Sovereign debt and defaults: A global study

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ABSTRACT

Governments borrow money locally and globally with an objective of economic growth and to govern. Financial distress and defaults in business and firms may cause stress and distress in the local economy which may spill over to other integrated economies. On the contrary, inefficient handling of an economy may negatively affect the inherent business and firms. This is an uncertain vicious cycle and a study of corporate distress is imperative along with a study on country distress. There have been a few studies in this direction, but very few refer to the use of logistic regression in the context of debt defaults across the globe. This study is an attempt in this direction.

The research uses the level of Debt/GDP ratio of a country to categorize defaulting countries. A total of nine variables for 111 countries, globally, were studied for the time period 2015-2017 where binary and multinomial logistic regression were used as a primary technique of analysis. Exploratory factor analysis and qualitative analysis were also done in the study. Out of total 111 sample countries, 38 (34%) were found to default based on 2017 data of Debt/GDP ratio. The study found international factors and local factors as the two components affecting debt default in countries.

The study is expected to provide inputs to policy makers, managers and bankers for effective distress and default management.

Keywords: *country risk, country default, logistic regression, world economy, macro-economy*
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Introduction

Countries borrow and may default or face distress on their borrowing. The concept of financial distress has received significant attention in the global context recently. There are recent examples of failures and financial distress in companies such as ILFS in India which defaulted on its payments or a country such as Greece which defaulted on its sovereign debt payment in 2015. There are several examples of government defaulting on their liabilities (Noack, 2015). The global bankruptcy report (2019) refers to issues such as global trade wars between big economies (USA and China) and slowing of big economies (Japan) indicating tough times ahead for countries across the globe.

Companies default and so do governments, and often they are interconnected. Slow down and defaults in corporate business affects the government's revenues which may lead to a government defaulting on its payments. Corporate and sovereign defaults are a part of the business system and the world trade, and a better understanding of these defaults would enable effective management for all related stakeholders. The paper by Ahmad, (2015a) focuses on the interconnectedness amongst economies and found that countries across the globe are maintaining different levels of interest rates; the co-integrated economies affect each other's interest rates, which consequently affects local economies. This results in contagion amongst the countries. However, Deceanu (2015) focused on issues related to sovereign debt, particularly sustainability issues. He states that debt sustainability should be understood considering state revenues and reserves. Thus, outcome of sovereign debt has to be looked from a very different perspective rather than a corporate.

The financial health of the banking industry is an important prerequisite for economic stability and growth. Interest rates are very relevant for debt transactions and one of the critical variables affecting debt defaults. Ahmad and Premaratne (2018) study the effect of negative and low interest rates between US, UK, Indian and Sri Lankan economies and find that interest rates affect both the set of economies and that the effect has a lag of eight years. There is a pass-through effect of interest rates on macroeconomic variables on co-integrated economies (Ahmad and Hossain, 2019). Repo rate is one of the main monetary policy tools that affect the liquidity of the banking system and influence the different macroeconomic variables such as economic growth, inflation, foreign direct investments, and foreign exchange rate (Ahmad and Nasrin, 2017).

Technical construct

There are various annual reports [Noack (2015), global bankruptcy report (2019)] by management and economic consultants on business and corporate defaults, but there are very limited studies on country defaults. Mathematical models based on empirical data have been used across the globe to predict distress, bankruptcy and financial defaults by companies using their financial data [Altman (1968)] but research studies focused on sovereign defaults and distress at country level (Ribeiro, 2001) are very limited. Some research studies [Sun et al., (2014); Becchetti and Sierra (2003) used cashflows; Kutty (1990)] have followed a similar research methodology which has been extended in this study. The basic model in the study is that distress and default due to government debt can be forecasted and understood using macroeconomic variables.

