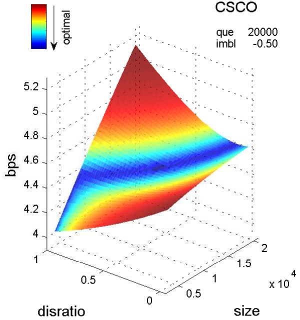

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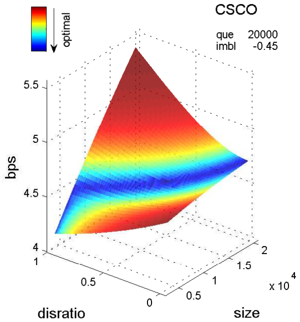

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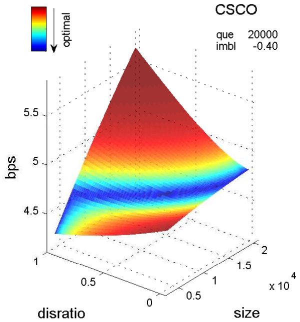

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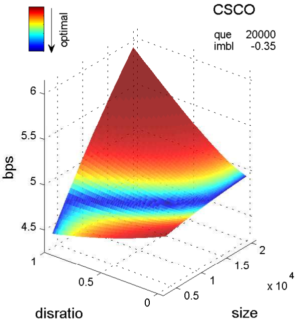

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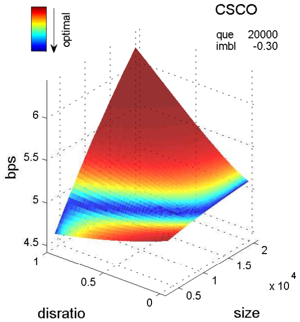

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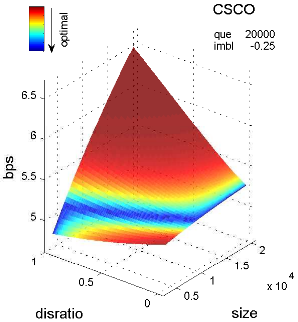

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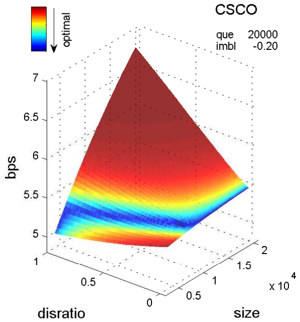

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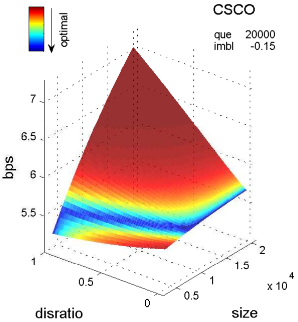

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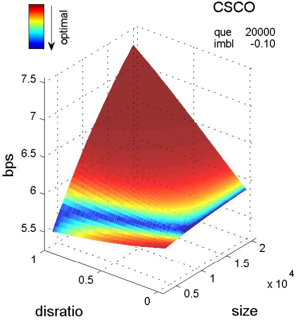

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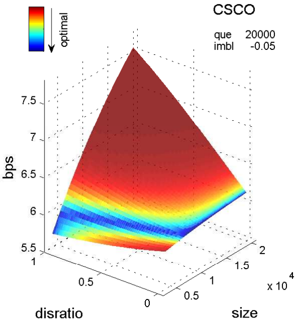

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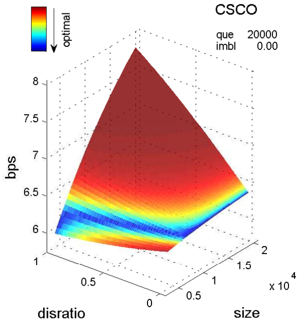

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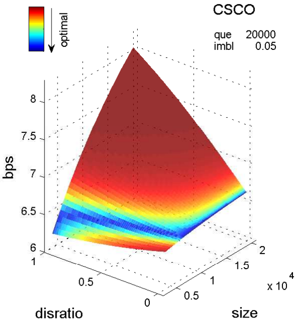

