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A new approach to modeling early warning systems for currency crises: Can a machine-learning fuzzy expert system predict the currency crises effectively?

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This paper presents a hybrid causal model for predicting the occurrence of currency crises by using the neuro fuzzy modeling approach. The model integrates the learning ability of the neural network with the inference mechanism of fuzzy logic. The empirical results show that the proposed neuro fuzzy model leads to a better prediction of crisis. Significantly, the model can also construct a reliable causal relationship among the variables through the obtained knowledge base. Compared to neural network and the traditionally used techniques such as logit, the proposed model can thus lead to a somewhat more prescriptive modeling approach based on determinate causal mechanisms towards finding ways to prevent currency crises.

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1. Introduction

Since the breakout of the various currency crises in the 1990s, there have been several attempts devoted to the construction of an early warning system for predicting the probability of the next crisis

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in order to avoid its recurrence. The European currency crises in 1992, the Mexican peso crisis in 1994, the Asian crises in 1997–98, and the Russian currency crisis in 1998 were indeed telling, as was the devastation resulting from the Argentine crisis later. In order to prevent or at least to manage better such damage to the world economy, finding an effective early warning system has become an important issue.

Basically the work done so far can be divided into four main categories. First, there are papers that emphasize the change in some important indicators before the crisis. However, these papers do not usually go into the empirical testing of these indicators (Dornbusch et al., 1995; Goldstein, 1996; Krugman, 1996; Milesi-Ferretti and Razin, 1996). Second, some papers emphasize the difference in values of the variables between the crisis period and the precrisis period (Eichengreen et al., 1995; Frankel and Rose, 1996; Moreno, 1995). Third, some other papers predict the probability of the crisis according to a given theoretical model (Blanco and Garber, 1986). This can also be divided into two further categories, single country model (Cumby and Wijnbergen, 1989; Kaminsky et al., 1998 (hereafter KLR); Otker and Pazarbasioglu, 1994, 1996) and multiple countries model (Collins, 1995; Frankel and Rose, 1996; Klein and Marion, 1994; Milesi-Ferretti and Razin, 1998), including some papers using macroeconomic variables to explain the contagion phenomena (Sachs et al., 1996). Fourth, Kaminsky and Reinhart (1999) innovatively propose the signal approach to construct an early warning system. This approach looked promising at the time it was proposed. However, according to some more recent work (e.g., Chowdhry and Goyal, 2000), the forecasting results for the out-of-sample data for Asian crisis case are disappointing for most of the theoretical models. It appears that, this problem of finding an effective early warning system remains an outstanding issue and still needs further investigation. The possibility of extensive nonlinear relationships among the relevant variables motivates us to explore the problem from a neural network perspective.

From this perspective, as far as the nonlinear problem is concerned, the progress in artificial intelligence technology can now provide a possible alternative that deserves further exploration. In recent years, expert systems, fuzzy logic, and neural network all have been refined in order to help managers in making real world decisions. The expert system can embed the past experience into the system; fuzzy logic can describe the problem in a way that is close to the human reasoning process and accommodate the inaccuracy and uncertainty associated with the data; the neural network can learn from historical data. However, the difficulty with the acquisition of the knowledge base for both the expert system and fuzzy logic and the difficulty with the causal explanation through the construction of appropriate 'real' relations among the variables for the neural network model have constrained the application of these three methods.¹ A method which can combine the advantages of these three methods while avoiding some of the weaknesses, would seem to hold some promise.

In this paper, we follow this intuition and use the neuro fuzzy, a hybrid of neural network and fuzzy logic, to construct an early warning system to predict a currency crisis. In addition to providing better out-of-sample forecasting results, the proposed model can also provide a knowledge base to describe the complicated relationship among the variables. This last step can potentially open up a more concrete way to prevent a currency crisis. The paper is constructed as follows. Section 2 is the literature review. The construction of neuro fuzzy and its benchmarks is described in Section 3. Section 4 describes the research methodology. The empirical results are displayed and interpreted in Section 5. Finally we give conclusions and suggestions for further research in Section 6.

2. Literature review

2.1. Theoretical literature

The economic model-based formal explanations for speculative attacks and balance of payments crisis are first proposed by Krugman in (1979). His model shows that, under a fixed exchange rate, domestic credit expansion in excess of money demand growth leads to a gradual but persistent loss

¹ In the sense of being approximately true. See Khan (2004a,c) and chapters 6 and 7 of Khan (2004b) for a discussion of the related philosophy of science issues.

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