Literature review

Shapiro (1999) defines country risk as the phenomenon which involves a general level of political and economic uncertainty in a country affecting valuation of financial instruments in the country. Ahmad (2015b) integrated macroeconomics data with corporate data in India; Avramovic (1968) used economic variables (export growth rate, debt service payments/exports, foreign exchange reserves/ imports, GDP growth rate, investment/GDP, exports/GDP and inflation rate) to study country risk; Ribeiro (2001) categorized economic variables as external, internal and other variables while Andrade & Teles (2004) study foreign reserves, world oil prices,

nominal interest rates and public debt in similar studies.

Sethi (2019) studied inequalities in economies and found that it is grossly affected by technological progress and that trade reduces it and capital flows increase it. Economic stress scenarios are studied using macroeconomic variables (Alfaro and Drehmann, 2009 using GDP).

Feldman et al. (2019) studied risk and found that regulatory measures which discourage firms to access capital through public markets will result in reduction in R&D spending which adds to firm risk and systemic risk. Considering interest rates and debt levels, Lorenzoi and Werning (2019) suggest that debt dynamics are characterized by a tipping point below which debt falls and stabilizes, and above which debt and default rates grow. Gennaioli et al. (1969) found that government defaults will lead to a decline in private credit and that such decline would be larger in countries where financial institutions are more developed, and banks hold more government bonds. In such countries, government defaults should be less likely. Bisias & Flood (2019) agree that systemic risk is a multifaceted problem and any single definition may not explain it and may provide a false sense of economic security. Brutti (2011) is of the opinion that any default reduces investment by directly reducing the net worth of ultimate investors and has little effect on financial intermediation.

Pioneering work in predicting financial crisis was done by Kaminsky and Reinhart (1996) who found that macroeconomic parameters can be used to predict financial crisis. Gonzalez-Hermosillo, Pazarbasioglu and Billing (1997) applied a duration-based model on banking data and found that the likelihood of default and its timing can be predicted using such a model. Kutty (1990) studied 79 developing countries and developed a Logistic regression (Logit) based model which was able to predict few country defaults two years ahead of the default. Hardy and Pazarbasioglu (1999) used logit models for advanced and developing countries and found that the current account was not significant, although the change in the gross foreign liabilities of the banking sector was found significant. Barrell et al, (2010) focused on some unconventional indicators of a crisis such as unweighted capital adequacy and bank liquidity ratios. Multiple Discriminant Analysis (MDA) and Logistic regression (Logit) are two commonly used techniques to study distress and defaults. MDA does not consider probabilities and assumes that predictors have normal distributions which would restrict the use of dummy independent variables (Ohlson, 1980). The dependent variables in logistic regression are normally qualitative or dummy. Martin (1977) was one of the first to use logistic regression for prediction of bankruptcy based on financial statements. This research uses logistic regression on macroeconomic data to analyse distress and defaults caused due to sovereign debt.

Research Methodology

The primary objective of the research is to study sovereign debt defaults focusing on the reasons and its prediction using logistic regression.

A total of nine macroeconomic variables were used in the research. The ratios are the same as those used by Deceanu (2015). The raw data for these variables was extracted from the World Bank database (www.data.worldbank.org) for the time period 2015-2017, which is the latest data available with the source. The said variables and their explanation, based on data source explanation (World Bank), is given below.

1. Gross Domestic Product (current USD) is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Termed as GDP in analysis and used to calculate 'Debt/GDP' ratio for a country.
2. Real interest rate (%) is the lending interest rate adjusted for inflation. Termed as 'RIR' in analysis.
3. Gross savings as a percentage of GDP. Here, gross savings are calculated as gross national income less total consumption, plus net transfers. Termed

as 'S.GDP' in analysis.

