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# Itchy feet vs cool heads: Flow of funds in an agent-based financial market ☆

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ABSTRACT

Investors tend to move funds when they are unhappy with their current portfolio managers' performance. We study the effect of the size of this flow of funds in an agent-based model of the financial market. The model combines the discrete choice approach from agent-based modelling, where all capital is mobile, with the evolutionary finance framework where all growth is endogenous. Our results show that, if investors exhibit recency bias in evaluating portfolio managers' performance, even a small amount of freely flowing capital has a huge impact on the market dynamics and the survival of noise traders. We also find that investors' intensity of choice is a driving force for excess volatility and extreme price movements when the size of the flow of funds is large.



## 1. Introduction

Providers of portfolio management services chase excess returns in the asset market as well as new money from investors. These are two closely intertwined goals: a portfolio manager who outperforms many of their peers tends to see exogenous growth through the inflow of money from new and existing clients as well as endogenous growth through returns on the capital employed.[1]

The exogenous growth of investment funds through the inflow (or outflow) of money is at the heart of much of the agent-based literature on financial markets, see, e.g., the textbook Hommes (2013) and the surveys Hommes (2006), Chiarella et al. (2009), Hommes and Wagener (2009), and Lettau (1997). These models are populated by a small number of

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[1] See, e.g., the survey papers by Constantinides et al. (2013), Chapters 14, 15, 21 and 22 and Anderson and Ahmed (2005).

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different investment styles and an infinite number of clients who move money between the available styles based on differences in performance, measured, e.g., as a weighted average of realised excess returns. To capture the impact of portfolio managers' performance on the reallocation of investors' money, this literature generally employs a discrete choice model. In the absence of borrowing/lending constraints, strategies can lever their positions without limit and, as a result, have a disproportional short-term price impact. As money under management does not matter for a fund's asset allocation, asset prices are driven by the dynamic of expectations about future excess returns which can result in excess volatility with consistent deviation of asset prices from fundamental values.

Endogenous growth through investment returns and its consequences for asset prices in evolutionary, agent-type finance models have been studied in Amir et al. (2013) and Evstigneev et al. (2006, 2008). These models contain a small number of portfolio managers who aim to grow funds under management but do not face client attrition. The price impact of investors is proportional to their funds, and there is no leveraging. A main result in that literature is that there is only one asset price system that is stable (in the long term) against the entry of new investment styles. This benchmark price system is given by the expected value of the discounted sum of relative asset payoffs (a generalisation of the Kelly investment rule).

This paper combines exogenous and endogenous growth of funds in one model. Investors can move their funds between portfolio mangers with different styles, but the total amount of freely flowing capital is a model parameter. There is no leveraging: the more funds a portfolio manager holds, the stronger its price impact. By varying the size of the flow of funds in this model, we can explore the relative importance of the two different sources of growth for asset price dynamics.

The exogenous amount of freely flowing capital in each time period can be interpreted as the average client's degree of patience. If the proportion is small, most investors keep cool heads and tend to stick with their portfolio manager even during long periods of poor performance. On the other hand, when this amount is large, clients have itchy feet and tend to desert an under-performing portfolio manager quickly. There is a substantial difference between this approach to modelling the flow of funds and the usual discrete choice formula in agent-based models of financial markets: we can control the amount of freely flowing capital and thus the general degree of impatience in the market by varying the level of client attrition. The discrete choice formula is used however to model the destination of the free capital. The idea of modelling non-switching and switching investors is similar to the one of Dieci et al. (2006) with the same motivation. However, their model is based on the framework of Brock and Hommes (1997, 1998) where the budget effect and the interdependence between wealth and prices are left in the background. An exception is Bottazzi and Dindo (2014) who study agents with decision rules that can be driven by past prices.

The agent-based part of the model presented here is most closely related to that part of this literature that forbids short-selling: Anufriev and Dindo (2010), LeBaron (2001, 2002, 2006a,b) and Levy and Levy (1996), Levy et al. (1994, 1995, 2000). In these papers the budget constraint limits the potential market impact of the different investment styles. This is in contrast to the models where unlimited positions are possible (e.g. Chiarella et al., 2006 and Brianzoni et al., 2010) and those where asset prices are driven only by funds' expectations about future returns (e.g. Brock and Hommes, 1997, 1998, Gaunersdorfer and Hommes, 2007).

The evolutionary finance part of the model extends Evstigneev et al. (2011) by adding an explicit mechanism that reallocates a certain proportion of funds between the different portfolio managers. In these models leverage is excluded and therefore the available budget constrains the positions that a fund manager can take on as well as their market impact. The hybrid model presented here bridges the gap between the agent-based and the evolutionary approach. It can be used as a powerful tool to obtain insightful results regarding the feedback loop between the exogenous flow of funds with budget effect, the endogenous growth of wealth, and the price dynamics.

Our paper is also closely related to inquires into the interaction of *passive* and *active* learning dynamics, as defined in LeBaron (2011). Passive learning refers to the market force by which wealth accumulates on investment strategies which have done well (in relative terms). Active learning refers to the switching behaviour by which investors reallocate wealth into strategies which have performed well in the past. As LeBaron points out, although both learning types and their consequences on the price dynamics have been extensively studied in isolation, the interaction between the two remains largely unexplored.

We are particularly interested in the impact of the size of the flow of funds on systematic deviations of prices from fundamental values as well as on excess volatility. This inquiry has both theoretical as well as practical aspects. Under the discrete choice model, all capital is ready to move at any time. In evolutionary finance models, all funds stay with the same portfolio manager. In reality however clients' behaviour fits neither description. Investors do not continuously monitor the performance of all portfolio managers and move funds at all times, nor do they ignore performance and never switch to managers with superior performance. As stressed by Dieci et al. (2006, p. 520): "*Empirical evidence has suggested that, facing different trading strategies and complicated decision, the proportions of agents relying on particular strategies may stay at constant level or vary over time.*"

Since our model separates the clients' allocation decision from the amount of freely flowing capital, we look more closely into the relation between behavioural aspects, such as differences of opinions, recency bias in performance evaluation, conservatism bias (e.g., Edwards, 1968) and rational herding, and the model parameters. We also explore the impact of some of these behavioural phenomena on the asset price dynamics.

The next section introduces the general framework of the hybrid model and provides a specification with three investment styles. The detailed numerical study of the model is provided in Section 3. Section 4 concludes. All proofs are collected in an appendix. The software and data are available at www.schenk-hoppe.net/software/flow-of-funds/.