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## Does ambiguity aversion survive in experimental asset markets?<sup>☆</sup>

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### ABSTRACT

Although a number of theoretical studies explain empirical puzzles in finance with ambiguity aversion, it is not a given that individual ambiguity attitudes survive in markets. In fact, despite ample evidence of ambiguity aversion in individual decision making, most studies find no or only limited ambiguity aversion in experimental financial markets, even when they exclude arbitrage. We argue that ambiguity effects in markets depend on market feedback and on a sufficiently strong bias toward ambiguity among the participants. Accordingly, we find significant ambiguity effects in low-feedback call markets for assets that provoke high ambiguity aversion, but no ambiguity effects in high-feedback double auctions.

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## 1. Introduction

Many real-life decisions are characterized by ambiguity, in which we lack important information such as the objective probabilities of the relevant states. [Keynes \(1921\)](#) proposed a simple thought experiment to illustrate the effects of ambiguity.

Imagine “[...] the two cases following of balls drawn from an urn. In each case we require the probability of drawing a white ball; in the first case we know that the urn contains black and white in equal proportions; in the second case the proportions of each color is unknown, and each ball is as likely to be black as white. It is evident that in either case the probability of drawing a white ball is 1/2, but that the weight of the argument in favor of this conclusion is greater in the first case.” ([Keynes, 1921](#), chapter VI.6)<sup>1</sup>

[Ellsberg \(1961\)](#) used this experimental design, commonly referred to as the ‘2-color Ellsberg urn’ to show that a preference for the risky urn (with measurable probabilities) over the ambiguous urn (with immeasurable probabilities) violates the Subjective Expected Utility Theory and the Sure-thing Principle of the Savage axioms ([Savage, 1954](#)). Since then a large body

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<sup>1</sup> [Keynes \(1921\)](#) did not use the term ambiguity. Instead, he referred to ‘the weight of arguments’, but was not sure about this concept. In fact, at the beginning of the chapter VI he writes: “[A]fter much consideration I remain uncertain as to how much importance to attach to it” ([Keynes, 1921](#), chapter VI.1)

of individual choice experiments have confirmed that, on average, decision makers are 'ambiguity averse' when confronted with the above-quoted choice.<sup>2</sup> In a recent survey of the experimental literature, [Trautmann and Van De Kuilen \(2013\)](#) conclude that "there is clear evidence that on the average, and across various elicitation methods, ambiguity aversion is the typical qualitative finding."

Ambiguity aversion is a possible cause for a number of empirical puzzles in financial economics, which expected utility theory would consider to be (behavioral) anomalies. After the development of several non-expected utility models of individual decision making that considered ambiguity attitudes (e.g., [Gilboa and Schmeidler, 1989](#); [Ghirardato et al., 2004](#); [Klibanoff et al., 2005](#); [Nau, 2006](#)), a growing number of theoretical papers incorporated ambiguity aversion into market models to explain long-standing anomalies in finance, like the equity premium puzzle ([Epstein and Wang, 1994](#); [Maenhout, 2004](#); [Cao et al., 2005](#); [Leippold et al., 2008](#)), portfolio inertia ([Epstein and Wang, 1994](#); [Illeditsch, 2011](#)), the familiarity bias and the home bias in investments ([Uppal and Wang, 2003](#); [Huang, 2007](#); [Cao et al., 2011](#)), amplification effects ([Routledge and Zin, 2009](#); [Guidolin and Rinaldi, 2010](#); [Illeditsch, 2011](#)), and asymmetric reactions to good and bad news ([Epstein and Schneider, 2008](#); [Epstein et al., 2010](#); [Illeditsch, 2011](#)).

Yet, it is not a given that ambiguity aversion found in individual decision making arises and even survives when market forces are at work. In markets, decisions are no longer independent as they are subject to market feedback from other traders. According to the efficient market hypothesis (henceforth EMH, [Fama, 1970](#)), market mechanisms and incentives should eliminate or at least reduce behavioral biases and non-expected utility behavior, including ambiguity aversion ([Camerer, 1987](#)). In fact, despite the burgeoning theoretical literature and the promising explanatory potential of ambiguity aversion, no experimental study has provided definite evidence of ambiguity aversion in experimental asset markets (see Section 2.1).