4. Total central government debt. Here, the debt taken is the total of direct government obligations. It includes domestic and foreign liabilities and is measured on a given date. It is used to calculate 'Debt/GDP' ratio for a country.
5. Official exchange rate. This is in local unit per USD. Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. Termed as ER in analysis.
6. Inflation of consumer prices (annual %) is measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Used as 'Inf' in analysis.
7. Total reserves (in current USD) comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. Used as 'Reserves' in analysis.
8. Gross Domestic Product growth (annual %) is the growth rate of GDP at market prices based on constant local currency. Used as 'GDP.Gr' in analysis.
9. Current account balance (in current USD) is the sum of net exports of goods and services, net primary income and net secondary income. Used as 'CAB' in analysis.

Binary and multinomial logistic regression has been used in the current research as the primary tool of analysis. Logistic regression is a type of regression where the dependent variable is a categorical variable and independent variance could be categorical or continuous. Since the technique is based on logarithm, it is also known as Logit. The outcome of this regression is not an absolute value but the chance or probability of occurring of an event.

In a simplest form, a multinomial Logit model can be represented as Equation 1.

$$P(Y)=1/[1+e^{-(b0+b1X1i+b2X2i....+bnXnij}] \quad \text{..... (1)}$$

According to Chowdhury and Islam (2010), on an average, public debt in United States rose from 60% of GDP in 2007 to almost 75% by the end of 2009, which was during the financial crisis of 2008, hinting that Debt/GDP ratio may be an indicator of impeding country default and economic crisis. They suggest a value of 60% for developed countries and 40% for developing countries as an optimal Debt/GDP ratio. We consider a middle value, 50% of Debt/GDP ratio, as the qualifying threshold for categorizing a country as default/no default. Countries having a Debt/GDP ratio of more than 50% were listed as default (labelled as 1) and others as no default (labelled as 0). The Debt/GDP ratio was calculated as the total Government Debt of a country divided by the GDP of the country and represented as ($Debt_i/GDP_i$), where 'i' indicates the respective country which varies from 1 to 111. This ratio is used as a dependent variable in subsequent Logit analysis which is a binary variable where any country which had a ratio more than 50% was treated as defaulter country and marked as 1, else 0 (similar to Cox et al., 2017). The absolute data of other ratios was taken as independent variables (all continuous variables). The data is used for the period 2015-2017 where the year 2017 is considered as the year of default and two immediately preceding years (2015 and 2016) are considered as the years of distress for a country. A cross-sectional binary and multinomial logistic regression is run for the year 2017 for analysing the default characteristics and also a comparison of default and non-default countries was done for 2017, 2016 (one year before default) and 2015 (two years before default) for a more comprehensive analysis.

The total data was available for 220 countries and the final sample was taken for 111 countries/segments, across the globe, for which data was available for Debt/GDP ratio as this was the variable used to categorize countries as default/non default. Countries not having debt, such as Gulf nations, and countries with data not available, were excluded from the study.

Initially, correlation analysis of all ratios and variables was done with an objective to find any trend and to

find high and low outliers. Subsequently, Exploratory Factor Analysis (EFA) was done on independent variables to reduce data into components. Consequently, logistics regression was conducted.

SPSS 20.0 was used for data analysis. The Hosmer and Lemshow test (Hosmer et al., 1980) is used to test for goodness of fit of models. If this test is insignificant (p-value is high), the model is assumed to be a good fit.

High Debt/GDP ratio with high GDP growth is acceptable, but with low GDP growth, it is a disaster in the making (Chowdhury and Islam, 2010). Thus, there should be a negative correlation between Debt/GDP ratio and growth rate for all countries. Also, if savings in a country are increasing, they tend to improve the current account balance (Barrell and Davis, 2010). Thus, there should be a positive correlation between CAB and Savings. Based on these theoretical premises, two null hypotheses were also developed and tested in the research.

H01: Debt/GDP ratio is NOT negatively correlated with GDP growth rate.
H02: Current account balance is NOT positively correlated with savings.

Data Analysis:

Overall, out of total 111 sample countries, 38 (34%) were found to default based on 2017 data of debt/GDP ratio of above 50% threshold, across the globe.

