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Econometric models of limit-order executions ☆

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Abstract

We develop and estimate an econometric model of limit-order execution times using survival analysis and actual limit-order data. We estimate versions for time-to-first-fill and time-to-completion for both buy and sell limit orders, and incorporate the effects of explanatory variables such as the limit price, limit size, bid/offer spread, and market volatility. Execution times are very sensitive to the limit price, but are not sensitive to limit size. Hypothetical limit-order executions, constructed either theoretically from first-passage times or empirically from transactions data, are very poor proxies for actual limit-order executions.

JEL classification: G23

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1. Introduction

One of the most important tools for trading equity securities is the limit order, which is an order to transact a prespecified number of shares at a prespecified price. Indeed, limit orders constitute a significant fraction of stock market trading activity, accounting for approximately 45% of total NYSE orders (Harris and Hasbrouck, 1996). The primary advantage of a limit order is the absence of price risk—a transaction occurs only if the *limit price* is attained. However, this advantage does not come without a cost: execution is not guaranteed, and the time-to-execution is a random function of many factors, such as the limit price, the number of shares, market conditions, and private information. For some trades, the uncertainty in execution time is unimportant, but for others, the opportunity cost of waiting can be significant.

If immediacy is critical, the market order is the appropriate instrument to use. However, market orders can be subject to significant price risk, particularly for large orders and in volatile markets. In practice, traders submit both market and limit orders, with an eye towards balancing the risks of delaying execution against the risks associated with immediate execution.[1] A prerequisite for any quantitative approach to making such tradeoffs is an econometric model of limit-order execution times and the associated execution probabilities.

Limit orders play another important role in determining trading costs: they influence bid/offer quotes and, therefore, spreads. Chung et al. (1997) estimate that 21% of the quotes in their sample originate from limit orders on both the bid and offer sides without any direct participation from the specialist. Therefore, limit-order execution times affect the frequency with which quotes are updated and are likely to be a major factor in the dynamics of bid/offer spreads. Moreover, limit-order execution times have been used to measure the overall quality of equity markets (e.g., Battalio et al., 1999; SEC, 1997), hence their determinants can have important implications for the economic consequences of market fragmentation, the practice of "preferencing", and the relative merits of specialist vs. multiple-dealer market structures.

In this paper, we propose and estimate an econometric model of limit-order execution times using actual historical limit-order data. Using survival analysis, which is a well-known statistical technique for modeling failure times and other nonnegative random variables, we are able to estimate the conditional distribution of limit-order execution times as a function of economic variables such as the limit price, order size, and current market conditions. Because limit-order execution times can be interpreted quite naturally as failure times—they are nonnegative, random, and temporally ordered—survival analysis is the most appropriate method for modeling their evolution.

[1] See, for example, Cohen et al. (1981), O'Hara and Oldfield (1986), Glosten (1989, 1994), Easley and O'Hara (1991), Parlour (1998), Chakravarty and Holden (1995), Keim and Madhavan (1995), Belonsky (1996), Harris and Hasbrouck (1996), Kavajecz (1998), Rock (1996), and Seppi (1997).