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# Modelling country default risk as a latent variable: a Multiple Indicators Multiple Causes (MIMIC) approach

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We study the determinants of country default risk by applying a Multiple Indicators Multiple Causes (MIMIC) model. This accounts for the fact that country default risk is an unobservable variable. Whereas existing (regression-based) approaches typically use only one of several possible country default risk indicators as the dependent variable, the MIMIC model enables us to consider several indicators at once. The simultaneous consideration of sovereign yield spreads and S&P ratings may help to improve the identification of the latent country default risk. Our results confirm most of the literature's main findings regarding important determinants of country default risk, refute others and provide new evidence to controversial questions.

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## I. Introduction

Country default risk, or sovereign risk, is an important issue in international lending – in particular in lending to developing and emerging market countries – since a country’s potential inability or unwillingness to make debt servicing payments influences the lender’s expected profit and, hence, its investment decision. A proper assessment of country default risk should help to reduce inefficiencies in international lending, on the one hand, by avoiding over-borrowing and the evaporation of capital during financial crises and, on the other hand, by avoiding tightening of capital supply and overpricing (in terms of high interest rates). Much scientific work has, thus, been dedicated to the assessment of country default risk, especially its determinants. Knowing the determinants of country default risk may enable investors to assess the risk of a debt crisis and may help the governments in emerging countries to lower the risk of a debt crisis.

One major problem in assessing country default risk is that it is a latent variable that is, even *ex-post*, unobservable. Thus, whether a country has defaulted or not during a specific (forecast) period is observable but the probability of default is not. Robert Engle’s (1993) simile that “volatility forecasting is a little like predicting whether it will rain; you can be correct in predicting the probability of rain, but still have no rain,” also applies in the context of country default risk.

Because country default risk itself cannot be observed, scientific studies use several indicators for its approximation. One strand considers yield spreads between default risky government bonds of the respective country and the US treasury yield curve.

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3 Edwards (1986), Eichengreen and Mody (1998) and Min (1998), e.g., use issuance  
4 spreads, whereas Cantor and Packer (1996), Kamin and von Kleist (1999), Arora and  
5 Cerisola (2001), Rowland and Torres (2004) include spreads observed on secondary bond  
6 markets.<sup>1</sup> Another strand of the literature applies ratings provided by major rating  
7 agencies or business journals. Cantor and Packer (1996) and Afonso (2002) use ratings of  
8 S&P and Moody's in OLS regressions; Mulder and Perrelli (2001) include these ratings  
9 in a Panel framework. Rowland (2004) and Rowland and Torres (2004) consider the  
10 ratings by Institutional Investor in addition to those of S&P and Moody's.  
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22 Yield spreads and ratings represent country risk assessments made by different  
23 groups of agents with different incentives. While bond yield spreads are determined by (a  
24 multitude of) investors in the sovereign bond market, country ratings are determined by  
25 (small groups of) experts working for the agencies. The latter are not directly exposed to  
26 the risk of capital losses, but paid by the rated debtor countries whereas the former face  
27 potential capital losses but gain from increasing prices. It follows that both types of  
28 indicators may provide different assessments of country default risk. Although these  
29 indicators are closely related they contain different information, which is shown in  
30 several important empirical contributions (see, e.g., Cantor and Packer, 1996; Larrain et  
31 al., 1997; Scholtens, 1999, 2002). For example, ratings and spreads behave differently in  
32 time and ratings do not fully explain spreads in regression models. Thus, theoretical  
33 considerations as well as empirical findings suggest that the content of information and  
34 the risk assessment of both types of indicators differ.  
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56 <sup>1</sup> The existing literature is overviewed in Table A.1 in the Appendix and the results concerning  
57 determinants are discussed in more detail in Section III.  
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3 While the literature provides interesting results by applying regression approaches  
4 with only one indicator as the dependent variable, we contribute to the literature with an  
5 approach that allows simultaneous consideration of more than one indicator.<sup>2</sup> Using a  
6 structural equations model, more precisely a Multiple Indicators Multiple Causes  
7 (MIMIC) model, we treat country default risk as an unobservable variable that is  
8 approximated by applying two observable indicators.<sup>3</sup> In the application of the model, we  
9 simultaneously use yield spreads provided by JP Morgan's Emerging Market Bond Index  
10 (EMBI<sup>+</sup>) and sovereign ratings by Standard and Poor's (S&P). As explained above these  
11 indicators reflect an (at least slightly) different approximation of country default risk.  
12 Including both types of indicators, thus, considers more information and provides a better  
13 approximation of country default risk than using just one single indicator. Hence, our  
14 model may yield more precise results than alternative approaches and enables us to verify  
15 the results of the existing literature.  
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34 We proceed as follows. Section II explains the MIMIC model in detail. Section III  
35 presents the application of the model and discusses the indicators, causal variables and  
36 the data sample. The estimation results are presented in Section IV. Section V concludes.  
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48 <sup>2</sup> Some researchers are interested in the determinants of the indicator variables themselves rather than in  
49 their role as indicators for country default risk. If so, a regression using the respective variables as the  
50 dependent one is the natural choice. Since we are interested in the latent country default risk and in the role  
51 of the variables as risk indicators a MIMIC model seems to be an interesting alternative.  
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55 <sup>3</sup> MIMIC models have become popular in other fields dealing with latent economic phenomena such as the  
56 shadow economy and smuggling (see, e.g., Dell'Anno and Schneider, 2003; Buehn and Eichler, 2009).  
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## II. Methodology