Table 1: Correlation of Debt/GDP ratio with GDP growth ratio for the time period (1960-2017)

Country Name	*Correlations*	*Average growth rate (2017)*
Lower middle income	-0.60	4.84
Europe & Central Asia	-0.39	5.14
North America	-0.29	6.38
South Asia	0.07	2.01
High income	0.50	2.13
OECD members	0.57	2.53

Source: World Bank database and author's calculations

The correlations between Debt/GDP ratio and GDP growth rate for all the countries for the time period 1961-2017 (Table 1) indicates that countries which have demonstrated negative correlation historically are the ones with high average GDP growth rate in 2017. Also, when top ten negative correlations and top ten positive correlations between Debt/GDP ratio and GDP growth rate (1960-2017) were analysed, it was found that average growth rate (2017) was 4.18 and 3.88, respectively. The global average GDP growth rate for 2017 is 3.85. Thus, it can be interpreted that countries with high correlation between Debt/GDP ratio and GDP growth rate will demonstrate an above-average growth.

Subsequently, correlations amongst eight independent variables were analysed (Table 2). Although these correlations are cross-sectional, based on 2017 data for 111 countries, still they were able to indicate some trends in behaviour amongst themselves. Current account balance was found with high positive correlation with forex reserves (0.84), with GDP (0.77) and negative with inflation and RIR, indicating that if current account balance will increase, GDP and reserve will increase, and vice versa. Forex reserves were found as almost perfectly positively correlated (0.99) with GDP. Exchange rates were found to have very low correlation with almost all variables. This correlations analysis was also used to remove any

multi-collinearity where variables with high correlations (above 0.9) amongst themselves were removed. Any variable having very low correlation with majority of the variables was also removed as such a variable is not expected to add much to the explained variance. Thus GDP, exchange rates (ER) and real interest rates (RIR) were removed from the data set for better analysis.

Table 2: Correlations amongst independent variables

	CAB	ER	Reserve	GDP	GDP.Gr	Inf	RIR	S.GDP
CAB	1.00	-0.02	0.84	0.77	0.03	-0.09	-0.08	0.21
ER	-0.02	1.00	-0.02	-0.01	0.16	0.08	0.02	0.01
Reserve	0.84	-0.02	1.00	0.99	0.11	-0.07	-0.06	0.27
GDP	0.77	-0.01	0.99	1.00	0.11	-0.05	-0.04	0.28
GDP.Gr	0.03	0.16	0.11	0.11	1.00	0.00	0.07	0.15
Inf	-0.09	0.08	-0.07	-0.05	0.00	1.00	-0.13	-0.14
RIR	-0.08	0.02	-0.06	-0.04	0.07	-0.13	1.00	-0.08
S.GDP	0.21	0.01	0.27	0.28	0.15	-0.14	-0.08	1.00

The correlation analysis was also used to test the two null hypotheses where the null hypothesis (H01) was rejected as a negative correlation (-0.05) was found between Debt/GDP ratio and GDP growth rate. Also, null hypothesis (H02) was rejected as a positive correlation (0.031) was found between CAB and Savings/GDP ratio. The correlation used was Spearman's Rho as cross-sectional data has been used in the analysis.

Table 3: Descriptive statistics for the year 2017

Variable	Default		No Default	
	Average	CV	Average	CV
CAB	-2.9E+09	-2.82	1.2E+09	19.65
Debt/GDP	0.84	0.40	0.30	0.39
Exchange Rate	487	3.13	2087	2.76
Reserves	1.16E+10	1.87	9.29E+10	4.56
GDP	6.03E+10	2.46	3.53E+11	4.23
GDP.Gr	3.24	0.93	3.79	0.82
Inflation	3.90	0.79	5.59	1.10
RIR	6.80	0.82	7.07	1.41
Savings/GDP	19.78	0.42	19.74	0.69

A comparative analysis for default and non-default countries was done based on the descriptive statistics for the default year (2017) and the distress years, one year before default (2016) and two years before default (2015). Analysing Table 3, it was found that CAB is negative for default countries, Reserves are lower and GDP size smaller in comparison to the non-default countries. The average Debt/GDP ratio of default countries is 2.8 times of non-default countries.

