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# Active and Passive Learning in Agent-based Financial Markets

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## Abstract

This short note compares and contrasts two forms of learning which are present in most agent-based financial markets. First, passive learning refers to a form of “as if rationality” where wealth accumulates on strategies which have done relatively well. Second active learning refers to the active switching of agents across strategies. Most heterogeneous agent markets contain some form of both these types of learning. From what we know so far the dynamics of each may be quite different, and may yield a rich and complex joint dynamic.

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# Notes

1. This is not a survey of learning, or heterogeneous agent models finance. This is well beyond the scope of this short paper. On heterogeneous agent models many excellent surveys exist including, Chiarella et al. [2009], Hommes [2006], LeBaron [2006], and Lux [2009]. On learning models finance in general a recent survey of this large literature can be found in Pastor and Veronesi [2009].

2. Another early theoretical derivation is in Breiman [1961]. A nice summary of this is in Markowitz [1976]. Blume and Easley [1990] and Blume and Easley [2006] state the problem in the context of a utility maximizing portfolio decision. The latter paper proves that in a complete market world the convergence to true beliefs will occur regardless of preference parameters. However, the authors point out that in an incomplete market world this convergence is not guaranteed. Evstigneev et al. [2006] look at an incomplete markets world with endogenous prices. In their framework, the growth optimal strategy will dominate any other competing strategy in terms of acquiring all wealth in the long run.

3. Often this can be calibrated to some actual macro series.

4. Some agent-based learning models go further in that the functional forms of the rules themselves are allowed to change over time as in Chen and Yeh [2001] or Arthur et al. [1997].

5. There is one important class of models where passive learning is inactive. Models with Constant Absolute Risk Aversion (CARA) utility and adaptive rule selection generally have no passive learning component. Two very different examples of this are Brock and Hommes [1998] and Arthur et al. [1997]. Price formation depends on the fraction of traders in a given strategy, and not on their wealth.

6. The best-known case would be log utility.

7. See Pastor and Stambaugh [2009] for a more complete treatment of systems of this form in finance.

8. See LeBaron [2007] or Campbell and Viceira [2002] for derivations and connections to intertemporal preferences. The variance term in the numerator

can be thought of as an adjustment for the fact that these are log returns.

9. The consumption fraction, $\lambda$, is irrelevant for wealth races of this form where it is considered to be the same across all agents. Each period all agents consume the same fraction of wealth, so the relative performance is not affected by $\lambda$.

10. This is the risk-free return, which would generate the same utility as the return on the risky asset.

11. This point has been made by a large number of papers. For a result directly tied to Friedman's examples of firms and profit maximization; see Radner [1998] and Winter [1987].

12. The evidence in support of various forms of active learning extends beyond casual introspection. Laboratory evidence shows some support for various forms of active learning. Some of this work in financial markets is surveyed in Hommes [2010].

13. This is where Sims's [1980] critique of deviations from rationality is in full force.

14. Important current work has moved in the direction of estimating the intensity of choice as in Goldbaum and Mizrach [2008] or Boswijk et al. [2007].

15. It reminds one of Fisher Black's discussions in Black [1986].

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