Predicting sovereign debt crises: An Early Warning System approach

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ABSTRACT

In light of the renewed challenge to construct effective “Early Warning Systems” for sovereign debt crises, we empirically evaluate the predictive power of econometric models developed so far across developed and emerging country regions. We propose a different specification of the crisis variable that allows for the prediction of new crisis onsets as well as duration, and develop a more powerful dynamic-recursive forecasting technique to generate more accurate out-of-sample warning signals of sovereign debt crises. Our results are shown to be more accurate compared to the ones found in the existing literature.

1. Introduction

In the aftermath of the 2008 global financial crisis, which hit the major advanced economies and affected many emerging and developing countries, governments were forced to bail out and recapitalize their failing banking systems. Such interventions resulted in large fiscal deficits at the same time as their economies slowed after the burst of the property bubble. As a consequence, several European nations, in particular Greece, Portugal, Ireland and Spain, faced a prolonged debt crisis, unable to repay or refinance their sovereign debt and having to rely on the assistance of other Eurozone countries, the IMF and the ECB. Considering the economic and social effects of sovereign debt crises at both national and international levels, it has become increasingly important to construct financial monitoring tools that can forewarn the build-up of such financial turmoil. The main purpose of such systems is to provide policymakers with some lead time to take corrective actions that would help avert, or at least mitigate, the damage associated with an approaching crisis.

Since the late 1990s, several studies have attempted to develop a framework for such Early Warning Systems (EWS) using various econometric models.† However, the forecasting performance of these EWS was not generally satisfactory, especially in predicting out-of-sample crisis incidents (Berg et al., 2005). The challenge of designing an effective EWS escalated even further when the pre-2008 models failed to foresee the severity and international span of this recent global crisis (Candelon et al., 2014). As a result, several modified econometric methods have recently been introduced in the literature, which appear to outperform the traditional techniques in forecasting a specific type of financial crisis, or crises in a specific type of economy. However, no study has attempted to cross-evaluate the performance of these recent methods in forewarning sovereign debt crises in different regions.

The present study attempts to contribute to the literature in several ways. First, given the distinct nature of national economies, their vulnerability to shocks and the effectiveness of their institutions and policy responses, the causes and associated leading indicators of sovereign debt crises can reasonably be expected to differ across countries. Yet, until recently, the focus of

† See e.g. Frankel and Rose (1996), Kaminsky et al. (1998), Demirgüç-Kunt and Detragiache (1998), Peter (2002) and Manasse et al. (2003).
modeling EWS for sovereign defaults was on developing countries only, usually pooled into a single group. Our study, on the other hand, investigates the possibility of signaling indicator differences between developed and developing countries, and between different regions; our results support the notion of regional heterogeneity of forewarning indicators. Next, we evaluate and contrast the predictive performance of two recently developed econometric methods, namely the multinomial logit regression and the dynamic signal extraction approach vis-a-vis our own, novel specification of the binary logit model, in which the crisis variable accounts for all periods in which a country suffered a debt crisis as individual crisis episodes. In addition, we develop and apply a new dynamic-recursive forecasting technique to generate more accurate out-of-sample warning signals. We find that our binary logit specification significantly outperforms that of the multinomial logit and the traditional binary logit models prevalent in the literature, and to some extent also that of the dynamic signal extraction model.

The remainder of the paper is then structured as follows: Section 2 surveys the findings of the previous literature, while Section 3 summarizes the data and performs a preliminary quantitative analysis of the potential EWS indicators. The econometric methods and their results are then outlined in Section 4, the warning indicators and the results of the “horse-race” are presented in Section 5, while Section 6 concludes the paper.

2. Previous literature

Empirical studies that focus on constructing EWS for financial crises have mostly relied on one of two main approaches. Kaminsky et al. (1998) developed the (static) signal extraction approach, a non-parametric method that entails identifying and monitoring certain variables that tend to behave in an unusual manner in the build-up to financial or economic distress. This model is designed so as to signal an impending crisis if these indicators exceed a certain threshold value, calculated as a specific percentile of each indicator’s sample distribution. More recently, Casu et al. (2012) proposed a dynamic (non-sample-specific) choice of the threshold that focuses more on the volatility of the indicators. For this, they specified the threshold as a certain number of standard deviations away from the variable’s long-run mean. Whereas the static approach was developed in the context of currency crises, and the dynamic one for the detection of banking distress, neither specification has been used for the modeling of an EWS for sovereign defaults, with the exception of Savona and Vezzoli (2015).

