Chapter 17
Visualizing Indicators of Debt Crises in a Lower Dimension:
A Self–Organizing Maps Approach

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ABSTRACT

Since the 1980s, two severe global waves of sovereign defaults have occurred in less developed countries (LDCs): the LDC defaults in the 1980s and the LDC defaults at the turn of the 21st century. To date, the topic is contemporary, while the forecasting and monitoring results of debt crises are still at a preliminary stage. This chapter explores whether the application of the Self-Organizing Map (SOM), a neural network-based visualization tool, facilitates the monitoring of multidimensional financial data. Thus, this chapter presents a SOM model for visualizing the evolution of sovereign debt crises' indicators. The results of this chapter indicate that the SOM is a feasible tool for visualization of early warning signals of sovereign defaults.

INTRODUCTION

Throughout the entire monetary history, sovereigns have repeatedly defaulted on their external debt. Ever since the famous serial defaults during the reign of Philip II of Spain, 1556–1598, governments have regularly repudiated on their external debt. In the wake of the massive increase in lending in the 1970s, a wave of sovereign debt crises washed over the developing world in the 1980s. More recently, starting from Russia's default in August 1998, a new wave of sovereign defaults in less developed countries (LDC) has occurred. The latest wave of sovereign defaults was in fact preceded by the Mexican Tequila crisis in 1994. Furthermore, following the Asian crises from 1997–98, the Russian default triggered a severe series of debt defaults, including Turkey in 2001 and Argentina in 2002. Moreover, the history of serial defaults shows that countries, e.g., Spain and Portugal in the 19th century, have been allowed to become serial defaulters without suffering too much in terms of borrowing costs. The occurrence of sovereign debt crises correlates highly with

DOI: 10.4018/978-1-61350-116-0.ch017

the amount of research on the phenomena, thus causing a recent comeback in this particular field.

However, although most countries have recently shifted to floating exchange rates, resulting in infrequent currency crises, the early warning signal analyses have still mostly concentrated on currency crises. Moreover, the huge government deficits accumulated during the expansionary stimulus preceding the Sub prime crisis from 2007–2009 have arisen questions regarding the sustainability of some countries' government debts. Examples of recent concerns are the Icelandic referendum on paying external debt obligations, the rescheduling of small parts of the Dubai debt and the huge fiscal deficits and the total amount of sovereign debt in the Euro area. Thus, the fact that sovereigns run into series of defaults may currently indicate an imminent serial wave of sovereign defaults. This being the case, finding effective tools for monitoring early warning signals of debt crises remains an important issue for both private financial market participants and policy decision-makers.

To downsize financial volatility and instability, the broad scope of preventive monetary policy options should be introduced in an early stage of the pre-crisis period. Discovering the optimal timing of the policies has been attempted by systematic monitoring of indicators of debt crises. The empirical literature has been mostly based on early warning systems (EWSs) using conventional statistical modeling methods, such as logit and probit models (e.g., Detragiache and Spilimbergo (2001) and Ciarlone and Trebeschi (2005)). The occurrence of financial crises is, however, explained by complex, non-linear interactions between non-normally distributed economic and financial variables (Arciniegas Rueda and Arciniegas, 2009). These types of non-linearities derive, for example, from the fact that crises become more likely as the number of fragilities increase. Thus, because of distributional assumptions, conventional statistical modeling techniques may fail in explaining these events. The novel predictive models attempt, however, to apply artificial intelligence for the prediction of financial crises (e.g., Fioramanti (2008)). However, Peltonen (2006) shows that independent of which type of the earlier mentioned models one utilizes, the results of *a priori* predictions of financial crises are still disappointing. Thus, although the utilization of intelligent techniques has increased *a posteriori* prediction accuracies to a minor extent, the interpretability of the monitoring systems has not been addressed appropriately. Thus, rather than building highly complex and mathematical models, this motivates the development of monitoring systems with clear visual capabilities and intuitive interpretability, contributing instead to visual tools enabling real human perception.

The dimensionality of the problem complicates interpretability, since a large number of indicators are often required to accurately assess the vulnerability for a debt crisis. Using raw statistical tables, one indicator for approximately five countries can be analyzed at one point in time. Similarly, two- and three-dimensional visualization tools have limited capabilities for high dimensions. A further obstacle is the inclusion of a temporal dimension. The degree of difficulty to analyze statistical tables is demonstrated in Table 1. Although composite indices of leading indicators, and likewise predicted probabilities as outputs of EWSs, enable comparison across countries and over time, the weighting of the indicators is subjective in nature and visual in-depth analysis and comparison is hindered. Figure 1 illustrates the explanative weakness of Sarlin and Margescus' (2010) benchmark probit model. In other words, composite indices do not enable features of exploratory data analysis, such as projection of multidimensional data onto a two-dimensional plane and illustrating the structures in a data set. When attempting analysis of multidimensional data, such as statistical indicators for monitoring the financial stability, methods of exploratory data analysis are feasible techniques. Exploratory data analysis attempts describing different aspects of