The MIMIC model explains how observable causal variables determine the level of a latent phenomenon, like country default risk, which is approximated by several observable indicators.<sup>4</sup> Formally, the MIMIC model consists of two parts: the structural equation model and the measurement model. The structural equation model can be represented by:

$$\eta_t = \gamma'x_t + \zeta_t \quad (1)$$

where  $x_t' = (x_{1t}, x_{2t}, \dots, x_{qt})'$  is a  $q$  vector and each  $x_{it}$ ,  $i = 1, \dots, q$ , is a possible manifest cause of the latent variable  $\eta_t$ .<sup>5</sup> Here,  $\gamma' = (\gamma_1, \gamma_2, \dots, \gamma_q)'$  is a  $q$  vector of coefficients describing the relationships between the latent variable  $\eta_t$  and its causes. Thus, country risk is determined by a set of exogenous causes. Since they explain  $\eta_t$  only partially, the error term  $\zeta_t$  represents the unexplained component. Its variance is denoted by  $\psi$ .

The measurement model represents the link between the latent variable and its indicators, i.e. the latent variable determines its indicators. The measurement model is specified by:

$$y_t = \lambda\eta_t + \varepsilon_t \quad (2)$$

where  $y_t' = (y_{1t}, y_{2t}, \dots, y_{pt})'$  is a  $p$  vector of several indicator variables,  $\lambda$  is a  $p$  vector of regression coefficients and  $\varepsilon_t$  is a  $p$  vector of white noise disturbances. Their  $(p \times p)$  covariance matrix is denoted by  $\Theta_\varepsilon = E(\varepsilon_t \varepsilon_t')$ .

<sup>4</sup> Such types of models were first introduced into economics by Jöreskog (1970). For a more comprehensive description see, e.g., Bollen (1989) or Buehn et al. (2009).

<sup>5</sup> The subscript  $t$  indicates the time series dimension of the variables.

Substituting Equation 1 into Equation 2 yields a reduced form regression model where the indicators  $y_t$  of the latent variable  $\eta_t$  are the endogenous variables and the causes  $x_t$  the exogenous variables. This model can be written as:

$$y_t = \Pi x_t + z_t, \quad (3)$$

where  $\Pi = \lambda\gamma'$  is a  $(p \times q)$  matrix and  $z_t = \lambda\zeta_t + \varepsilon_t$ . The error term  $z_t$  in Equation 3 is a  $p$  vector of a linear transformation of the white noise error terms  $\zeta_t$  and  $\varepsilon_t$  resulting from the structural equation and measurement models, i.e.,  $z_t \sim (\theta, \Omega)$ . The covariance matrix  $\Omega$  is given as  $\Omega = \text{Cov}(z_t) = E[(\lambda\zeta_t + \varepsilon_t)(\lambda\zeta_t + \varepsilon_t)'] = \lambda\psi\lambda' + \Theta_\varepsilon$ .

Since the latent variable is not observable, its size is unknown and the parameters of the model must be estimated using the variances and co-variances of the observables. The goal of the estimation procedure is thus to estimate the MIMIC model's covariance matrix  $\Sigma(\theta)$ ,  $\hat{\Sigma} = \Sigma(\hat{\theta})$ , that is as close as possible to the sample covariance matrix of the observed causes and indicators.<sup>6</sup> Identification and estimation of the model is however not possible without placing restrictions on certain model parameters. Among others, a restriction often imposed on the model is that one element of the vector  $\lambda$ , i.e., one indicator, is set to an *a priori* value (often 1 or -1). In this way the researcher also establishes an interpretable scale for the latent variable (Bollen, 1989, pp. 91, 183).<sup>7</sup>

In the first step, the researcher selects those causes and indicators that are appropriate to define the latent variable and which address the hypothesized theoretical relationships.

