



# Speculation under unawareness<sup>☆</sup>

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## ABSTRACT

“No trade” theorems establish that, in various trading environments, investors who share a common prior will not engage in speculation, as long as expected utility, Bayesian updating and full awareness are imposed. We relax the last assumption by allowing for asymmetric unawareness and examine under which conditions speculative behaviour emerges. We find that if common knowledge is assumed (as in the settings of Aumann, 1976 and Milgrom and Stokey, 1982), unawareness cannot generate speculation. This is not true, however, in settings where no common knowledge is assumed, such as speculation in equilibrium (Geanakoplos, 1989) and betting that is always beneficial (Morris, 1994), unless stronger conditions on awareness are imposed.

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## 1. Introduction

A well established behavioural implication of the common prior assumption (Harsanyi, 1968) is that it precludes speculation, a result which is robust to the particular details of the trading environment and stems from the no-agreeing-to-disagree result of Aumann (1976). To focus on just four, Morris (1994), Samet (1998) and Feinberg (2000) show that there cannot be a bet that makes everyone strictly better off and this is common knowledge (we henceforth call this speculative betting) or it is true at all states (always beneficial bet). Geanakoplos (1989) shows that there cannot be trade from a Pareto efficient allocation in a Bayesian Nash equilibrium (speculation in equilibrium) and Milgrom and Stokey (1982) show that if an allocation is ex ante Pareto efficient it cannot be common knowledge in the interim stage that there is another allocation that Pareto dominates it (speculative trade).<sup>1</sup>

One reason why the details of these trading environments do not matter is that several idealised assumptions are imposed, such as expected utility, Bayesian updating (implying Dynamic Consistency) and full awareness of the relevant

<sup>☆</sup> Some of the results in this paper also appear in a much earlier form in Galanis (2011b). I am grateful to two anonymous referees, Paulo Borelli, Piero Gottardi, Larry G. Epstein, Martin Meier, Herakles Polemarchakis, Marzena Rostek, David Rahman, Fernando Vega-Redondo, Marek Weretka, Xiaojian Zhao, seminar participants at the European University Institute, the University of Southampton, the Summer in Birmingham workshop and the International Workshop on Unawareness, University of Queensland.

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<sup>1</sup> Although common priors are not required for the speculative trade theorem, a Pareto efficient allocation necessitates some form of common priors, as we explain in footnote 23. Also, the setting is slightly different from that of Milgrom and Stokey (1982), as we do not employ a signal structure but a type or belief structure.

dimensions of the environment. In this paper we examine whether and how speculation occurs when the last assumption is relaxed, so that some investors might be partially aware. We find that the details of the trading environment matter for speculation and, in particular, unawareness is compensated only by the property of common knowledge, which is sufficient to ensure no speculation.

Specifically, we show that common priors imply the absence of speculative betting. This result was also established in Heifetz et al. (2013a), however they also impose an additional property in their framework, Projections Preserve Posteriors, which is not needed.<sup>2</sup> We also show that the converse is true. In particular, we identify a condition, Enlargements Preserve Common Priors (EPCP), which requires that whenever there is a “local” common prior generating beliefs within all public or self evident events at each state space, there is also a common prior across all state spaces. This condition is automatically satisfied in the standard model without unawareness and a unique state space. We then show that no common priors and EPCP are equivalent to speculative betting.

Second, as long as the payoff relevant state space, where allocations depend on, coincides with the “common” state space, which is the most expressive state space that it is common knowledge that everyone is aware of, speculative trade (which also imposes common knowledge) cannot occur. This assumption would be true, for example, in the case where the payoff relevant state space describes the prices of all possible stocks, and this coincides with the common state space.

Unawareness, however, does break the connection between common priors and no speculation in environments where common knowledge is not assumed. Examples 1 and 2 show that no common priors are neither sufficient nor necessary for the existence of an always beneficial bet.<sup>3</sup> However, under Conditional Independence, an always beneficial bet implies no common priors. This property requires that investors do not misunderstand the signal created by the information revealed by their varying awareness.<sup>4</sup> Moreover, under the stronger condition of Projections Preserve Posteriors, no common “local” priors (in the state space where the bet is formulated) imply an always beneficial bet. Finally, we show that speculation does not occur in equilibrium if each investor’s information structure either satisfies Conditional Independence or path-independence. This last property specifies that each attained level of awareness specifies a unique path of successively lower levels of awareness that the investor has attained in other states.

When common knowledge is not assumed, an always beneficial bet can occur with a common prior because investors cannot reason properly about the information of others, as their awareness may be too low. This forces them to take information at face value, without being able to completely comprehend why others are selling when they are buying. This “bias” in reasoning is consistent with empirical evidence in psychology which shows that individuals are in general slow to incorporate additional information because of their confidence in their existing assumptions and opinions (Fischhoff et al., 1977).<sup>5</sup> Related is also the confirmatory bias, which suggests that once investors form strong hypotheses, they tend to ignore new information that contradicts them (Rabin, 1998).

These and other psychological biases have inspired a large literature in finance, which generates speculative behaviour with overconfident investors who overestimate the precision of some signals and underestimate the precision of others.<sup>6</sup> For example, Scheinkman and Xiong (2003) explain speculative bubbles and large trading volumes using two groups of investors and two signals that are publicly available. Each group is overconfident about one signal, regarding the other signal (and the fact that the other group is overconfident about it) as noise.

Most of these models assume that investors have a “wrong” perception of the signal structure, which can be formalised by having different priors over it. The main difference of the present paper is that it endogenizes the investors’ speculative behaviour by explicitly modelling their awareness, without altering the common prior assumption, thus providing an insight into why certain types of speculation occur whereas other do not. Moreover, as we argue in Section 3.5, at least in some settings (e.g. correlated equilibria), static models with different priors can always be reinterpreted as models with common priors and investors with significant information processing errors. This means that a model with different priors, which does not provide foundations for the investors’ errors or limited perception, may nevertheless have implications about them which are not clear.

Finally, examining speculation under various trading environments allows us to differentiate, in terms of behavioural implications, between unawareness models, different priors models (such as models with overconfidence) and models with information processing errors represented by non-partitional structures (e.g. Geanakoplos, 1989).

### 1.1. Related literature

The literature on no trade theorems stems from Aumann (1976), who shows that a common prior implies that it cannot be common knowledge that the posteriors are different. Investors trade because they have different priors, they have no common knowledge or they make information processing errors, for example by being unaware. In the context of the standard model where investors make no mistakes, Morris (1994), Bonanno and Nehring (1996), Samet (1998), Feinberg (2000),

<sup>2</sup> This property requires that posterior beliefs do not change as we project down to a state space describing lower awareness.

<sup>3</sup> Note that, under unawareness, what is always true may not always be common knowledge, because some unaware investors may fail to deduce it, due to their limited perception. As a result, an always beneficial bet does not imply speculative betting, as in the standard setting.

<sup>4</sup> It was first studied by Galanis (2015, 2016a) in the context of analysing the value of information in single-investor and multi-investor environments.

<sup>5</sup> See also Oskamp (1965), Mahajan (1992) and Paese and Kinnaly (1993) in the psychology literature.

<sup>6</sup> See Daniel and Hirshleifer (2015) for a survey. I thank a referee for pointing out the connection to the overconfidence literature.

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