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A battle of informed traders and the market game foundations for rational expectations equilibrium

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ABSTRACT

Potential manipulation of prices and convergence to rational expectations equilibrium is studied in a game without noise traders. Informed players with initially long and short positions (bulls and bears) seek to manipulate consumer expectations in opposite directions. In equilibrium, period 1 prices reveal the state, so manipulation is unsuccessful. Bears and uninformed consumers sell up to their short-sale limits in period 1. Bulls buy in period 1 but receive arbitrage losses. When the number of bulls and bears approaches infinity, the equilibrium converges to the REE. Without short-sale constraints there is a non-revealing equilibrium but no revealing equilibrium.

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1. Introduction

Manipulation of prices by agents with superior information is often thought to be both profitable to the individual and damaging to society. One classic example of price manipulation occurs when an agent ultimately wants to sell a commodity, but first buys in an attempt to influence the price at which she can sell in the future. However, it is difficult to capture such manipulation in a model in which the price formation process is explicit and all agents are fully rational. Auction models can be difficult to work with if buyers at one stage become sellers at another stage. Demand-curve submission games hold promise, but so far the models are either static or assume the presence of noise traders.[2] The present paper adopts a two-period Shapley–Shubik strategic market game. We reach the surprising conclusion that an informed trader may be unable to profitably manipulate prices when all agents are rational. Indeed, an informed trader may be at a disadvantage relative to uninformed traders. As a by-product of our analysis, we show that as the number of informed traders approaches infinity, the equilibrium allocation converges to what would obtain in a fully-revealing Rational Expectations Equilibrium (REE).

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[2] Vives (2011a, 2011b) offers an interesting and sophisticated analysis of a supply-function submission game. The model is static, and therefore not suited to the study of the type of situation in which an agent buys or sells at one stage, and then unwinds her trade at a later stage. Cespa and Vives (2012) study a dynamic trading model containing noise traders.

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In the market game model studied here, the same two goods are traded on two consecutive spot markets, where agents only care about their final holdings. Good y is the numeraire good, which can be thought of as money, and good x is the good whose price is being manipulated, which can be thought of as shares of stock in some firm. There is a continuum of consumers or small traders who are modeled as players in the game, and there is a finite number of large traders who value only the numeraire good. Some large traders are "bulls," who are endowed with a positive position in good x, and benefit from being able to sell their endowment at a high price. Other large traders are "bears," who are endowed with a negative position in good x, and benefit from a low price. Large traders observe the state of nature θ, drawn from a continuous distribution, but ordinary consumers are uninformed. We impose short-sale constraints and show that in a fully revealing equilibrium, the unconstrained traders (bulls) are at a disadvantage. Bulls purchase good x in period 1 in an attempt to manipulate the price and thereby manipulate the inferences of ordinary consumers. Still, the period 1 price in state θ, $p^1(\theta)$, reveals the state and the period 2 price in state θ, $p^2(\theta)$, is what would prevail in a fully revealing REE, so consumers are not fooled in equilibrium. However, $p^1(\theta) > p^2(\theta)$ always holds, so the bulls lose money on the round trip transaction of buying in period 1 and then selling in period 2. The bears and uninformed consumers sell up to their short-sale limits in period 1, and make arbitrage profits as a result.

Here is the intuition for why the bulls are willing to purchase good x in period 1. If a bull decided not to purchase, consumers would see a lower p^1 and infer that the state is lower than it actually is, resulting in a lower p^2. Thus, the bull avoids losing money on the round trip transaction of buying in period 1 and selling in period 2, but he reduces the money he receives from selling his endowment in period 2. As it turns out, these effects offset, so the bull's purchase in period 1 is optimal.

Consider a sequence of games in which the short sale constraint approaches infinity, in the sense that larger and larger short sales are allowed. Then in the sequence of fully revealing equilibria we construct, each bear's short sale constraint is binding everywhere along the sequence, so the quantity sold by each bear in period 1 approaches infinity. The quantity purchased by each bull in period 1 also approaches infinity. However, the limiting strategy profile with infinite bids and offers is not well defined and cannot constitute an equilibrium for the game without short sale constraints. Intuitively, the resulting battle between bulls and bears attempting to manipulate the market in opposite directions would lead each side to try to outleverage the other, with no fully revealing equilibrium possible.

What would happen if bears were not subject to short-sale constraints? Besides the fully revealing REE, the competitive economy has a rich set of partially revealing REE and a completely non-revealing REE. Without short-sale constraints, the market game has an equilibrium that implements the non-revealing REE allocation. If consumers believe that the period 1 price reveals nothing about the state, then there is no incentive for informed traders to try to manipulate the price. In equilibrium, the bulls and bears refrain from trading in period 1, and the price in each period equals the non-revealing REE price.[3]

Noise trader models have been used extensively in the finance literature. Noise trading refers to exogenously specified trading, usually independent of prices, but there is disagreement in the literature as to whether noise traders should be interpreted as irrational or constrained by liquidity needs. It is a tautology that any noise trader model can be recast as a model with fully rational but constrained traders. However, the constraints are usually implicit, with the utility maximization problems faced by these constrained traders rarely modeled formally. More importantly, the constraints implicitly assumed in the finance literature are very special. "Liquidity traders" choose their trade in a given period independently of their previous trades, any fundamental information, and (in many cases) prices. As a result, noise traders, whether irrational or rational but constrained, are set up to absorb losses and provide profit opportunities for other traders in the model. By modeling traders as rational with explicitly specified constraints, it becomes apparent that a wide range of new and interesting structures could be studied, yielding new outcomes. In the present paper, there are no liquidity traders in the sense of being constrained to trade in any one period. However, bulls and bears receive no utility from consumption of good x, and act as if they are constrained to close out their positions by the end of period 2. Although we can consider bulls and bears to be constrained to close out their positions, the constraints act over two periods and are affected by fundamental information. The main model also imposes short sale constraints, but these are again very different from the constraints implicit in noise trader models. Bulls and bears want to push consumer beliefs in opposite directions, and short sale constraints allow prices to be revealing with neither side having an incentive to deviate, since one side is already at a corner. Unlike any of the noise trader models, bears actually benefit from being constrained, and *uninformed* consumers succeed in selling high and buying low. Also, it is important to note that we consider pure strategy equilibria in which the magnitude of the "noise" is zero.

In Section 2, we discuss the relevant literatures. Section 3 presents the model with short-sale restrictions, and contains the equilibrium construction and result on convergence to REE. Section 4 contains the result of nonexistence of fully revealing equilibrium for the model without short-sale restrictions. Section 5 considers partially revealing and non-revealing equilibria. Section 6 works out an example in which consumers are noise traders with exogenously given bids and offers. In contrast to our main model, bulls and bears now make profits at the expense of consumers, resembling the results of other standard noise trader models. Section 7 offers some concluding remarks. Proofs are given in Appendix A.

[3] With short sale constraints, the non-revealing and partially revealing REE allocations obtain as an equilibrium allocation in the game, as the number of bears and bulls approaches infinity. Without short sale constraints, my conjecture is that the non-revealing REE is the only REE whose allocation is obtainable in an equilibrium of the market game.

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