MAR07-2006-000171

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Using behavioral statistical physics to understand supply and demand[1]

DOYNE FARMER, Santa Fe Institute

We construct a quantitative theory for a proxy for supply and demand curves using methods that look and feel a lot like physics. Neoclassical economics postulates that supply and demand curves can be explained as the result of rational agents selfishly maximizing their utility, but this approach has had very little empirical success. We take quite a different approach, building supply and demand curves out of impulsive responses to not-quite-random trading fluctuations. Because of reasons of empirical measurability, as a good proxy for changes in supply and demand we study the aggregate price impact function $R(V)$, giving the average logarithmic price change R as a function of the signed trading volume V. (If a trade v_i is initiated by a buyer, it has a plus sign, and vice versa for sellers; the signed trading volume for a series of N successive trades is $V_N(t) = \sum_{i=t}^{i=t+N} v_i$). We develop a "zero-intelligence" null hypothesis that each trade v_i gives an impulsive kick $f(v_i)$ to the price, so that the average return $R_N(t) = \sum_{i=t}^{i=t+N} f(v_i)$. Under the assumption that v_i is IID, $R(V_N)$ has a characteristic concave shape, becoming linear in the limit as $N \to \infty$. Under some circumstances this is universal for large N, in the sense that it is independent of the functional form of f. While this null hypothesis gives useful qualitative intuition, to make it quantitatively correct, one must add two additional elements: (1) The signs of v_i are a long-memory process and (2) the return R is efficient, in the sense that it is not possible to make profits with a linear prediction of the signs of v_i. Using data from the London Stock Exchange we demonstrate that this theory works well, predicting both the magnitude and shape of $R(V_N)$. We show that the fluctuations in R are very large and for some purposes more important than the average behavior. A computer model for the fluctuations suggests the existence of an equation of state relating the diffusion rate of prices to the flow of trading orders.

[1]In collaboration with Austin Gerig and Fabrizio Lillo. Work supported by Barclays Bank.