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<sup>6</sup>  $\theta$  is a vector that contains the parameters of the model and  $\Sigma(\theta)$  is the covariance matrix as a function of  $\theta$  implying that each element of the covariance matrix is a function of one or more model parameters.

<sup>7</sup> An alternative is to set the variance of the unobservable variable  $\eta_t$  to one. However, fixing one element of  $\lambda$  to an *a priori*-value is often more convenient for economic interpretation and thus often applied (Dell'Anno and Schneider, 2009).

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3 After model identification and determination of the latent variable's scale, the  
4 coefficients and model parameters are estimated and the hypothesized relationships  
5 between the latent variable and its causes and indicators are tested. Before we turn to the  
6 empirical specification and the concrete path diagram of the MIMIC model of country  
7 default risk in Section IV, the following section presents the theoretical reasoning for the  
8 selection of causes and indicators in the next.  
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### 20 **III. Empirical Analysis**

#### 21 *Indicators of country default risk*

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23 Previous studies employ either market information, reflected by bond yield spreads, or  
24 expert ratings as indicator for country default risk. We simultaneously consider both  
25 types of indicators that provide instant assessment of default risk. Like many other  
26 studies, we use ratings assigned by S&P, one of the major rating agencies. For sovereign  
27 yield spreads, we consider data from the EMBI<sup>+</sup> provided by JP Morgan for the first  
28 trading day of every year.  
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40 Data on S&P ratings are obtained from "Sovereign Ratings History Since 1975,"  
41 provided at S&P's website.<sup>8</sup> We consider the long-term rating for foreign currency debt  
42 valid at the beginning of each year. For the quantitative analysis we transform the ratings  
43 into numerical values. To be as precise as possible we assign a different numerical value  
44 for each rating grade as displayed in Table A.2 in the Appendix. In addition, we assign  
45 different numerical values for different statements in the outlook, i.e., negative, stable or  
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58 <sup>8</sup> See <http://www2.standardandpoors.com>.  
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3 positive. As a result, there are several numbers for each rating grade.<sup>9</sup> Since we assume a  
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5 nonlinear relationship between country default risk and ratings, we calculate the natural  
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7 log of the resulting numerical values, as it is done in other studies.  
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10 The data from JP Morgan's EMBI<sup>+</sup> used in our analysis is the average of data  
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12 from the most liquid bond issues. Using these averaged numbers rather than data from  
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14 single issues curbs the influence of potential price distortions concerning single issues.  
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16 We consider so-called stripped spreads, which are derived from adjusted prices that result  
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18 by subtracting collaterals from the observed prices.<sup>10</sup>  
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#### 24 *Potential determinants of country default risk*

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27 In the following, we discuss the causal variables used in the application of the MIMIC  
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29 model, which describe potential determinants of latent country default risk. In specifying  
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31 these variables we use the results of the literature.<sup>11</sup> The explanatory variables found in  
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33 the literature can be divided into several groups.<sup>12</sup>  
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41 <sup>9</sup> In addition to this (regular) outlook, S&P occasionally states that it will consider a particular borrower for  
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43 a possible rating change (i.e., put it on a "watch list") in the near future. We include this information by  
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45 adding or subtracting 0.5 from the integer value corresponding to the current rating.

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47 <sup>10</sup> Both Eurobond and Brady bond data are included in the calculation of the EMBI<sup>+</sup>. Brady bonds are  
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49 typically collateralized. Thus, stripped spreads (where the collateral value is subtracted from the observed  
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51 prices) reflect country default risk better than "raw" blended spreads.

