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Assessing sovereign default risk: A bottom-up approach

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ABSTRACT

This study assesses sovereign default risk of individual U.S. states utilizing information about default risk at the company level. We link integrated risk factors of the private sector to the overall sovereign risk of state governments in conjunction with additional financial variables. Using data on Moody's KMV expected default frequencies (EDFs) on corporate default risk, we derive credit risk indicators for different industries. Building on these measures, we then develop state level credit risk indicators encompassing industry compositions to explain the behaviour of credit default swap (CDS) spreads for individual states. We find that market-based measures of private sector credit risk are strongly associated with subsequent shifts in sovereign credit risk premiums, as measured by CDS spreads. The developed credit risk indicators are highly significant in forecasting sovereign CDS spreads at weekly and monthly sampling frequencies. Overall, our findings suggest a strong predictive link between market expectations of private sector credit quality and expectations of sovereign credit quality - a connection that is not directly discernible from scoring models.

1. Introduction

In recent years there has been an increased interest in sovereign credit risk, see, e.g., Pan and Singleton (2008), Caceres et al. (2010), Ang and Longstaff (2013), Longstaff et al. (2011), Aizenman et al. (2013), Janus et al. (2013). Sovereign risk is typically measured by credit spreads associated with the probability of default (PD) on sovereign debt securities, as there is uncertainty about receiving scheduled payments on time. Since the onset of the global financial crisis (GFC), Europe in particular has been the focus of much of this concern. While research on sovereign risk and advanced risk management tools had also accumulated before the European debt crisis, the crisis was unforeseen by many market participants. Despite being preceded by the GFC, in early 2009 neither observed CDS spreads nor ratings for European sovereign entities provided an indication of the magnitude of the soon-to-occur sovereign debt crisis. This may indicate a need to assess and predict sovereign credit risk using more responsive measures based on additional risk sources. Further, despite much effort from governments and global financial institutions, sovereign debt sustainability remains a major concern, which motivates us to develop a new framework for predicting sovereign default risk.

This study provides a new bottom-up approach to assess sovereign default risk at the state-level for 18 state governments in the U.S. As argued by Ang and Longstaff (2013), each U.S. state government retains the authority to establish its independent legal system and the ability to issue state bonds. As a result, state bonds are similar to federal bonds

and the economic behaviour of a state government can be considered as being similar to a sovereign entity. Given the recent financial distress of large municipalities such as Detroit or the U.S. territory of Puerto Rico, we also believe that a deeper analysis of sovereign debt at the state level is an important exercise more generally. We start with Moody's KMV expected default frequencies (EDFs) to assess credit risk at the corporate level for industries of economic importance. We then aggregate information extracted from EDFs at the company level to develop industry credit risk indicators (ICRIs). In a second step, the constructed ICRIs are then used to derive state credit risk indicators (SCRIs), based on the industry composition of each state. We thus calculate real-time bottom-up credit risk indicators at the state-level. Clearly, our motivation for constructing the SCRIs is to better understand whether variation in default risk in the private sector can presage market views on a sovereign's ability to service its debt obligations. Our study follows the motivation of Altman and Rijken (2011) in investigating the influence of the private sector on a sovereign entity's default risk. We assume that publicly listed companies contribute to a sovereign entity's wealth and, thus, also to its risk of default. The derived SCRIs are then investigated with regards to their predictive power for changes in credit default swap (CDS) spreads for the individual states. We find that the derived market-based measures of private sector credit risk are strongly associated with subsequent shifts in sovereign credit risk premiums, as measured by CDS spreads. Overall, the developed SCRIs are highly significant in forecasting sovereign CDS spreads at weekly and monthly sampling frequencies.

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Traditionally, the assessment of sovereign risk has relied heavily on macroeconomic variables containing information on economic conditions and aggregated national accounts. A variety of econometric frameworks using macroeconomic variables have been applied to explain the behavior of sovereign risk over time. [Grinols \(1976\)](#) applies both discriminant and discrete analysis to a sample of 64 nations to identify five significant national account variables in his assessment of debt service capability. [Morgan \(1986\)](#) studies debt rescheduling based on new short-term debt data and variables representing economic shocks, using logit and discriminant models. A more recent example is [Haugh et al. \(2009\)](#), where a range of macroeconomic explanatory variables are incorporated in a panel model to study sovereign spread differentials among European countries. Others studies such as [Fuertes and Kalotychou \(2004\)](#) and [Hilscher and Nosbusch \(2004\)](#) also examine the predictive power of similar variables.

A common approach across all these studies is the reliance on macroeconomic data, such as annual GDP growth rates, the balance of trade, tax receipts, debt servicing ratios, or similar. Although there is a significant body of research supporting the explanatory power of macroeconomic variables, the forecasting ability of these variables for crises or changes in credit quality of sovereigns has been questioned. In a comprehensive overview paper, [Babbel \(1996\)](#) argues that macroeconomic forecasting approaches generally fail to perform satisfactorily, and that the claimed predictive power of macroeconomic models is only illusory. The author argues that, upon closer inspection, the studies are mostly unsuccessful. [Bertozi \(1995\)](#) also questions the ability of macroeconomic models to provide a signal for early warning. One possible reason for the inadequate response times of macroeconomic models are the infrequent updates of input data, which are also subject to delayed release by government statistical offices. Thus for timely projections of changes in sovereign risk, it might be more beneficial to identify early warning signals in order to harness the limited time that policy makers and financial managers typically have to change strategies ([Bertozi, 1995; Neziri, 2009](#)). Models that only use one set of observations per year will undoubtedly have difficulties in capturing changes in sovereign risk in a timely manner ([Oshiro and Saruwatari, 2005](#)). [Aizenman et al. \(2013\)](#) also argue that while macroeconomic factors are statistically and economically important determinants of sovereign risk, the pricing of this risk for Eurozone periphery countries is not predicted accurately either in-sample or out-of-sample with these factors.

