An order book approach to the price impact function

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The price impact function describes the relation between the number of stocks bought or sold in a given time interval and the price change caused by these trades. Usually the price impact function is calculated from information about prices and quotes. The quotations allow to determine whether a given transaction was buyer or seller initiated and in this way allow to determine the number of excess buy or sell orders and the impact of trading on the stock price. There have been several works investigating its properties, finding evidence for nonlinearity as described by a square root or a logarithm [1, 2]. In order to understand the mechanism behind price impact one needs to analyze the order book, which contains not only the current bid and ask price but complete information about supply and demand away from the current stock price. The specific form of the price impact function was suggested to originate in the humped shape of the average order book, which was found in empirical data [3] and modelled theoretically [4].

We present an order book based mechanism that quantitatively explains the functional form of the price impact function as calculated from trades and quotes information. We find that both information about static properties of the average order book and dynamic properties of the average order flow and its reaction to price changes are necessary for an explanation of the price impact function. We analyzed all limit and market orders from the Island ECN order book (NASDAQ's largest electronic communications network) for the ten most frequently traded companies in the year 2002.

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