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53 <sup>11</sup> See Table A.1 in the Appendix. Here, we additionally consider studies that use default dummies as  
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55 dependent variable. These default dummies, in contrast to ratings and spreads, give no instant indication of  
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57 default risk, they only provide an *ex-post* assessment of whether a default has occurred or not. Thus, they  
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59 cannot be used as instantaneous risk indicators for investors trying to measure the country default risk on  
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3 One important group comprises rather general measures of the country's current  
4 economic state of development and its future prospects. While GDP per capita reflects a  
5 country's current situation, its investment ratio is related to its future development since  
6 investment fosters economic growth. Keeping in line with the literature, we expect these  
7 variables to have a negative influence on country default risk, i.e., higher values of the  
8 explanatory variables correspond to lower country default risk.  
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12 Another important variable is the country's *openness* measured typically by the  
13 ratio of the sum of exports and imports to GDP. Some important theoretical contributions  
14 (for an overview see, e.g., Eaton et al., 1986; or Eaton and Fernandez, 1995) state that  
15 enforcement problems and a country's *(un)willingness to pay* play a major role in the  
16 occurrence of debt crises. According to this literature more open countries are less  
17 willing to default on their debt than less open countries as the costs of trade disturbances  
18 – typically associated with a default – are higher.  
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22 Other variables related to the external sector reveal whether a country is able to  
23 accumulate foreign exchange for the purpose of debt servicing. Of course the existing  
24 foreign exchange reserves itself are important in this respect. We use reserves to imports  
25 and reserve growth in our analysis since these variables were frequently found to be  
26 significantly (negatively) correlated with country default risk in the literature. Besides the  
27 existing foreign exchange reserves also foreign exchange inflows caused by international  
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30 their investment. Nevertheless, the results with respect to determinants may give interesting hints for our  
31 research question.  
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35 <sup>12</sup> Often the employed variables differ slightly between studies. Including all of these variables  
36 simultaneously would be problematic due to multi-co-linearity. Thus, we choose the most popular variables  
37 for our analysis.  
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3 trade are important. Thus, we include the trade balance and the growth rate of exports in  
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5 our analysis. Better terms of trade are important as well because they increase a country's  
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7 ability to accumulate resources for debt servicing.  
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10 In addition to the ability to provide funds for debt servicing, *the payment*  
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12 *requirements resulting from outstanding debt* are also found to be significant in the  
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14 literature. Thus, we include total debt to GDP in our analysis. This variable rather  
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16 measures possible solvency problems, whereas a number of studies emphasizes that also  
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18 liquidity issues and the composition of debt are important. Thus, we include the debt  
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20 service ratio, i.e., short-term debt payment requirements to exports and the ratio of short-  
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22 term to total debt.  
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27 The last group of country-specific determinants of country default risk is related  
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29 to the monetary situation. Several studies consider these indicators as the monetary sector  
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31 influences the economic performance and, hence, the ability to service debt. We use  
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33 inflation and changes in the money supply in our analysis, which are found to be  
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35 positively correlated with country default risk in the literature.  
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39 Besides these country-specific variables, the US interest rate as an indicator of  
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41 changing lending conditions in the world economy is analyzed in several studies. The  
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43 literature is divided over the influence of the US interest rate: some studies find it to be  
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45 significant while other do not.<sup>13</sup>  
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54 <sup>13</sup> As shown in Table A.1, Eichgreen and Mody (1998) and Arora and Cerisola (2001) find significant  
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56 influence of the risk-less US interest rate, whereas Min (1998) and Kamin and von Kleist (1999) find the  
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58 US interest rate to be insignificant.  
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#### IV. Results

In the application of the MIMIC model, we consider annual data from 31 countries from 1994 to 2006. The sample is determined by the availability of data on EMBI<sup>+</sup> spreads and ratings. This implies also that the time series for some countries start after 1994. We consider annual data for two reasons: first, we are interested in the long-term rather than short-term determinants of default risk; and, second, many of the economic variables are not available at a higher frequency.

Clearly, most causal variables belonging to the same group are highly correlated, which hampers the analysis of significant influence. Thus, we run several regressions where we exchange a causal variable for a different variable from the same group.<sup>14</sup> Column 1 of Table 1 presents the results for the benchmark model for which the path diagram is shown in Fig. 1. Columns 2 to 7 of Table 1 present the results for the alternative MIMIC model specifications.

[Table 1 and Fig. 1 here]

Our analysis confirms most of the literature's results with respect to significant explanatory variables. The benchmark model reveals that openness is the most important variable to explain country default risk, followed by GDP per capita, the inflation rate and total debt to GDP. Overall, the importance of these variables is robust across all estimated model specifications with the expected sign. The debt service ratio is

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<sup>14</sup> As in the regression models typically used in the literature, the time series in MIMIC models are assumed to be stationary. We test this hypothesis and find all variables used in the estimations to be stationary. Results are available upon request.