Frankel and Rose (1996) alternatively proposed the utilization of logit or probit regression models to estimate the probability of an approaching currency crisis. Manasse et al. (2003) and Fuertes and Kalotychou (2006) analogously applied pooled logit models to examine debt crises in emerging economies. Manasse et al. (2003) argued that logit models tend to perform better than probit ones when the dependent variable is not evenly distributed between the two outcomes, i.e. crisis and no crisis; this is usually the case as crisis events are not too common. More recently, Jedidi (2013) attempted to predict sovereign debt crises using a fixed-effects logit model while including a number of developed countries, whereas Pescatori and Sy (2007) and Lausev et al. (2011) applied a random-effects model instead.

It is important to note that EWS that are based on binary dependent variable models, where the crisis variable assumes the value of one for the periods a country is hit by a crisis and zero otherwise, have an inherent endogeneity problem. This is due to the fact that the behavior of the indicator variables is affected both by the crisis itself and the policies undertaken to mitigate it. Furthermore, the signaling indicators can be reasonably expected to behave differently during tranquil times as compared to post-crisis periods, where the economy is undergoing an adjustment process to recover from a crisis. Hence, combining observations of tranquil periods with those of post-crisis ones into a single (zero) group can lead to a form of bias; Bussiere and Fratzscher (2006) referred to this as “post-crisis bias”. To avoid this pitfall, several authors (e.g. Fuertes and Kalotychou, 2007; Savona and Vezzoli, 2015) dropped the post-crisis observations from their sample; however, thereby suffering from loss of information, while others (e.g. Peter, 2002; Manasse et al., 2003) used a dummy variable to allow for different coefficients in the post-crisis periods. Bussiere and Fratzscher (2006), on the other hand, suggested the use of a multinomial crisis variable instead that reflects all three states of the economy. Carlone and Trebeschi (2005), employing an earlier (2002) version of Bussiere and Fratzscher, investigated its performance in predicting debt crisis episodes in the case of emerging economies.

Several other less common methods were proposed in the literature. Fuertes and Kalotychou (2007) used the K-means clustering approach, which entails assigning every observation to the cluster with the nearest mean vector so as to maximize within-cluster similarity and between-cluster discrepancy. However, their results showed that the binary logit regression outperforms this approach in the out-of-sample period. Moreover, Manasse et al. (2003) and Manasse and Roubini (2009) used regression tree analysis, while Fioramanti (2008) applied artificial neural network models to predict sovereign defaults. However, the author noted that despite its better ability to predict crises than probit regressions, neural network models do not give any marginal effects interpretation of the individual signaling indicators, and thus are less useful as a policy tool.

There appears to be a widespread consensus in previous studies regarding significant indicators that could act as explanatory variables for debt crises. In particular, several ability-to-pay indicators are emphasized, such as the external debt ratio, growth in foreign exchange reserves and export earnings, reflecting the ability to service debt. In addition, often highlighted is the importance of current account deficits as a measure of illiquidity risk, and other macroeconomic indicators that affect a country’s capacity to meet its obligations. Further indicators, such as trade openness and measures of macroeconomic stability, were also suggested by the willingness-to-pay approach, pioneered by Eaton and Gersovitz (1981); here defaults are modeled as an event where a sovereign chooses to repudiate its debt if the perceived costs of defaulting are less than the benefits. Additionally, the survey of Reinhart (2002), covering about 60 countries over the period 1979–1999, conveyed that 84% of the sampled debt crises were preceded by a currency crisis. Hence, variables that are well-suited for predicting currency crisis could also be expected to have some explanatory power in EWS for sovereign defaults. Chakrabarti and Zeaiter (2014) carried out a recent comprehensive review regarding these issues, summarizing the empirically significant factors and their observed effect on the probability of sovereign default.

3. Data and preliminary analysis

Our panel consists of 38 advanced and emerging economies during the period 1980–2012. We rely on an annual frequency of the data, as sovereign debt crises tend to last for prolonged periods and show persistence (Manasse et al., 2003). For the construction of the

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2 This is mainly due to the fact that there were previously no major concerns about governments in developed countries not being able to meet their obligations to an extent that would progress into a serious debt crisis.

3 See Table 1 in Chakrabarti and Zeaiter (2014).
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