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## Inference, arbitrage, and asset price volatility<sup>☆</sup>

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### ABSTRACT

Does the presence of arbitrageurs decrease equilibrium asset price volatility? I study an economy with arbitrageurs, informed investors, and noise traders. Arbitrageurs face a trade-off between “inference” and “arbitrage”: they would like to buy assets in response to temporary price declines—the arbitrage effect—but sell when prices decline permanently—the inference effect. In equilibrium, the presence of arbitrageurs increases volatility when the inference effect dominates the arbitrage effect. From a technical point of view, the paper offers closed form solutions to a dynamic equilibrium model with asymmetric information and non-Gaussian priors.

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### 1. Introduction

The importance of hedge funds as financial intermediaries has been growing in recent years. This growth of importance is primarily due to the increased size of hedge fund assets under management and the increased share of hedge funds’ trading volume in many financial assets. In addition, capital allocated to quantitative trading strategies within the hedge fund sector has been rising. In this paper, I interpret hedge funds that employ quantitative trading strategies as arbitrageurs that trade aggressively on publicly available information, and ask whether their presence increases or decreases equilibrium asset price volatility.

I assume that arbitrageurs are unconstrained, infinitely lived, and risk neutral. Arbitrageurs trade against agents that have more information, an assumption that captures the growing importance of quantitative arbitrageurs who focus on the processing of publicly available information. Arbitrageurs’

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priors about the fundamental growth rates of assets are non-Gaussian, an assumption leading to richer pricing dynamics than the Gaussian set-ups of Wang (1993) and Vives (1994).

In the model, arbitrageurs exploit temporary deviations of prices from their fundamental value due to noise traders. The principal difficulty for arbitrageurs is to distinguish temporary from permanent shocks. In the absence of arbitrageurs, the presence of noise traders causes the equilibrium price to be predictable, presenting profit opportunities. Under complete information, the presence of arbitrageurs leads unambiguously to lower volatility of asset returns.

When arbitrageurs have limited information, their presence might increase or decrease equilibrium asset price volatility and the trading strategy of arbitrageurs can be upward-sloping in prices. Intuitively, arbitrageurs face a trade-off between an “inference effect” and an “arbitrage effect.” When prices increase, arbitrageurs have an incentive to sell the risky asset as it becomes more expensive (holding constant the beliefs about the asset’s fundamental value). This is the arbitrage effect. However, a higher price also makes it more likely that future payoffs are higher, which leads to an updating of beliefs. This is the inference effect. When the inference effect dominates the arbitrage effect, the arbitrageurs asset holdings can be upward sloping in prices, and the presence of arbitrageurs can increase equilibrium price volatility.

The sensitivity of asset holdings with respect to price depends on the forecast error of arbitrageurs about the fundamental value of assets. When the forecast error is small, arbitrageurs are relatively certain about the long-run growth rate of the risky asset’s fundamentals, so that their trading strategy is downward-sloping and relatively insensitive to prices (they become contrarian investors). However, when the forecast error is large, an upward movement in prices can lead to a strong updating of their priors. As a result, the volatility of price changes is higher than it would be in the absence of arbitrageurs. Small disturbances make prices move very strongly in ranges of the price where the forecast error is large. When prices are very low or very high, the forecast error is small, not much is learned from new information, and the price reacts little to either noise or news.

The rest of the paper is organized as follows. The next Section 2 discusses related literature in more detail. In Section 3, I show that the presence of arbitrageurs unambiguously decreases asset price volatility in the benchmark economy with perfect information. In Section 4, it is assumed that there is a permanent shock to the drift of the dividend process at time 0 that is unobserved by arbitrageurs, leading to the possibility that the presence of arbitrageurs increases equilibrium price volatility. Section 5 concludes. All of the proofs are in Appendix A.

## 2. Related literature

In the literature on equilibrium pricing with asymmetric information, the current paper is most closely related to Wang (1993) and Vives (1994). Wang studies an economy with informed and uninformed investors as well as noise traders. As in Grossman and Stiglitz’s (1980) static setting, noise traders prevent prices from being fully revealing in Wang’s setting. In Wang (1993), all shocks and priors are Gaussian, so that the equilibrium can be solved in closed form with infinitely lived agents. In the current paper, priors are non-Gaussian, and closed form solutions require the assumption that informed investors are short-lived (i.e. they do not hedge the stochastic investment opportunity set). A similar assumption is made in Vives (1994), who examines equilibrium pricing in an economy with a non-hierarchical information structure (investors have differential information setting in Vives, but hierarchical information in Wang and this paper).

The result that the presence of arbitrageurs can lead to higher price volatility under some circumstances addresses the old question in finance whether speculation is stabilizing or destabilizing. Friedman (1953) argues that rational speculation generally reduces price volatility, whereas Hart and Kreps (1986) give a simple example that shows how speculation can destabilize prices.

In the case of perfect information, the model presented here is similar to DeLong et al. (1990a). As in DeLong et al. (1990a), investors are myopic and noise is priced. The first section of the paper shows that the introduction of risk-neutral, infinitely lived arbitrageurs into the (continuous time analogue) of DeLong et al. (1990a) noise trader economy stabilizes prices, as long as the arbitrageurs know the full structure of the model. However, when arbitrageurs have to learn about the drift of the dividend process, this result no longer holds: the present paper shows that volatility of returns can actually

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