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3 significant with the expected positive sign for all specifications with the exception of  
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5 model 3. Reserve growth and terms of trade change have no significant influence in the  
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7 benchmark model.  
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10 In model 2, we exclude the debt service ratio from the benchmark model to test  
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12 the influence of the ratio of short-term to total debt, for which we do not find significant  
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14 influence. The fact that – in contrast to the ratio of short-term debt to total debt – the  
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16 other debt figures are significant indicates that *indebtedness* influences country default  
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18 risk, regardless of whether *solvency or liquidity* aspects are considered. We do not find  
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20 significant influence for the terms of trade or for trade balance to reserves (tested in  
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22 model 5), which is in line with the findings of some other articles. Still, the significantly  
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24 (negative) influence of export growth (as shown by model 3) indicates that the *external*  
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26 *sector and a country's ability to acquire foreign exchange through trade* does influence  
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28 country default risk. We also find evidence that high *reserves* may reduce country default  
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30 risk. This can be seen since reserve growth (at least for some specifications) and reserves  
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32 to imports (model 4) show significant influence. The *monetary variables* are also  
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34 significantly related to country default risk, regardless of whether we consider the  
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36 inflation rate or changes in money supply (model 6). Higher measures of both variables  
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38 increase country default risk. The *US interest rate* is, by contrast, not found to be  
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40 significant (model 7). Thus, our results contribute to the debate in the literature on  
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42 whether the US interest rate is important for country default risk or not by providing  
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44 evidence that this is not the case.  
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53 Section II explains that estimation of a MIMIC model requires imposing  
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55 assumptions on the model and a popular, widely used one is to normalize one indicator of  
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57 the latent variable by setting its coefficient to a nonzero value. In our MIMIC model, we  
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3 set the coefficient of the S&P ratings to 1. We choose this indicator because rating  
4 agencies assign a “default” rating for every defaulting country, i.e., every country that  
5 defaults receives the same rating and, thus, the same index value.<sup>15</sup> Observed spreads, on  
6 the other hand, differ widely between different defaulted countries (although they are  
7 very high for every defaulted country).<sup>16</sup> Turning now to the interpretation of the  
8 indicators, we see that they are consistent for all estimated specifications. As expected,  
9 we always find a strong, significant, positive relationship between country default risk  
10 and EMBI<sup>+</sup> spreads, which confirms the findings of the existing literature. Both EMBI<sup>+</sup>  
11 spreads and ratings appear to be reliable indicators of country default risk. The slight  
12 difference between the standardized coefficients for both variables leads us to the  
13 conclusion that (under the assumptions of the MIMIC approach) the S&P ratings do a  
14 slightly better job in indicating country default risk than the EMBI<sup>+</sup> spreads.  
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32 In order to assess the models’ fit, Table 1 reports the main *goodness-of-fit*-statistics  
33 such as the chi-square, the Goodness-of-Fit Index (GFI) and the degrees of freedom. The  
34 *chi-square*-tests whether the model fits the data perfectly, i.e. it tests  $\Sigma = \Sigma(\theta)$ . Smaller  
35 values indicate a better fit, i.e., a smaller chi-square does not reject the null hypothesis  
36 that the model reproduces the sample covariance matrix of causes and indicators. The  
37 Root Mean Squared Error of approximation (RMSEA) measures the model’s fit based on  
38 the difference between the covariance estimated and the actual covariance matrix.  
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50 <sup>15</sup> To be precise, S&P uses two different default ratings: ‘D’ for default and ‘SD’ for selected default. The  
51 two ratings are nevertheless much more alike than observed spreads within default countries.  
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54 <sup>16</sup> Even defaulted bonds are not completely worthless after default since the bond holder can expect a  
55 certain nonzero recovery rate. Since these expected recovery rates differ across countries, the spreads of  
56 defaulted bonds differ widely.  
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3 *RMSEA*-values smaller than 0.05 indicate a good fit (Browne and Cudeck, 1993). This is  
4 true for all estimated model specifications. We thus conclude that the model fits the data  
5 reasonably well and our results are robust across all estimated MIMIC model  
6 specifications.  
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## 14 15 **V. Conclusion**

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18 In this article, we examine the determinants of country default risk using a MIMIC  
19 model. This approach accounts for the fact that country default risk – even *ex-post* – is an  
20 unobservable variable that can be only approximated with observable indicators.  
21 Contrary to regression models typically used in the literature, where one single indicator  
22 is used to identify country risk, the MIMIC approach enables us to consider more than  
23 one indicator to identify the latent country default risk. We employ country default risk  
24 assessments based on two types of indicators: bond spreads, provided by JP Morgan's  
25 Emerging Market Bond Index<sup>+</sup>, and ratings, provided by Standard and Poor's. Since the  
26 use of more than one indicator likely improves the approximation of the latent variable,  
27 we may be able to yield more precise results and, thus, verify the results of the literature  
28 with respect to our research question: what are the main determinants of country default  
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46 Our results confirm most of the literature's findings refute others and provide new  
47 evidence for issues still being debated. We find that the most important determinants of  
48 country default risk are openness, GDP per capita and inflation. The investment ratio,  
49 foreign exchange reserves, changes in the money supply, total debt to GDP and the debt  
50 service ratio are also significant. Contrary to some previous articles, we do not find  
51 significant influence for the composition of debt, i.e., the ratio of short-term to total debt.  
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3 With respect to the controversially discussed US interest rate, our results support the  
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5 strand of the literature that objects a significant influence of this variable on country  
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7 default risk.  
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10 The overall fit is quite good for every specification and both types of indicators  
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12 approximate the latent country default risk nearly equally well. All in all, the MIMIC  
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14 approach yields plausible and interesting results that confirm most previous findings.  
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16 Additionally, it enables a more accurate risk approximation by including more than one  
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18 indicator.  
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For Peer Review

