



# A normalized value for information purchases <sup>☆</sup>

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## Abstract

Consider agents who are heterogeneous in their preferences and wealth levels. These agents may acquire information prior to choosing an investment that has a property of no-arbitrage, and each piece of information bears a corresponding cost. We associate a numeric index to each information purchase (information-cost pair). This index describes the normalized value of the information purchase: it is the risk-aversion level of the unique CARA agent who is indifferent between accepting and rejecting the purchase, and it is characterized by a “duality” principle that states that agents with a stronger preference for information should engage more often in information purchases. No agent more risk-averse than the index finds it profitable to acquire the information, whereas all agents less risk-averse than the index do. Given an empirically measured range of degrees of risk aversion in a competitive economy with no-arbitrage investments, our model therefore comes close to describing an inverse demand for information, by predicting what pieces of information are acquired by agents and which ones are not. Among several desirable properties, the normalized-value formula induces a complete ranking of information structures that extends Blackwell’s classic ordering.

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## 1. Introduction

We refer to any pair consisting of an information structure and a price for it as an *information purchase*. Such purchases, if they happen, are the manifestation of the demand for information. How many people purchase a piece of information necessarily depends on three components: the quality of that information, the cost of acquiring it, and the agents' primitives given by their wealth and preferences. The current paper aims at answering the following questions. First, given an information purchase, can its normalized value, which captures the information-price tradeoff, be uniquely characterized?<sup>1</sup> Second, in a competitive economy, who are the agents willing to go ahead with a given information purchase?

We answer these questions by analyzing information purchases made by risk-averse agents (or investors) prior to choosing among risky investments. Key to our analysis is the set of investments available which we call *no-arbitrage investments*. In order to study information acquisition based on investment motives, we assume that no-arbitrage investments are not profitable under the agents' prior; the only investors who find investments profitable are the ones who acquire some information. Second, we note that for the value of information to be meaningful and comparable across heterogeneous agents, one needs the set of available investments to be rich enough; in particular, we assume the existence of complete markets.<sup>2</sup> We follow the literature on this subject (such as Kelly, 1956; Arrow, 1971) and take as *no-arbitrage investments* the set of all those with a nonpositive expected return under the prior.<sup>3</sup>

We begin by showing that an agent's demand, or her preference, for information is characterized by her degree of risk aversion. Less risk-averse agents have a stronger preference for information than do more risk-averse agents, in the following sense. We show that an agent  $u_1$  is uniformly less risk-averse than agent  $u_2$  if and only if the fact that agent  $u_2$  acquires some information is enough to guarantee that agent  $u_1$  also acquires that information, independently of the wealth levels considered.<sup>4</sup> Therefore, agents' demand for information in our model is entirely captured by their uniform ranking of risk aversion.

We seek an objective underpinning of normalized values. That is, paralleling the approach of Aumann and Serrano (2008) for ordering riskiness, we apply the following duality principle to define the normalized value of an information purchase<sup>5</sup>: For an information purchase to be considered as objectively more valuable than another one, it must be the case that, whenever

<sup>1</sup> We add the “normalized” qualification because the index will also rely on the price of the purchase, and not be based only on the information structure. The term “normalized informativeness” could also be used to refer to our index.

<sup>2</sup> For instance, some agents find it beneficial to have access to a certain futures market, while others do not value information about this market as much.

<sup>3</sup> No-arbitrage investments, in this sense of not offering any profitable or “arbitrage” opportunity, were also used in Cabrales et al. (2013). “No-speculative” investments could be an alternative name to express the same idea.

<sup>4</sup> To be precise,  $u_1$  is uniformly less risk-averse than  $u_2$  when, for all wealth levels  $w_1$  and  $w_2$ , the coefficient of absolute risk aversion of  $u_1$  at  $w_1$  is not greater than the coefficient of risk aversion of  $u_2$  at  $w_2$ .

<sup>5</sup> In Aumann and Serrano (2008), riskiness is conceived as “dual” to risk aversion, while here the value of information is “dual” to preference for information.

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