Passive Insights

July 8, 2014

Fundamental Scoring for Fixed Income

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Executive Summary

Over the last few years, many investors have started to question the risk embedded in fixed income market-cap weighted indices. In particular, the tendency of market cap indexing to overweight heavily indebted contries and their reliance on agency ratings has been highlighted.

This situation creates new challenges and opportunities for passive index-based investment approaches and there is now growing demand for innovative alternatives to market-cap weighted indices in the fixed income space.

Through this paper, we revisit the "Smart Beta for Fixed Income" thematic and we suggest a new framework to include macro economic factors in fixed income investments.

Having extensively reviewed both the existing academic research and the market initiatives developed to address these issues, we compile a macro economic database. Following a thorough statistical analysis based on this database, results shows that it is possible to estimate the credit-worthiness of a country using a parcimonious set of macro-economic factors and to derive a unified fundamentally driven scoring methodology.

This scoring methodology could lead to interesting capabilities:

- Ranking countries' relative creditworthiness both in developed and emerging markets
- Following closely a country's financial health over time

These capabilities are illustrated in Section 3.2.

This methodology is readily available to be implemented as part of a fundamentally weighted fixed income strategy or as an input to fundamentally driven portfolio construction.

Contents

Introduction

In the wake of the financial and economic crisis of 2008-2009 and the Eurozone crisis, sovereign issuers' creditworthiness has been under increasing scrutiny. It has become evident that investments in sovereign bonds, even in major developed countries' debt, is not as safe as it was thought to be and that to some extent markets are mispricing this risk. For many investors, the downgrade of the U.S. by S&P has acted as a wake up call.

This situation raises new challenges for passive, index-based investment approaches and fixed income market cap-weighting's performance is now under question. This debate that started with equities has now spilled over into fixed income and a number of concerns have been expressed about these indices' relevance.

> Three-quarters of European institutional investors view traditional market-capitalisation weighted equity and corporate bond indices as problematic, according to a survey by Edhec-Risk Institute.

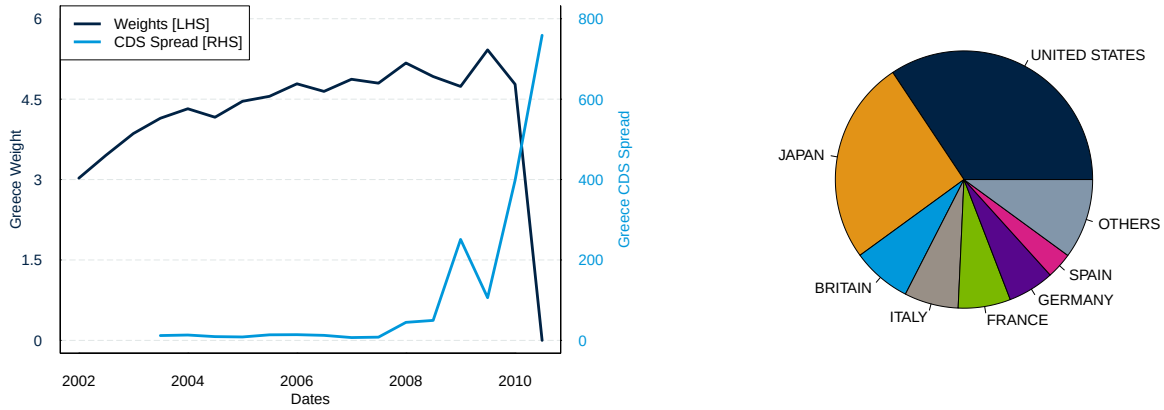
Financial Times - Traditional indices lose trust (1st May 2011)

By construction, despite their characteristics (liquidity, capacity, tradability and representativeness among others), fixed income market-cap weighted indices tend to exhibit a series of potential flaws:

- Overweighting of heaviliy indebted countries
- Concentrated, poorly diversified portfolios
- Momentum bias
- Mean-variance inefficiency
- Backward looking bias

From a creditworthiness perspective, those indices may be considered riskier as they tend to increase the allocation to a country's debt with the increase of its debt, also known as the "bums problem"(Siegel, 2003). This problem is highlighted by the increased weight of Greece in leading sovereign bond Indices in the years preceding its default (see Figure 1a)[1].