**Table 1. Results of the MIMIC Model Estimations (Standardized Coefficients)**

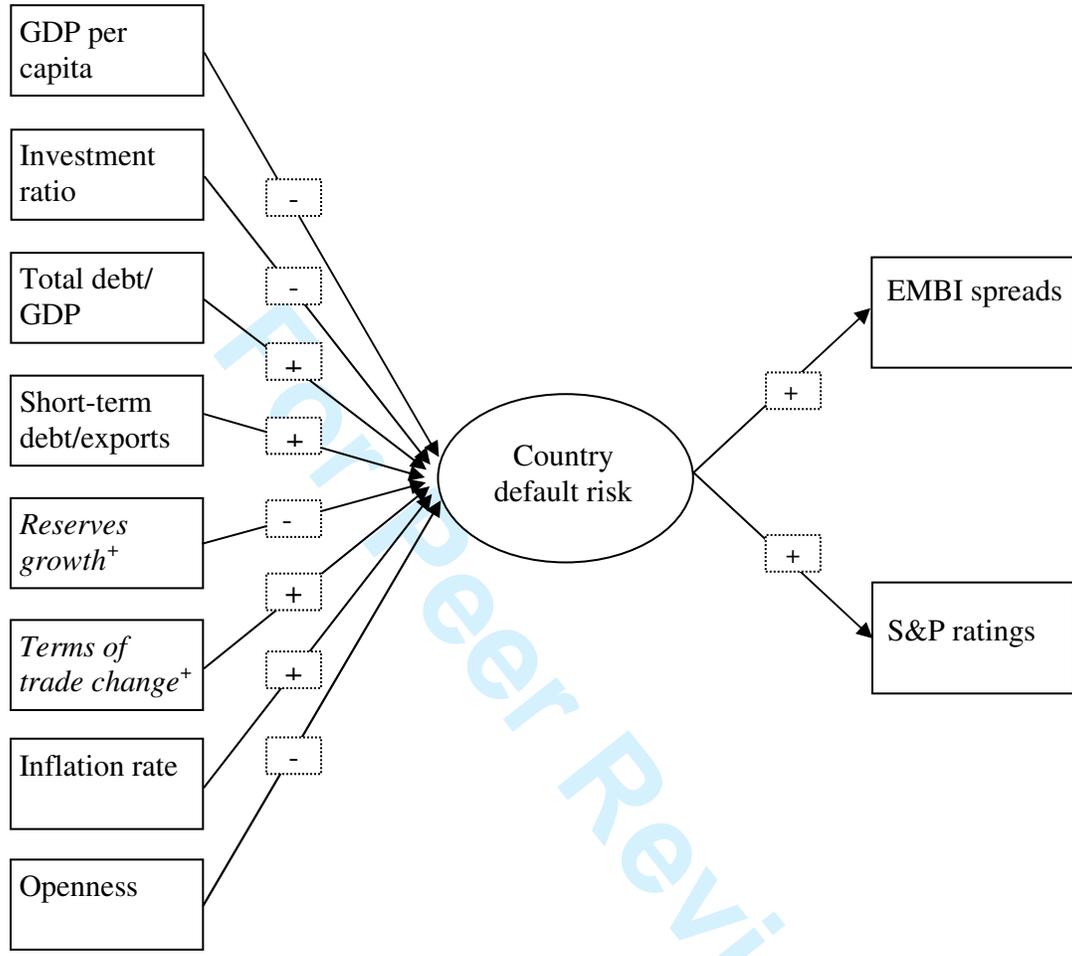
<i>Causes:</i>	<i>Specification:</i>	1	2	3	4	5	6	7
GDP per capita		-0.28*** (-7.21)	-0.27*** (-8.63)	-0.20*** (-5.29)	-0.28*** (-7.32)	-0.30*** (-7.62)	-0.33*** (-8.76)	-0.27*** (-6.82)
Investment ratio		-0.15*** (-3.96)	-0.19*** (-5.50)	-0.09*** (-2.63)	-0.17*** (-3.93)	-0.17*** (-4.23)	-0.21*** (-5.01)	-0.14*** (-3.72)
Total debt / GDP		0.25*** (7.22)	0.28*** (7.57)	0.32*** (8.84)	0.23*** (6.88)	0.21*** (5.98)	0.21*** (6.15)	0.28*** (8.65)
Short-term debt / exports		0.10*** (3.20)		0.03 (0.89)	0.13*** (4.89)	0.12*** (3.54)	0.15*** (4.07)	0.10*** (3.13)
Short-term debt / total debt			-0.03 (-0.98)					
Reserves growth'		-0.06 (-1.47)	-0.07** (-1.98)	-0.10*** (-2.47)		-0.06 (-1.58)	0.01 (0.22)	-0.06 (-1.59)
Reserves / Imports ratio					-0.07* (-1.80)			
Trade balance / Reserves						0.03 (1.34)		
Change of the Term of trade		-0.01 (-0.24)	-0.01 (-0.16)		0.00 (0.04)		-0.01 (-0.25)	-0.02 (-0.44)
Exports growth'				-0.12*** (-2.71)				
Inflation rate		0.26*** (11.36)	0.25*** (11.14)	0.25*** (10.76)	0.26*** (11.51)	0.27*** (11.49)		0.24*** (11.05)
Change of money supply							0.18*** (5.06)	
Openness		-0.37*** (-9.38)	-0.41*** (-12.27)	-0.47*** (-12.13)	-0.36*** (-8.38)	-0.37*** (-9.48)	-0.34*** (-8.76)	-0.40*** (10.432)
US interest rate								-0.01 (-0.30)

