On the Role of Risk Preference in Survivability

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Abstract. Using an agent-based multi-asset artificial stock market, we simulate the survival dynamics of investors with different risk preferences. It is found that the survivability of investors is closely related to their risk preferences. Among the eight types of investors considered in this paper, only the CRRA investors with RRA coefficients close to one can survive in the long run. Other types of agents are eventually driven out of the market, including the famous CARA agents and agents who base their decision on the capital asset pricing model.

1 Introduction

The paper is concerned with a part of the debate on the *market selection hypothesis*. The debate, if we trace its origin, started with the establishment of what become known as the *Kelly criterion* ([8]), which basically says that a rational long-run investor *should* maximize the expected growth rate of his wealth share and, therefore, should behave as if he were endowed with a logarithmic utility function. Alternatively speaking, the Kelly criterion suggests that there is an optimal preference (rational preference) which a competitive market will select and that is logarithmic utility. The debate on the Kelly criterion has a long history, so not surprisingly, there is a long list of both pros and cons standing alongside the developments in the literature.[1]

The Kelly criterion may further imply that an agent who maximizes his expected utility under the *correct* belief may be driven out by an agent who maximizes his expected utility under an *incorrect* belief, simply because the former does not maximize a logarithmic utility function, whereas the latter does. [1] were the first to show this implication of the Kelly criterion in a standard asset pricing model. As a result, the market selection hypothesis fails because agents with accurate beliefs are not selected. A consequence of this failure is that asset prices may not eventually reflect the beliefs of agents who make accurate predictions, and hence may persistently deviate from the *rational expectations equilibrium* and violate the *efficient market hypothesis*.

[1] See [11] for a quite extensive review.

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However, a series of recent studies indicates that the early analysis of [1] is not complete. [10] shows that, if the saving behavior is endogenously determined, then the market selection hypothesis is rescued, and in the long run, only those optimizing investors with *correct beliefs* survive. The surviving agents do not have to be log-utility maximizers, and they can have diverse risk preferences. [10]'s analysis is further confirmed by [2] in a connection of the market selection hypothesis to the *first theorem of welfare economics*. [2] show that in a dynamic and complete market *Pareto optimality* is the key to understanding selection either for or against traders with correct beliefs: in any optimal allocation the survival or disappearance of a trader is determined entirely by beliefs, and not by risk preferences.

Despite the rigorousness of these theoretical studies, there exists a fundamental limitation, which may make it difficult to grasp their empirical counterparts, namely, they are *non-constructive*.[2] Take [10] as an example. First, the analysis crucially depends on the appearance of agents who *eventually make accurate predictions* or *eventually make accurate next period predictions*. Nevertheless, the process that shows the emergence of these sages is unknown. It is, therefore, not clear how these agents emerge, or whether they will ever emerge.[3] Second, maximizing expected utility is equivalent to assuming that agents are able to solve any infinite-time stochastic dynamic optimization problem implied by their utility function. However, current dynamic optimization techniques, regardless of whether they include stochastic optimal control or stochastic dynamic programming, can only help us solve a very limited subset of the whole problem space. As for the rest of them, it is necessary to rely on numerical approximations, and their effectiveness to a large extent is also unknown.

Given these practical limitations, we are motivated to re-examine the issue from a more realistic perspective or, technically speaking, a computational perspective. By remaining in the general equilibrium analysis framework, we replace the rational agents with bounded-rational agents. More precisely, these agents are constructed in terms of what is known as *autonomous agents* in agent-based computational economics ([12]). Basically, these agents are able to learn to optimize and to forecast in an autonomous manner. So, they are not necessarily utility-maximizers. Instead, they use adaptive computing techniques to approximate the optimal solution. In this sense, they are Herbert Simon's *satisfying* agents. Similarly, they base their decisions upon beliefs which may not be and may never be correct, but are reviewed and revised continuously ([9]).

By introducing autonomous agents, we are getting closer to the world of flesh and blood, and enhancing the study of the empirical relevance of risk preference to survival dynamics.

[2] This kind of issue is generally shared in many general equilibrium analyses.

[3] Back to the real world, we have not been convinced that these agents have ever appeared in human history.