Therefore, over the last decade, sovereign risk has typically been measured by more timely and frequently available data from financial variables such as sovereign bond prices or CDS spreads. Examples include [Pan and Singleton \(2008\)](#), [Beber et al. \(March 2009\)](#), [Hui and Chung \(2011\)](#), [Fender et al. \(2012\)](#), [Aizenman et al. \(2013\)](#), [Ang and Longstaff \(2013\)](#), [Arce et al. \(2013\)](#), [Calice et al. \(2013\)](#), [Groba et al. \(2013\)](#), [Janus et al. \(2013\)](#), [Dewachter et al. \(2015\)](#), and [Chen et al. \(2016\)](#). Recent studies have focussed on CDS spreads in particular, since they provide a more direct measure of sovereign risk. [Pan and Singleton, 2008](#) analyze default risk and recovery rates implicit in the term structure of sovereign CDS spreads. [Ang and Longstaff \(2013\)](#) adopt CDS spreads for the U.S. Treasury, individual U.S. states, and major Eurozone countries, to study the nature of systemic sovereign credit risk. [Aizenman et al. \(2013\)](#) examine CDS as a measure of sovereign default risk and argue that CDS spreads provide a good proxy for market-based pricing of default risk. The authors also provide a market-based real-time indicator of sovereign credit quality and default risk. [Beber et al. \(2009\)](#), [Arce et al. \(2013\)](#), [Calice et al. \(2013\)](#) focus on price discovery, liquidity spill-over and flight-to-quality effects in the sovereign CDS market. [Groba et al. \(2013\)](#) focus on financially distressed economies inside the European Union and their impact on the CDS market.

One limitation of these studies in assessing sovereign risk is that so far little attention is given to the private sector, which can yield a more direct measure of economic activities within a sovereign entity.

Generally, the productivity, profit and economic performance of companies in a state can be expected to have a direct impact on tax receipts and the wealth of a sovereign government. As a result, the financial health of a sovereign entity will be sensitive to financial crises, the poor performance of major industries in a state or a slowdown of the economy. Incorporating forward-looking company level information into the risk assessment process therefore has the potential to provide important fundamental information that may help predict financial distress at the state or government level. Due to the importance of measuring default risk at the firm level in financial markets, credit rating agencies such as Standard & Poor's, Fitch or Moody's KMV provide timely information on default risks at the company level ([Trück and Rachev, 2009](#)).

To take advantage of the abundant company level data for assessing sovereign risk, [Altman and Rijken \(2011\)](#) were among the first to propose a bottom-up approach to incorporate private sector information in the assessment process, considering this information as a crucial determinant of sovereign risk. They test the predictive power of factors generated from listed companies at country level, assuming that sovereign financial health relies on the economic performance of the private sector. [Altman and Rijken \(2011\)](#) focus on major European countries during the debt crisis and assess the probability of sovereign default based on the credit risk of the private sector. Their prediction model demonstrates greater effectiveness in providing advance warnings compared to those of credit rating agencies. Incorporating listed company information also enlarges the available data points and gives greater opportunity for investigating sovereign default risk.

A potential disadvantage of the approach developed by [Altman and Rijken \(2011\)](#) is its reliance on corporate credit scores, based on infrequently updated variables such as company leverage, profitability, and liquidity. Thus, corporate credit scores may provide a picture of retrospective rather than prospective company performance. In addition, macroeconomic variables such as GDP growth and inflation, that are available at a low frequency only, are also included into the model ([Altman and Rijken, 2011](#)).

To overcome these shortcomings, this study assesses sovereign risk at the state level, using market variables encompassing industries of economic importance to each state. However state government defaults are different from corporate defaults because of different legal enforcements. Unlike the bankruptcy procedure following the default of a company, a state government's assets cannot be credibly liquidated or transferred to the debtor ([Ang and Longstaff, 2013](#)). Therefore, we argue that state governments can be considered as independent sovereign entities. Our motivation is to better understand whether variation in default risk in the private sector can improve prediction for a sovereign's ability to service its debt obligations. Our study follows the motivation of [Altman and Rijken \(2011\)](#) by investigating the influence of the private sector on a sovereign entity's credit risk. We assume that publicly listed companies contribute to a sovereign entity's wealth and also its risk of default, and use Moody's KMV EDFs for individual companies to create industry-level and state-level credit risk indicators. EDFs are forward-looking measures of default risk, based on the structural model developed by [Merton \(1974\)](#) combined with information on historical defaults. The accuracy of EDFs for predicting defaults has been documented in a number of studies, see, e.g. [Kealhofer \(2003\)](#), [Dwyer and Korabev \(2007\)](#), [Bharath and Shumway \(2008\)](#). Next to the developed EDF-based industry- and state-level credit risk indicators, our model also incorporates additional financial variables that have been suggested to have predictive power for default risk. In contrast to previous studies, we use a bottom-up approach to predict sovereign CDS spreads that may be particularly useful for capturing and forecasting short-term changes in sovereign risk. Due to the inclusion of SCRIs, the proposed models may be able to better predict state CDS spreads at the weekly and monthly frequency. Thus, they could prove to be helpful to participants in financial markets, in particular those who trade credit-default swaps or other

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