<b>Indicators:</b>	<b>Specification:</b>	1	2	3	4	5	6	7
EMBI <sup>+</sup> spreads		0.86*** (27.51)	0.88*** (28.73)	0.86*** (31.25)	0.84*** (27.23)	0.84*** (27.51)	0.80*** (23.54)	0.88*** (29.53)
S&P ratings		0.98	0.96	0.98	0.98	0.98	1.00	0.97
<b>Goodness of Fit Indices:</b>								
No. of observations		242	242	242	242	242	242	242
Degrees of freedom		43	43	43	43	43	43	43
Chi-square		50.05	54.84	119.53	25.20	66.20	62.83	79.48
GFI		0.96	0.95	0.91	0.98	0.95	0.95	0.96
RMSEA		0.03	0.3	0.09	0.00	0.05	0.04	0.05

Note: All calculations have been carried out using LISREL<sup>®</sup> 8.80; z-statistics in parentheses; \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% level, respectively. The standardized coefficients indicate the response of the latent variable, *ceteris paribus*, for a one standard deviation-change in an explanatory, causal variable, indicating the relative effects of the causes on the latent variable (Bollen, 1989). The degrees of freedom are determined by  $0.5(p + q)(p + q + 1) - t$ , where  $p$  = the number of indicators,  $q$  = the number of causes, and  $t$  = the number of free parameters. If the model fits the data perfectly and the parameter values are known, the sample covariance matrix equals the covariance matrix implied by the model. The null hypothesis of perfect fit corresponds to a  $p$ -value of 1.

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Fig. 1. Path diagram (benchmark model)



Notes: + No significant influence.

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## Appendix

**Table A.1. Literature review on country default risk**

Panel A. Studies with bond spreads and/or ratings as a dependent variable

Study	Sample	Explanatory variables with significant influence
Edwards (1986)	1976 – 1980, 13 countries, 167 bonds.	Debt to output ratio, Gross investment ratio, Debt service ratio, Maturity.
Cantor and Packer (1996)	September, 29, 1995, 45 countries.	Ratings (S&P and Moody's), External debt, Stage of economic development (according to IMF classification), Default history.
Min (1998)	1991 – 1995, 10 countries, 482 bonds.	Debt Service Ratio, Terms of Trade, Growth rates of exports and imports, Current account balance, Ratio of debt to GDP, Ratio of reserves to GDP.
Eichengreen and Mody (1998)	1991 – 1996, 55 countries, 1033 bonds.	Ratio of debt to GDP, Debt Service Ratio, Dummy for rescheduling, (10 year) risk-less US interest rate, Private placement, Israel dummy, Supranational, Public or private issuer, Currency (DM/Yen), Latin America dummy, Ratings of Institutional Investor.
Kamin and von Kleist (1999)	1991 – 1997, 304 bonds.	Debt Service Ratio, Ratio of total debt to GDP, Ratio of reserves to imports; Ratings of S&P and Moody's, Maturity, Currency dummy (Yen, Non USD), Time dummies.
Arora and Cerisola (2001)	1994 – 1999, 11 countries.	Risk-less interest rates, Debt service ratio, Ratio of total debt to GDP, Ratio of reserves to GDP, Ratio of reserves to imports.
Afonso (2001)	June 2001, 81 countries.	GDP per capita, external debt, stage of economic development, default history, real growth rate, inflation rate.
Mulder and Perrelli (2001)	1992 -1995, 25 countries.	Debt over exports, default history, fiscal balance , output growth, log of inflation, investment ratio to GDP, external current account deficit.
Rowland (2004)	July 2003, 50 countries.	GDP per capita, the economic growth rate, the inflation rate, external debt ratio, debt-service ratio, the level of international reserves, openness of the economy.
Rowland and Torres (2004)	1998 – 2002, 16 countries.	Economic growth, Ratio of debt to exports, Ratio of debt service to GDP, Ratio of reserves to GDP.

