REFEREE REPORT

Market Runs of Hedge Funds during Financial Crises*

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Summary

In this paper the authors use a global games approach to show how interaction (a) among hedge funds and (b) between hedge funds and their investors can lead to market runs with fire sales of risky assets. The key idea is that any hedge fund's investment decision has an impact on other funds through its impact on market prices. Moreover, withdrawals by loss-sensitive uninformed investors can trigger fire sales that further depress the market price.

In the model, an exogenous negative shock to the price of a risky asset motivates hedge funds (who know the fundamental value) to invest in the asset. To do so, they collect funds from investors and decide how much to invest in the risky asset vs. how much to hold in risk-free cash. Hedge funds' purchases of the risky asset mitigate the drop in the asset price, but since uninformed trend followers amplify the initial drop in the price, it does not immediately return to its fundamental value. What is more, an exogenous "funding liquidity shock" wipes out a fraction θ of hedge funds and the managers of the surviving funds decide whether to keep their positions or whether to liquidate and exit the market as well.

This is where the global game component comes in: Individual hedge fund managers do not observe the actual fraction θ, but only a noisy signal. Since exits trigger proportional fund withdrawals by investors, there is a complementarity in fund managers' actions: If more surviving funds exit, the remaining funds face higher withdrawals and may have to sell the risky asset, thereby depressing its price and making it less attractive to stay in the market. Fund manager i's fear that other managers might exit can thus make it optimal

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to exit as well, even though the price drop associated with θ fundamental exits would not make fund i insolvent *per se*.

The authors derive a Nash equilibrium strategy according to which fund managers exit iff their private signal is above an endogenous threshold. They show that this threshold decreases (and so the probability of market runs increases) with investment in the risky asset. Hence, compared to a situation where runs are not allowed, fund managers optimally choose smaller market exposure when runs are possible. The authors claim that their model explains some stylized facts regarding hedge fund behavior before and during the financial crisis of 2007-2009.

Comments

1. The goal of the paper, i.e. to shed light on the detailed interaction of agents in financial markets that gives rise to strategic fragility, is interesting and definitely deserves scholarly attention.

2. The paper tells a reasonable story that indeed seems to match stylized facts from the financial crisis. However, many parts of this story are, unfortunately, assumed exogenously to make the narrative coherent. Therefore, the actual contribution of the model in terms of economic mechanisms is rather marginal so far. What is more, as far as I can tell, the technical analysis is flawed. Details follow below.

3. In general, the paper uses appealing language and vocabulary. Sometimes, however, it lacks clarity because it uses terms without properly defining them.

4. It is not clear why the authors included "trend followers" in the model. First of all, they have neither an objective function nor a choice to be made; they only serve as a narrative for why the price of the risky asset drops between t_1 and t_2. Second, I am not even convinced that this additional drop (on top of the exogenous price shock s) is even necessary for the results. In addition, the sensitivity analysis in section 4.2 is interesting, but in my opinion the authors oversell their interpretation of τ. Increasing τ simply means that the (exogenous!) price drop between t_1 and t_2 becomes more severe. It is not a deep, structural parameter of, say, risk aversion. Suggesting otherwise is misleading.

5. A general problem in the exposition of the paper is that the authors often use the terms "price" and "return" interchangeably and thus confuse them. Most of the time they are talking about the effect of managers' actions on the market *return* of the risky asset when in fact the *price* is affected. Even though the purchase price is normalized to 1, confusion remains and makes reading parts of the paper a bit tedious.

6. The contribution of the paper to the literature, especially compared to Liu & Mello (2011), is not clear. If the main contribution is the interaction between hedge funds through market prices and the withdrawals of investors, then unfortunately, I do not think the analysis is sufficiently rigorous. Investors are assumed to mechanically withdraw a fraction proportional to the share of exiting funds, so the actual economic incentives of uninformed investors remain obscure. Similarly, the market price of the asset is assumed to increase one-to-one with the amount of investment from hedge funds. Without any account of market structure, this is a very *ad hoc* way of generating the desired payoff structure for the global game. In my view, the additional insights with respect to Liu & Mello (2011) are not significant enough to justify the loss of rigor in modelling.

7. The execution of the global games exercise (starting from section 3.2) looks solid and here the authors explain very well what they are doing and why. Up to potential algebra mistakes it is nice that the authors find analytical expressions for some key equilibrium objects. The problems rather lie in the first part of the paper, i.e. in the attempt to micro-found the payoff structure.

8. Other comments and details

   - Please explain the purpose of the paper and your contribution *before* the literature review. Some references seemed quite far-fetched from the content of the paper.
   - I do not think that "(funding) liquidity shock" is a good description of what θ does, because it suggests an endogenous reaction of the concerned hedge funds. In fact, it is just an exogenous solvency shock that kills a fraction of hedge funds.
   - Equation (1) is referred to as "market clearing condition", but I cannot see how the terms relate to demand, supply or general equilibrium. All I see is an *ad hoc* pricing equation where the price (normalized to unity) is equal to the fundamental value minus the exogenous shock plus the compensating fund purchases.
   - I think there is an error in equation (3). In the last three lines there should be no r multiplying the x's. The point is that the market price r decreases by the amount $\frac{f}{n}x_k$ for every defaulting hedge fund. This error leads to some follow-up errors later on, e.g. in (7) or the definition of π_i on p. 8.
   - I think the expression for expected payoffs *ex ante* in (12) and its successors are wrong. The expectation operator in $E[\Pi_i^S]$ is also with respect to θ, so how can it be taken out of the integral? Should it not read $\int_0^1 (1-\theta)\Pi_i^S(x,\theta)d\theta$?
   - The authors refer to "liquidity inflows" into the risky asset market at t_2, but do not explain where these come from. It seems like all exiting funds sell their risky as-

sets to new market participants (hence there is an inflow), but then why is there no corresponding inflow for the $(\lambda - c_k)$ portion of liquidated assets? Is this asymmetry really without loss of generality?

- The effect of $\epsilon \to 0$ should become clearer. Which results survive for general ϵ?
- Minor typos:
  - p. 4 "high-volatility *stocks*"
  - p. 7 "Fund managers who receive this shock go bankrupt" (without *should*)
  - p. 8 "π_i is the upper bound of λ ..."
  - p. 13 "fund managers know that in the region $(\bar{\theta}, \pi)$ ..." instead of $\underline{\theta}$
  - p. 13 "as the private signal approaches $\underline{\theta}$, the *perceived* probability that θ is in $[0, \underline{\theta})$ decreases to $1/2$."
  - p. 18 "..., but the remaining *funds* then become more fragile ..."