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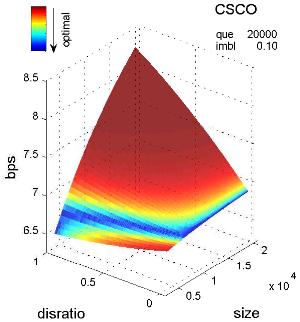

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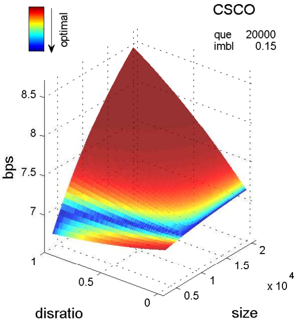

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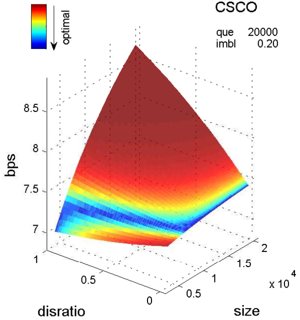

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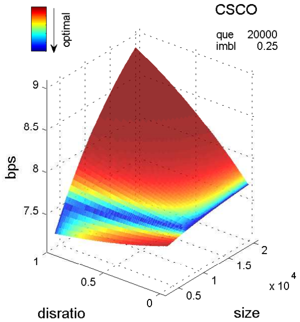

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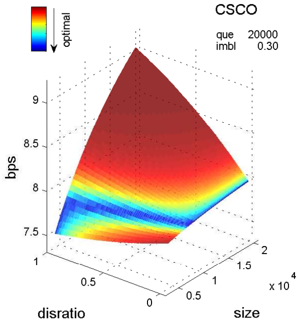

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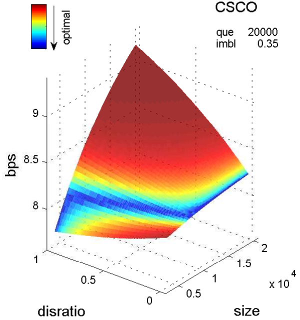

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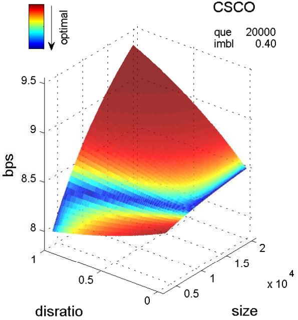
Calibration Results: The Optimal Display Strategy



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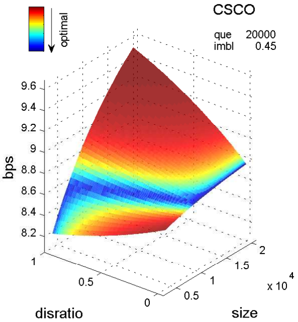

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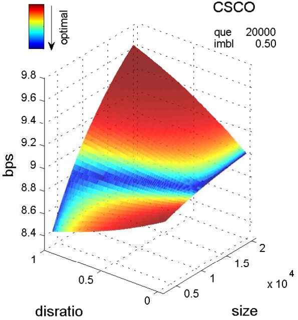

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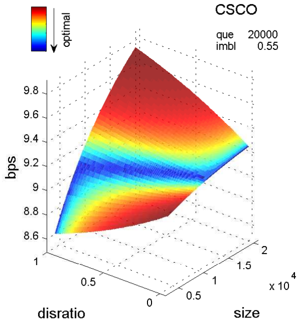

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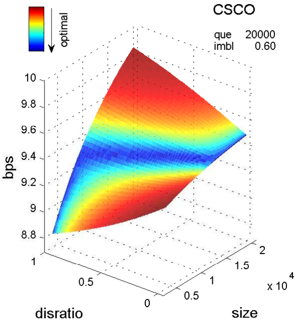