This study attempts to shed some light on the underlying reasons for the discrepancy between ambiguity effects in individual decision making and experimental asset markets.<sup>3</sup> In doing so we propose and test an experimental setup in which we give ambiguity effects ample room to survive market forces. In our search for possible underlying reasons, we start with the conditions of the EMH under which (efficient) market forces can eliminate ambiguity effects. The EMH rests on three, progressively weaker conditions, any one of which will lead to market efficiency: (i) full rationality, (ii) independent deviations from rationality, and (iii) arbitrage ([Shleifer, 2003](#)). We reformulate these three conditions for market efficiency under ambiguity as follows: either (i) all market participants are ambiguity neutral; or if (i) does not hold, (ii) a symmetric distribution of ambiguity attitudes around ambiguity neutrality offsets the influence of ambiguity-averse and ambiguity-seeking market participants; or if both (i) and (ii) do not hold, (iii) ambiguity-neutral traders take full advantage of arbitrage opportunities.

Condition (i) can be ruled out by clear experimental evidence that individuals frequently violate ambiguity neutrality (see Section 2). In many experiments, condition (iii) also does not apply because even in the absence of arbitrage opportunities ambiguity aversion did not survive in experimental asset markets (see Section 2.1). However, in support of condition (ii), a number of recent studies have found that the distribution of ambiguity attitudes is often quite symmetric around neutrality ([Halevy, 2007](#); [Corgnet et al., 2013](#)) including ambiguity seekingness (e.g., [Einhorn and Hogarth, 1985](#); [Kahn and Sarin, 1988](#); [Curley and Yates, 1989](#)) and a large percentage of people with highly inconsistent behavior under ambiguity ([Charness et al., 2013](#)). In this paper, we therefore focus on condition (ii) for two possible explanations of the empirical phenomenon that ambiguity effects are rarely found in experimental asset markets.

For our first explanation, the group of people with inconsistent ambiguity attitudes is of special interest. Experimental evidence on group behavior and feedback shows that ambiguity neutrality has a 'persuasive edge' with a tendency to de-bias ambiguity-seeking and ambiguity-averse individuals ([Charness et al., 2013](#); [Keck et al., 2014](#)). Market participants also use market prices to update heterogeneous beliefs ([Banerjee, 2011](#)) and to coordinate price forecasts ([Hommel, 2011](#)). We therefore conjecture that continuous market feedback may de-bias participants with inconsistent ambiguity attitudes and may serve as a reason why ambiguity aversion is rarely observed in experimental asset markets. To test our hypothesis on market feedback we compare the ambiguity premium, i.e., the price difference between the risky asset and the ambiguous asset between two market institutions: a continuous open-book double auction with a high level of intra-period market feedback and a call market without any intra-period market feedback.<sup>4</sup> Note that the current literature primarily administers double auction markets. We suggest that this market institution provides sufficient feedback to wash out ambiguity effects.

Our second explanation builds on evidence that ambiguity attitudes are very heterogeneous and that the bias of the distribution toward ambiguity aversion is, even in individual decision making, not very strong and is sometimes close to neutral ([Trautmann and Van De Kuilen, 2013](#)). Based on the divergence of opinions literature, which posits that optimists determine asset prices even if they are in the minority ([Miller, 1977](#)), it is possible that the average bias toward ambiguity aversion is not strong enough for ambiguity premiums to survive in markets. To investigate the validity of this argument we increase the ambiguity aversion in a market. We do this by comparing a medium objective winning probability condition (50%) to a high objective probability condition (75%) in a 2-color Ellsberg urn setup. This setup has already been proven to increase average ambiguity aversion in individual decision-making tasks (e.g., [Abdellaoui et al., 2011](#)). By applying this setup

<sup>2</sup> For excellent overviews, see [Camerer and Weber \(1992\)](#), [Wakker \(2010\)](#), [Etner et al. \(2012\)](#), and [Trautmann and Van De Kuilen \(2013\)](#).

<sup>3</sup> With ambiguity effects we generally refer to differences between, *ceteris paribus*, ambiguous and risky assets with regard to asset prices, volatility, trading volume or final asset holdings.

<sup>4</sup> In the call market traders are informed of the clearing price after the period.

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