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A Cardan's discriminant approach to predicting currency crashes

Seng Kee Koh [b], Wai Mun Fong [a,*], Fabrice Chan [a]

[a] *Department of Finance and Accounting, National University of Singapore, Singapore 117592, Singapore*
[b] *School of Business, Singapore Management University, Singapore 259756, Singapore*

Abstract

This paper models large swings in exchange rates by introducing nonlinearity via the generalized normal (GEN) distribution [Lye, J.N., Martin, V.L., 1993. Robust estimation, nonnormalities and generalized exponential distributions. Journal of the American Statistical Association 88, 261–267]. As the distribution allows for bimodality, a switch between modes may give rise to currency crashes. A statistic known as Cardan's discriminant, based on the shape parameters of the GEN, is used to detect bimodality. The Cardan's discriminant is found to reliably predict currency crashes for eight emerging countries and generate relatively low false signals for stable currencies.

JEL classification: F31

Keywords: Cardan's discriminant; Currency crashes; Emerging markets; Generalized normal model; Multimodality

1. Introduction

Exchange rates are a critical input in the strategic and operating decisions of many individuals, companies and countries. In tranquil financial markets, where currencies fluctuate within narrow bands, exchange rates can be predicted with reasonable accuracy. Hence, forecasting errors are both small and less critical. In volatile markets, when currencies are subject to intense

* Corresponding author.
E-mail address: bizfwm@nus.edu.sg (W.M. Fong).

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speculative pressures, the ability to forecast an impending crash is critical as sharp swings in exchange rates can lead to devastating effects on investors' wealth, corporate profits and the real economy. The spate of global financial crises in the 1990s is a potent reminder of how currency crises can develop into widespread economic and social crises.

Forecasting currency crashes presents a formidable challenge for the applied economist. Firstly, it is difficult enough to forecast exchange rates under normal market conditions. These difficulties are best expressed by Meese and Rogoff (1983) who find that no structural model can deliver superior forecasts compared to the simplest of models, the random walk. Secondly, currency crashes are intrinsically a nonlinear phenomenon. Most of the earlier models assume that exchange rates are a linear function of economic fundamental variables such as interest rates and money supplies. Not surprisingly, the empirical evidence shows that linear models are inconsistent with the data. Meese and Rose (1991) argue forcefully that exchange rates exhibit significant nonlinearities, but they are unable to find a nonlinear model that can consistently dominate the random walk in out-of-sample forecasts.

Nonlinearities may arise in several ways. For example, the relationship between exchange rates and economic fundamentals may not be linear. This type of nonlinearities can be handled using nonparametric techniques, although the forecasting performance of such techniques is mixed (see Diebold and Nason, 1990; Chinn, 1991). Nonlinearities can also occur if there are jumps or regime shifts in the parameters of the exchange rate process. Such jumps have been modeled using a variety of methodologies, the most popular of which is the Markov switching model of Hamilton (1989). The Markov switching methodology is attractive because regimes are treated as latent variables rather than assumed to be observable. Nonetheless, Markov switching models also have difficulty beating the random walk as well as linear models in out-of-sample forecasts (Engel, 1994; Martin et al., 1997).

This paper presents an alternative methodology for forecasting exchange rates with a focus on predicting currency crashes. Our approach is consistent with current consensus in the theoretical literature that (a) economic fundamentals tend to evolve slowly while crashes tend to occur suddenly and unexpectedly, (b) crashes can occur not primarily because of poor fundamentals, but also due to self-fulfilling expectations and (c) currencies are most vulnerable to self-fulfilling speculations when the exchange rate lies in a zone of multiple equilibria, a state where the market has no unique view of the ''correct'' equilibrium exchange rate.

To capture these stylized features in a parsimonious way, we follow the work of Creedy et al. (1996) by modeling a currency crash as a jump between the modes of a bimodal exchange rate distribution. This approach is similar in spirit to the Markov switching model in which the exchange rate at any point in time is assumed to be drawn randomly from one of many distributions. The main difference is that while the Markov switching approach can only predict a future crash if the currency has experienced previous crashes during the estimation period, our model can potentially detect a crash even if the currency has been stable in the estimation period.

The bimodal distribution analyzed in this paper is the generalized normal (GEN) distribution which was studied by Cobb et al. (1983) and Lye and Martin (1993). Cobb et al. (1983) show that the GEN distribution can be derived by solving a general continuous time model of exchange rate. A unique feature of the GEN distribution is that its distribution parameters can be time-varying functions of the economic fundamentals. This provides a nonlinear channel through which slowly evolving fundamentals can amplify their effects on the exchange rate. A crash occurs when the exchange rate jumps from the higher mode to the lower mode, which may be interpreted as a jump between equilibrium exchange rates. A statistic known as Cardan's discriminant is introduced as a crash predictor based on the relative values of the