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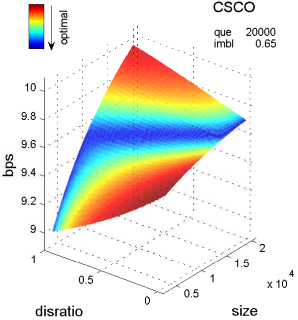

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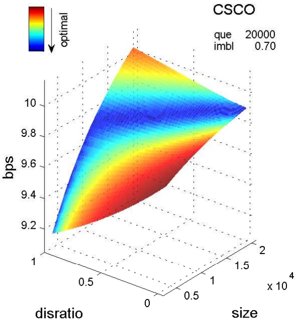

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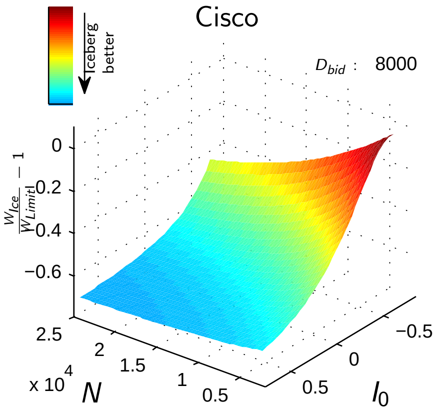
- $\frac{\Delta^*}{N}$ increases for large $|I_0|$

Calibration: Benchmark Test (Iceberg vs Limit Order)



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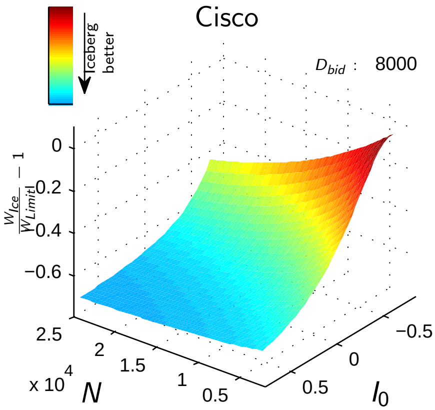

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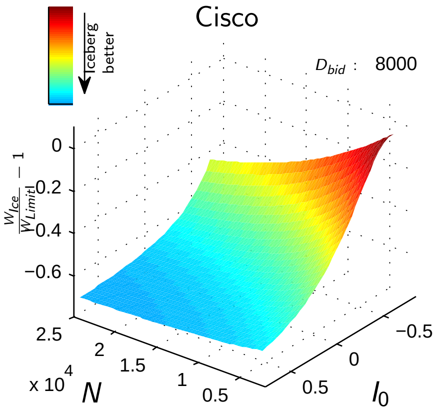

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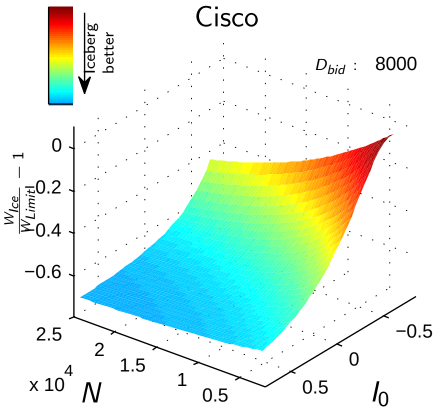

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  - for large order sizes ($N \gg 0$)
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- Up to 70% performance gain.

Conclusion

- Simple sequential trade model with minimal assumptions
- Providing Δ^*(numerical solution)
- Consistent with prior empirical research on *hidden* order submission strategies (Bessembinder,2009)
- Main-Feature: Priority-Gain vs Market Impact Loss
- Δ^*: Trade-Off between Market Impact and Priority-Gain
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  - At best bid: Hide more for "tight" stocks (there i's only marginal priority-gain!)
  - Optimal display ratio $\frac{\Delta^*}{N}$ decreases with N
  - Usage of Icebergs can significantly boost performance, particularly for large N and when initial imbalance on the same side ($I_0 \gg 0$)

Thank you !