**Table A.1. Literature review on country default risk**

Panel B. Studies with a crisis dummy as a dependent variable

Study	Sample	Explanatory variables with significant influence
Frank and Cline (1971)	1960 – 1968, 26 countries.	Debt Service Ratio, Ratio of imports to reserves, Ratio of debt repayments to total debt.
Sargen (1977)	1960 – 1976, 44 countries.	Debt service ratio, Inflation, Export growth, growth rate of money supply, Real GDP growth rate, Deviations in purchasing power parity.
Saini and Bates (1978)	1960 – 1977, 25 countries.	Growth rate of consumer prices, Growth rate of money supply, Current account balance to exports, Growth rate of reserves.
Mayo and Barrett (1977)	1960 – 1975, 45 countries.	Ratio of credits to exports, Growth rate of consumer prices, Ratio of reserves to imports, Ratio of imports to GDP, Ratio of gross capital formation to GDP, Ratio of IMF quota to imports.
Feder and Just (1977)	1965 – 1972, 30 countries.	Debt Service Ratio, Ratio of imports to reserves, Ratio of debt repayments to total debt, Per capita income, Ratio of capital inflows to debt repayments, Growth rate of real exports.
Lloyd-Ellis, McKenzie and Thomas (1989)	1977 – 1981, 27 countries.	Growth rate of exports, Ratio of long-term debt to total debt, Ratio of short-term debt to total debt of banks, Ratio of bank deposits to disbursed credits, Ratio of reserves to IMF-Quota.
Detragiache and Spilimbergo (2001)	1971 – 1998, 69 countries.	Ratio of short-term debt to total debt, Ratio of total debt to GDP, Ratio of reserves to GDP, Overvaluation of the currency, Share of credits from multilateral creditors on total debt, Openness of the economy.
Manasse, Roubini and Schimmpfennig (2003)	1970 – 2002, 47 countries.	Ratio of short-term debt to reserves, Ratio of debt services to reserves, Ratio of current account balance to GDP, Interest rate on US treasury bills, Growth rate of GDP, Dummy for inflation rate above 50%, Dummy for past defaults, Index of political freedom, Dummy for years with presidential election.

**Table A.2. Ratings conversion**

S&P Rating	Numerical Values
AAA	1-2
AA+	3-5
AA	6-8
AA-	9-11
A+	12-14
A	15-17
A-	18-20
BBB+	21-23
BBB	24-26
BBB-	27-29
BB+	30-32
BB	33-35
BB-	36-38
B+	39-41
B	42-44
B-	45-47
CCC+	48-50
CCC	51-53
CCC-	54-56
CC	57-59
C	60-62
SD/D	63/64

*Notes:* The numerical value is specified depending on the outlook: positive is means the lowest number, stable the second lowest number and negative the highest number.

**Table A.3. Data description**

No	Variable	Description / Source
I	EMBI <sup>+</sup> sovereign yield spread	The EMBI <sup>+</sup> spread is the average spread of several bond issues of the respective country. For a more detailed description see JP Morgan (1999).
II	S&P's Sovereign ratings	Numerical values calculated by taking the natural logarithm of the values numerical values corresponding to the different ratings, see Table 2.
1	GDP per capita	In thousands of US Dollar
2	Investment ratio	Describes the gross fixed investment as a percentage of GDP.
3	Total debt / GDP	Total debt describes the total external debt stock, comprising public and publicly guaranteed debt, private nonguaranteed debt, use of IMF credit and short-term debt.
4	Debt service ratio	The ratio of short-term debt payments to exports. Short-term debt includes all payments with a maturity up to one year.
5	Short-term debt / total debt	See row 3 and 4 for the short-term and total debt, respectively.
6	Reserves growth	Foreign exchange reserves comprise foreign exchange reserves plus gold.
7	Reserves / imports ratio	Annual changes in imports (cif).
8	Trade balance / reserves	Exports minus imports over reserves (see row 6)
9	Change of the term of trade	Describes annual changes in the terms of trade.
10	Exports growth'	Annual changes in exports (fob).
11	Inflation rate	To calculate inflation we use data on consumer price indices provided by DataStream <sup>®</sup> .
12	Money supply change	This variable describes the yearly change in the money supply (M1).
13	Openness	Sum of Imports plus exports over GDP.
14	US interest rate	Describes the short-term (one-year) US interest rate, as specified by the OECD.

*Notes:* Data are provided by DataStream<sup>®</sup> unless explained otherwise.