MSc Thesis proposal

Integrating Cross-Impact and Cross-Correlation in High-Frequency Trading: A Case Study on FTSE MIB

Banca Sella Holding

Description:

Banca Sella is a leading Italian bank with a long-standing history of innovation and a strong regional and national presence. In its Financial Markets division, Sella Financial Markets, market-making strategies are developed as a foundation for executing high-frequency trading with precision and efficiency.

A novel market-making strategy, developed by the quantitative team of Sella Financial Markets, has recently been adopted by the equity trading desk. The algorithm determines the quoted prices for the constituent stocks of a market index by leveraging the prices of the futures contracts on the same index. The strategy has currently been built and testes on the FTSE MIB, an index comprising of the 40 most liquid and capitalized stocks listed on the Euronext Milan and Euronext MIV Milan markets, but it is adaptable to other contexts and market environments.

That said the pricing of stocks within the strategy requires enhancement. Specifically, the focus should be on developing a pricing mechanism that not only captures but also models the cross-impact of different order flows in equity markets and the cross-correlation among different financial products, all within the high-frequency realm. Both aspects are critical for improving the robustness and accuracy of the strategy.

Previous studies on stock price responses to individual trades primarily focused on single stocks. For instance, Lillo and Farmer [1] identified a power-law relationship between order size and price change, while authors in [2] demonstrated that the relationship could also be expressed logarithmically. These two approaches, although different in formulation, are mathematically equivalent. However, since our market-making strategy involves trading across multiple components of a market index simultaneously, it is essential to account for cross-impact effects.

Cross-impact refers to the phenomenon where the purchase (or sale) of one financial instrument leads to an average increase (or decrease) in the prices of other correlated assets. As suggested in [3], understanding and modeling cross-impact is pivotal for accurately estimating trading costs in a multi-asset context. Further exploration in [4] compares parametric and non-parametric models of cross-impact, evaluating their robustness across diverse scenarios. Meanwhile, in [5], a parametric approach is employed to analyze how stocks respond to broader market movements and sector-specific dynamics. These studies provide essential insights into constructing a more effective pricing mechanism.

At the same time, cross-correlation offers valuable complementary information. As a statistical measure, cross-correlation quantifies how one time series relates to a lagged version of another. By examining the lead-lag relationships between futures contracts on an

index and the constituent stocks of that index, we can derive predictive relationships within the high-frequency domain. For instance, the ability to identify whether futures prices lead or lag stock prices is instrumental in developing predictive models. In [6], various methods for constructing cross-correlation matrices from high-frequency trading data are compared, providing useful techniques for analyzing such relationships.

Research questions:

- Which market impact models from the literature are best suited for pricing the stocks that make up the FTSE MIB index? What criteria and metrics should we consider when selecting one model over another?
- How can we measure high-frequency cross-correlation?
- How can we utilize these findings to develop a pricing mechanism for the stocks that constitute the FTSE MIB index?
- Can we utilize other index futures (i.e. on euro stoxx 50) to improve our pricing or in general the strategy performance?

Literature:

[1] Lillo, F., & Farmer, J. D. (2004). The long memory of the efficient market. *Studies in nonlinear dynamics & econometrics*, *8*(3).

[2] Bouchaud, J. P., Gefen, Y., Potters, M., & Wyart, M. (2003). Fluctuations and response in financial markets: thesubtle nature ofrandom'price changes. *Quantitative finance*, *4*(2), 176.

[3] Benzaquen, M., Mastromatteo, I., Eisler, Z., & Bouchaud, J. P. (2017). Dissecting cross-impact on stock markets: An empirical analysis. *Journal of Statistical Mechanics: Theory and Experiment*, *2017*(2), 023406.

[4] Tomas, M., Mastromatteo, I., & Benzaquen, M. (2022). How to build a cross-impact model from first principles: Theoretical requirements and empirical results. *Quantitative Finance*, *22*(6), 1017-1036.

[5] Wang, S., Schäfer, R., & Guhr, T. (2015). Price response in correlated financial markets: empirical results. *arXiv preprint arXiv:1510.03205*.

[6] Precup, O. V., & Iori, G. (2004). A comparison of high-frequency cross-correlation measures. *Physica A: Statistical Mechanics and its Applications*, *344*(1-2), 252-256.

Other Relevant Literature:

[7] Avellaneda, M., & Stoikov, S. (2008). High-frequency trading in a limit order book. *Quantitative Finance*, *8*(3), 217-224.

[8] Bouchaud, J. P., Mézard, M., & Potters, M. (2002). Statistical properties of stock order books: empirical results and models. *Quantitative finance*, *2*(4), 251.