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Leverage causes fat tails and clustered volatility

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Abstract

We build a simple model of leveraged asset purchases with margin calls. Investment funds use what is perhaps the most basic financial strategy, called ‘value investing’, i.e. systematically attempting to buy underpriced assets. When funds do not borrow, the price fluctuations of the asset are approximately normally distributed and uncorrelated across time. This changes when the funds are allowed to leverage, i.e. borrow from a bank, which allows them to purchase more assets than their wealth would otherwise permit. During good times, funds that use more leverage have higher profits, increasing their wealth and making them dominant in the market. However, if a downward price fluctuation occurs while one or more funds is fully leveraged, the resulting margin call causes them to sell into an already falling market, amplifying the downward price movement. If the funds hold large positions in the asset, this can cause substantial losses. This in turn leads to clustered volatility: before a crash, when the value funds are dominant, they damp volatility, and after the crash, when they suffer severe losses,

volatility is high. This leads to power-law tails, which are both due to the leverage-induced crashes and due to the clustered volatility induced by the wealth dynamics. This is in contrast to previous explanations of fat tails and clustered volatility, which depended on 'irrational behavior', such as trend following. A standard (supposedly more sophisticated) risk control policy in which individual banks base leverage limits on volatility causes leverage to rise during periods of low volatility, and to contract more quickly when volatility becomes high, making these extreme fluctuations even worse.

Keywords:

Systemic risk | Clustered volatility | Fat tails | Crash | Margin calls | Leverage

JEL Classification:

E32 | E37 | G01 | G12 | G14

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Notes

⊤For previous equilibrium-based analyses of leverage that show that prices crash before default actually occurs, see Geanakoplos (1997, 2003), Fostel and Geanakoplos (2008), Brunnermeier and Pedersen (2009) and Geanakoplos (2010).

†The nonlinear feedback that we describe here, which is driven by investors selling into a falling market, is in this sense similar to the model of hedging by Gennotte and Leland (1990); they also discuss how such feedbacks can cause crashes.

‡See Palmer et al. (1994), Arthur et al. (1997), Brock and Hommes (1997, 1998), Caldarelli et al. (1997), Lux (1999) Lux and Marchesi (1999) and Giardina and Bouchaud

(2003). See also Friedman and Abraham (2009), who induce bubbles and crashes via myopic learning dynamics.

†Another good example from the recent meltdown illustrating how individual risk regulation can create systemic risk is the use of derivatives.

‡The failure of Long Term Capital Management in 1998 was an example of a near-crisis caused by the precise mechanism discussed here. Some other types of investment strategies, such as trend-following or portfolio insurance, cause nonlinear feedback in prices, which is further amplified by leverage.

†Using a positive survival threshold for removing funds avoids the creation of 'zombie funds' that persist for long periods of time with almost no wealth.

‡Some of the references that document or discuss the flow of investors in and out of mutual funds include Chevalier and Ellison (1997), Remolona et al. (1997), Sirri and Tufano (1998, Busse (2001) and Del Guercio and Tka (2002).

†We measured γ using a Hill estimator (Hill 1975) based on the largest 10% of the returns. The value of γ when $\lambda = 1$ should be infinite, in contrast to the measured value. Large values of γ are difficult to measure correctly, whereas small values are measured much more accurately.

†This actually happened when the Bear-Stearns hedge funds went out of business; the bank attempted to sell the underlying assets, but the liquidity was so low that they gave up and simply held them.

†There are two reasons why aggressive funds grow faster than passive funds. The superior returns achieved by using leverage both make the funds already under management grow faster and attract new investors. As the wealth of the funds grows sufficiently large, their market impact also grows, decreasing returns. This can drive the returns of the less aggressive funds below the benchmark return r^b and cause them to lose investment capital. This explains the pattern seen in figure 2, in which less aggressive funds grow in the period right after a crash but then eventually shrink.