Table 4: One year before default (2016)

	Default		No Default	
Variable	**Average**	**CV**	**Average**	**CV**
CAB	-2.4E+09	-2.40	1.29E+09	20.96
Debt/GDP	61.02	0.50	33.23	0.70
ER	476.01	3.13	1931.19	2.83
Reserves	1.08E+10	1.92	8.48E+10	4.69
GDP	5.65E+10	2.60	3.17E+11	4.26
GDP.Gr	3.41	0.69	3.44	1.11
Inflation	3.25	1.39	5.10	1.15
RIR	7.71	0.58	9.25	1.05
Savings/GDP	18.38	0.49	18.95	0.70

Analysing the descriptive statistics, one year prior to default (Table 4), it was found that for default countries, CAB was negative while it was positive for no-default countries. A similar finding emerged from two years prior to default data (Table 4) and 2017 data indicating that current account imbalances can provide some indication about country default. The Debt/GDP ratio of default countries was found to be more than double in comparison to no-default countries, both, for one year and two-year prior data.

Savings/GDP ratio of default countries was found to be equal for default countries for one year and slightly lower for the two years prior to default data. Another significant finding was about inflation, which reduced sharply during the default year (2017) for default countries from 4.14 to 3.25 (2016) prior to default. Also, it had a high coefficient of variation (CV) indicating the volatility of inflation as an indicator of country default.

The CV in interest rates was found to be lower for default countries indicating a stagnancy in interest rates, low levels of business activity and an impending crisis. The CV of two positive ratios (reserves and GDP) and their average values, were found to be much higher for non-default countries rather than default countries for the years 2015 and 2016. This indicates some seasonal effect or unusual transactions which might have positively added to the national income and reserves of the country, but have also increased its volatility.

Table 5: Two years before default (2015)

	Default		No Default	
Variable	**Average**	**CV**	**Average**	**CV**
CAB	-2.5E+09	-2.34	1.95E+09	20.54
Debt/GDP	58.71	0.50	32.40	0.64
ER	465.99	3.18	1818.80	2.87
Reserves	1.06E+10	1.96	8.91E+10	4.89
GDP	5.76E+10	2.56	3.14E+11	4.24
GDP.Gr	2.93	1.10	3.38	1.50
Inflation	4.14	2.00	4.33	1.14
Real IR	8.30	0.87	10.61	1.18
Savings/GDP	17.82	0.41	19.67	0.65

The Exploratory Factor Analysis (EFA) technique was used to converge the remaining five variables in possible related components, as three variables (Exchange rate, GDP and real interest rates) were not considered because of low and high correlations. Considering a minimum factor loading of 0.5, two factors/components (Table 6) were found and were used in subsequent logistic regression. Total explained variance by the three components was found to be 61% and KMO value was calculated as 0.53 (acceptable) with Bartlett's test of sphericity found as significant. The two components were labelled as international factors (component 1) which includes two variables - current account balance and forex reserves, and the other as local factors (component 2) which includes another two variables - GDP growth rate and savings/GDP ratio. One variable, Inflation rate was removed from the analysis as suggested by EFA based on minimum factor loading of 0.5.

Table 6: Rotated Component Matrix for EFA

	Components	
	International factors	Local factors
CAB	.952	
Reserve	.943	
GDP.Gr		.702
S.GDP		.664

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Binary logistic regression was performed with 'Default/No Default' as the binary dependent variable and each of the four independent variables, separately (Table 7) to understand the relationship better. Only GDP growth rate was found to explain about 1% variance and hence, binary logistic regression results were broadly inconclusive.