On top of an increased exposure to relatively indebted countries, such a market-cap weighted methodology may also create concentrated portfolios since a significant share of the investment is diverted to the most indebted countries as demonstrated in Figure 1b[2]. In this example United States and Japan alone represent more than 50% of the index.



(a) Evolution of Greece weight in a EUR sovereign bond index (b) Country weights in a global sovereign bond index as of 2013

Figure 1: Illustration

Furthermore, since market-cap weighting follows the outstanding debt of each country it follows as well the short term performance of its debt. This translates into a significant so-called "momentum bias", commonly described as a strategy that buys at market highs and sells at market lows. The weight change of Greece in leading sovereign bond indices is an illustration of this bias as it forced all investors to suddenly sell large quantities of distressed bonds at the time of its downgrade out of investment grade (2011), pushing the prices down and creating significant losses for the investors (see

[1]Source: IBoxx EUR Sovereign Index as of 31st Dec 2013
[2]Source: DB Global Sovereign Index in EUR as of 31st Dec 2013

Figure 1a).

Finally, recent literature has shown that those indices are mean-variance inefficient. As for equity market-cap weighting, this demonstrates that the usual CAPM assumptions (perfectly efficient capital markets, rational investors) are not validated at all times. In fixed income, such a relative mispricing of sovereign bond credit risk may lead to sub-optimal returns for the investors.

Consequently, Smart Beta strategies for fixed income, which aim to address some of these issues, have gained traction with investors over the last two years. These initiatives can be classified in 3 groups:

- Fundamentally driven
- Diversification driven
- Liability driven

In this paper we focus on fundamentally driven strategies which allocate capital according to the relative economic strength of each country, instead of the size of their total debt, using a systematic set of rules.

The objective of this paper is to develop and present an innovative and unified scoring methodology. As a first step, we review the potential drivers of the credit ratings, as well as CDS Spreads, as extensively studied in academic literature. In numerous studies over the last 30 years, academics have tried to pinpoint which fundamental variables were the most likely to explain the creditworthiness of a country or to predict a default. Across the literature, a lot of country universes, statistical methodologies as well as explanatory variables have been used and even if the results vary quite significantly from one research paper to another, we have found several trends to consider and we have summarized the most significant results in Section 4.

In Section 1, we focus on the variables which demonstrate the most consistent results accross studies (i.e. accross country universes and methodologies). In order to consolidate our initial results, we have compared those variables to other markets intiatives trying to use macroeconomic inputs in fundamental fixed income frameworks. Overall, such intiatives rely on variables that may be classified in 4 main groups:

- Solvency and Debt Structure
- Macro Economic
- Political Stability, Competitiveness and Society Indicators
- Discrete Variables

It appears that most variables are common to both reviews with the notable exceptions of the Society Indicators that are used more extensively by those intiatives.

1 Towards a fundamental scoring methodology: Macroeconomic data

As a stepping stone to this paper, we have compiled an extensive macroeconomic database on which to develop our statistical analysis as well as our scoring methodology. It comprises a comprehensive repository of data for 77 countries and 18 explanatory variables.

1.1 Explanatory Variables

In order to extract the most relevant explanatory variables to use in the construction of our scoring methodology, multiple statistical analyses on this dataset have been performed and the results can be found in Section 2.

We consider a universe of 18 explanatory variables which are the results of both our academic review as well as the review of existing fundamental scoring intiatives for fixed income, as described in the Introduction. The complete list can be found in Table 1[3]. The database is populated on a semi-annual basis.

In the rest of the paper, the variables are described using their Short Name.

[3]For the purpose of the analysis, Quality of Education has been removed from the set due to lack of Data prior to 2006. However, we have looked at this explanatory variable separetely in the Annex called "Fundamental Scoring for Fixed Income - Annex with EDU.pdf".

