# Block House Task

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**Question 1:** What's the motivation behind measuring OFI at multiple depth levels of the order book?

**Answer:**

The best-level OFI measures only the net order flow at the top of book:

$$\mathrm{OFI}_1(t) = \sum_{n \in (t-h,\, t]} \big[\Delta q_{1,b}^{(n)} \;-\; \Delta q_{1,a}^{(n)}\big].$$

However, imbalances deeper in the book (levels $m = 2, \ldots, 10$) also become price-sensitive once the top levels are cleared. By defining

$$\mathrm{OFI}_m(t) = \sum_{n \in (t-h,\, t]} \big[\Delta q_{m,b}^{(n)} \;-\; \Delta q_{m,a}^{(n)}\big], \quad m = 1, \ldots, 10,$$

and normalizing each by the average depth $Q^M(t)$, one captures the full supply–demand pressure across multiple levels. Empirically, including levels 2–10 steadily increases the variance explained in short-term price moves, providing a more complete picture of liquidity imbalances.

**Question 2:** Why do the authors use Lasso regression rather than OLS for estimating cross-impact?

**Answer:**

In the cross-impact model each stock's return

$$r_i(t) = \alpha_i + \sum_{j=1}^{N} \beta_{ij}\, \mathrm{OFI}_j^I(t) + \varepsilon_i(t),$$

has $N$ other assets' OFIs as predictors. When $N$ is large relative to sample size and predictors are highly correlated, ordinary least squares (OLS) overfits and yields unstable estimates. LASSO solves

$$\min_{\{\beta_{ij}\}} \sum_t \Big[r_i(t) - \alpha_i - \sum_j \beta_{ij}\, \mathrm{OFI}_j^I(t)\Big]^2 + \lambda \sum_{j=1}^{N} \big|\beta_{ij}\big|,$$

shrinking many $\beta_{ij}$ to zero. This enforces sparsity, improves out-of-sample stability, and highlights only the most significant cross-impact effects.

**Question 3:** Why is OFI considered a better predictor of short-term returns than trade volume?

**Answer:**

Trade volume aggregates only executed market orders:

$$\text{Volume}(t) = \sum_{n \in (t-h,\, t]} sizeoftrades_n,$$

whereas OFI combines *all* order-book changes:

$$\text{OFI}(t) = \sum_{n \in (t-h,\, t]} \Big( \Delta limit - adds_n - \Delta cancellations_n + \Delta trades_n \Big).$$

Cancellations and new limit orders alter the visible liquidity and often forecast imminent price moves—even without trades. Therefore, OFI captures the *net supply–demand pressure* driving short-term price changes more comprehensively than raw trade volume, leading to stronger contemporaneous correlations with returns.