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Financial crises and regime-dependent dynamics☆

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ABSTRACT

Generalized with the regime-dependent beliefs and regime-switching dynamics, the simple market-maker framework established by Day and Huang (1990) is capable to model all types of crises, that is, sudden crisis, disturbing crisis and smooth crisis, and to offer economic and dynamic justifications on how and why these crises appear. Moreover, the model simulations verify the salient qualitative and statistical properties commonly observed in the real financial data such as fat tails, volatility clustering, long range dependence, leverage effect and other stylized facts. Additionally, the model replicates the various chart patterns widely applied in the technical analysis.

1. Introduction

Global financial crises can be broadly classified into sudden crisis, smooth crisis and disturbing crisis according to their depth and duration (Rosser, 2000; Kindleberger and Aliber, 2005; Huang et al., 2010). Sudden crisis is characterized by a succession of precipitate price drops from the peak straight down to the bottom. Even though the duration of such crisis is short, the depth is dramatic as a result of continuous and steep declines. The tulip crisis in 1637 and the silver crash in 1980 were two typical examples of sudden crises. Smooth crisis reflects itself in a series of moderate but persistent price declines. Although the magnitude of a single-period price drop is small in smooth crisis, the cumulative price decline is very large as a result of persistent falls over a long period. Two examples of smooth crisis were the 1990–2007 Japanese stock market distress and the 1931–1932 US stock market depression. In both these two instances, the stock market indices fell smoothly but persistently for a considerately long period. However, the most common crisis pattern yet the least studied is the disturbing crisis (Gallegati et al., 2011), which typically starts with a period of financial distress characterized by volatile fluctuations with a downward trend and follows by a sudden crash that may not necessarily mark the end of crisis. Almost all destructive crises, such as the stock market crash in October 1929, the 2000–2002 dotcom crash, and the 2007–2009 global credit crunch, belong to this type.

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Although most heterogeneous agent models (HAMs) in literature are able to generate some, if not all, financial crisis patterns simultaneously within a same framework,[1] none of them explains why these financial crises differ one from the other. This may partly due to the complexity nature of HAMs and partly due to the excessive variables and factors they account for. Current research intends to fill such a gap by modelling all three types of financial crises within a deterministic HAM model that is as simple as possible. It is found that, simply generalizing Day and Huang's classical market-maker framework with regime-dependent beliefs can easily fulfill such a goal. As in Day and Huang (1990), we assume that a financial market consists of two types of investors: fundamentalists and chartists, and a market-maker. However, we assume that both type of investors have regime-dependent beliefs, by which we mean that investors evaluate their price expectations relatively to a reference state that varies with the price regimes. Such a generalization is motivated by observations in technical trading[2] and supported by empirical evidence that the price follows a complicated process with multiple regimes and that such non-linear process affects investment decisions (Ang and Bekaert, 2002; Guidolin and Timmermann, 2007, 2008).[3]

When investors are allowed to act and update their beliefs continuously, the price trajectories generated by this simple HAM model can exhibit very rich and complex dynamic patterns. In particular, it is found that (i) sudden crisis is associated with continual jumps from high price regimes to low price regimes that trigger steep price falls; (ii) smooth crisis is mostly related to price dynamics within the same regime and, occasionally, smooth transitions to relatively low price regimes, which give rise to moderate but consecutive price declines; and (iii) disturbing crisis typically starts with turbulent switching between high and low price regimes that represents the period of financial distress, and follows by sudden transition from high to low price regimes.

Moreover, the simplicity of our model does not imply any trade-off of other important aspects in financial market, either empirical or theoretical. We proceed our justification by (i) successfully simulating price series that match with the widely documented chart patterns in technical trading; and (ii) testing the model's capability of capturing various stylized facts that are commonly observed in real financial time-series, such as fat tails, volatility clustering, power-law distribution, long-range dependence and leverage effect. Our simulations and test results suggest that, simple as the model is, it well reproduces most of these qualitative and quantitative features in financial market.

The rest of this paper is organized as follows. Section 2 describes the model. Section 3 discusses its theoretical implications and the linkage between regime-dependent dynamics and financial crises. Section 4 conducts simulation to verify how dynamic patterns contribute to differentiate financial crises. Section 5 considers alternative parameter specifications to check the robustness of the model performance. Section 6 concludes.

2. Model

We consider a market with one risky asset and two types of investors distinguished by their trading strategies— fundamentalists (α-investor) and chartists (β-investor).[4] The excessive demand from these investors is balanced by the market maker, who subsequently adjusts the price up or down accordingly.

2.1. Fundamentalists

Fundamentalists expect the asset price to converge towards its long term fundamental value $\overline{p}_{\alpha,t}$, with a time-varying convergence speed ϑ_t. They buy in the asset when the price is below $\overline{p}_{\alpha,t}$ and sell it out vice versa. Given the asset price p_t, fundamentalists' demand of the risky asset at period t, $D_{\alpha,t}$, is given by:

[1] For example, Day and Huang (1990) and He and Westerhoff (2005) capture the sudden crisis, Chiarella et al. (2003) model the smooth crisis, and Gallegati et al. (2011) study the disturbing crisis and Huang et al. (2010) generate all types of crises. Introducing the jump diffusion into the model may easily capture these patterns of crisis by simply adjusting the jump scales. Nonetheless, it is hard to justify the scales of jump from external resources. This is especially the case if one believes that crises are essentially determined by the internal dynamics rather than external shocks.

[2] In technical analysis, investors identify the support price level, at which buying force is believed to be strong enough to prevent the price from dropping further, and the resistance price level, at which selling force is thought to be large enough to curb the price from rising further. So long as the price moves within the same regime enclosed by current support and resistance price levels, investors form their expectations based on the same level of beliefs. On the other hand, if the price breaks through the boundaries of current regime, new support and resistance levels will be established, and investors will shift their beliefs accordingly. Based on their trading experience and technical analysis, investors form a series of trading regimes enclosed by different support and resistance price levels, referring to which they develop their beliefs of future price movements. In order to decide optimally whether to maintain or to shift their beliefs, it is important for investors to continuously update the support and resistance price levels and to extrapolate the contemporaneous trading regime from the latest market information.

[3] The idea of modelling investor's belief as regime-dependent is not new to HAMs. Manzan and Westerhoff (2007) model the chartist sentiment, the degree to which chartist acts on his belief, as a two-state process and show that their model exhibits out-of-sample forecasting power for some currencies. Tramontana et al. (2010) and Chiarella et al. (2012) describe two types of chartists and fundamentalists, whose sentiment follows either a two-state or three-state process. Their model are capable of generating a relatively comprehensive set of dynamic behavior. Huang et al. (2012) define chartists' beliefs to depend on pre-specified price regimes and shows that the model is capable of replicating a wide range of stylized facts. It can be observed that most HAMs involving regime-dependent beliefs are capable of generating qualitative and quantitative features in the real financial market, in one way or another. Unfortunately, due to the complex structures, they are not able to explain how and why regime-dependent dynamics contribute to the model performance.

[4] Simple HAM that consists of fundamentalists and chartists can be traced back to Frankel and Froot (1986), Day and Huang (1990), and Huang and Day (1993). This framework is further generalized in different directions by Lux (1995), Brock and Hommes (1998), Farmer and Joshi (2002) and He and Li (2007), to list a few.