Table 7: Binary logistic regression (Dependent variable: Default/No Default)

Predictor	Beta	Odds ratio	Accuracy (%)	Goodness fit (Hosmer and Lemeshow test)	-2 Log likelihood	Nagelkerke R Squared (%)
CAB	0	1	63	Good fit	130	1.8
Reserves	0	1	62	Good fit	124	7.1
GDP.Gr	-.06	0.94	65	Yes	140	1.1
Savings/GDP	0	1	64	Yes	111	0

Subsequently, multinomial logistic regression is done using all the four predictor variables. The two estimates of explained variance for the multinomial regression were found to be satisfactory with Cox and Snell's value as 11.2% and Nagelkerke's value as 15.2%. These two measures are the proxy R-squared value measures used in logistic regression. The combined prediction accuracy of the model was 57%.

Table 8: Parameter estimates from multinomial logistic regression

	B	Wald	p-value	Exp (B)
Intercept	0.39	0.47	0.49	
CAB	0	2.18	0.14	1
Reserve	0	2.92	0.09	1
GDP.Gr	0.041	0.19	0.67	1.04
S.GDP	-0.019	0.66	0.42	0.98

The reference category is: Default

Through the multinomial logistic regression (Table 8) only Savings/GDP ratio could explain the country defaults. The current account balance and reserves were found to be insignificant and irrelevant to multinomial logistic regression as their beta coefficients were almost at zero levels and odds ratio were found to be around 1. Savings/GDP was found to have a negative beta coefficient (-0.019) and odds ratio less than 1 (0.982) indicating that if savings would increase, the chances of default would decrease.

Thus, a mathematical model based on multinomial logistic can be specified as Equation 2.

Country default= 0.29+ 0.041* GDP growth rate-0.019*Saving/GDP ratio ….(2)

Conclusion

The research was initiated with an objective to study the debt default levels across the globe and developing a model for the same. The significance of Debt/GDP ratio was revalidated as one of the most imperative variables to categorize countries as default or non-default. The Debt/GDP ratio of default countries was found to be more than double of non-default countries in the distress time period (2015 and 2016) and was found to be 2.8 times of non-default countries for the default years (2017).

It was also found that current account imbalances can provide some indication about country default. Savings/GDP was also found to have a negative beta coefficient (-0.019) and odds ratio less than 1 (0.982)

with country default, indicating that if savings would increase, the chances of default would decrease.

EFA was conducted for data reduction which resulted in two factors (components) including two variables each. The two components were named as international factors (component 1) which include current account balance and forex reserves, and the other as local factors (component 2) which include GDP growth rate and savings/GDP ratio. A multinomial logistic regression was done using all the four predictor variables from the two factors. The two estimates of explained variance for the multinomial regression was found to be satisfactory with Cox and Snell's value as 11.2% and Nagelkerke's value as 15.2% with a combined prediction accuracy of the model as 57%. Multinomial logistic regression was found to better capture such defaults in comparison to binary logistic regression.

The two null hypotheses were not accepted, and this indicated that Debt/GDP ratio and GDP growth rate follow an inverse relationship while current account balance was found to be positively correlated with savings for a country.

A fall in inflation rate and its high volatility indicates financial distress in a country. The CV of interest rates was found to be lower for default countries indicating stagnancy of interest rates and low levels of business activity in the country.

Managerial implications and Generalization

The research highlighted the importance of Debt/GDP ratio, GDP growth rate, inflation volatility and two factors (Local and International) to explain sovereign debt distress and defaults. The policy makers, managers and bankers should consider such macroeconomic variables while focusing on business in a country. The multinomial logistic model in Equation 2 can be generalized across countries as the sample used was global.

Sovereign debt sustainability is a future area of research which can be addressed by researchers and policymakers. In subsequent studies, the role of demographic variables (Population rate, literacy rate) can also be explored while studying country default risk.

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