Name	Short Name	Source
National Debt in % of GDP	DEBTGDP	World Economic Outlook of the IMF
National Debt in % of Exports	DEBTEXP	World Economic Outlook of the IMF and World Bank (WDI)
External debt in % of GDP	EXTDEBTGDP	World Bank - SDDS-GDDS/QEDS Data
Reserves in % of GDP	RESERVGDP	World Bank - World Development Indicators (WDI)
Fiscal Balanced in % of GDP	FISCBALGDP	World Economic Outlook of the IMF
Current Account Balance in % GDP	CURRBALGDP	World Economic Outlook of the IMF
GDP per Capita in USD	GDPPCI	World Economic Outlook of the IMF
GDP Growth	GDPGRWTH	World Economic Outlook of the IMF
Inflation	INFL	World Economic Outlook of the IMF
Openness in % of GDP	OPEN	World Bank - World Development Indicators (WDI)
Unemployment rate	UNEMP	World Economic Outlook of the IMF
Global Competitiveness	COMPETE	World Economic Forum - Competitiveness Index
Quality of Education	EDU	World Economic Forum - Competitiveness Index
Old Age Dependency Ratio	DEMO	UN department of Economic and Social Affairs
Corruption Perception Indicator	CORRUPT	Transparency International
Basic Political Rights	POLITIC	Freedom House
History of Default	DFLT	Research Papers and Rating Agencies
Developed or emerging country ?	DEVCNTRY	World Economic Outlook of the IMF

Table 1: List of Public Data Sources used

1.2 Data Treatment

For ease of interpretation, all analyses have been run on normalized data ("Cross Sectional Z-score"[4]) instead of the corresponding raw data[5]. All Z-scores are calculated on the full country universe.

Also in order to extract as much information as possible from our set of explanatory variables, we tried to increase their granularity. For example we modified the DFLT variable by transforming it from a discrete variable to a finer variable using the following rule:

- Default<5 Years old – 1
- 5 Years<Latest Default<10 Years old – 0.75
- 10 Years<Latest Default<15 Years old – 0.5
- 15 Years<Latest Default<20 Years old – 0.25
- 20 Years<Latest Default – 0

Score	S and P	Fitch	Moodys
1	AAA	AAA	Aaa
2	AA+	AA+	Aa1
3	AA	AA	Aa2
4	AA-	AA-	Aa3
5	A+	A+	A1
6	A	A	A2
7	A-	A-	A3
8	BBB+	BBB+	Baa1
9	BBB	BBB	Baa2
10	BBB-	BBB-	Baa3
11	BB+	BB+	Ba1
12	BB	BB	Ba2
13	BB-	BB-	Ba3
14	B+	B+	B1
15	B	B	B2
16	B-	B-	B3
17	CCC+	CCC+	Caa1
18	CCC	CCC	Caa2
19	CCC-	CCC-	Caa3
20	CC	CC	Ca
21		C	C
22	SD	D	D

Table 2: Scoring for Ratings from S&P, Moody's and Fitch

Each of the above explanatory variables illustrates a part of a country's economic/social state and it is clear that for each of them there is a rational expectation of how they should impact the rating of that specific country. We use this expectation to assign a sign to the Z-Score calculated for each variable. For example, if the DEBTGDP increases, i.e. the debt burden of the country increases, we would expect the creditworthiness of this country to deteriorate. This would lower the CDS or lower the rating of the country. Therefore, we consider that DEBTGDP has a negative impact on the credit and therefore we will assign a negative sign to its Z-Score[6].

1.3 Dependent Variable - Country Ratings

In order to run a statistical analysis, the explanatory variables are tested against a dependent variable, the historical series of ratings for each country.

To create this rating indicator, we aggregate the latest long-term foreign currency ratings published by S&P, Moody's and Fitch as of the end of February and August each year (in line with the compilation of the database) since the late 90s by calculating the arithmetic average of the score defined in Table 2. This Table illustrates the way the slightly different ratings produced by the three rating agencies are transformed into numerical values.

[4]A Cross Sectional Z-Score is a statistical measurement of a score's relationship to the mean in a group of scores. A Z-score of 0 means the score is the same as the arithmetic average. A Z-score can also be positive or negative, indicating whether it is above or below the mean and by how many standard deviations.

[5]We also ran some analysis on the raw data to validate the robustness of the results obtained using normalised data. See Sub Section 2.4

[6]It is important to note that in the academic literature, Inflation is in general looked at as an odd variable. It behaves indeed in different ways depending on the country universe, methodology. For this reason we decide not to assign a specific sign to inflation.

2 Statistical Analysis

2.1 Analysis on the Full Country Universe

We first undertake the analysis on the full country universe and full set of explanatory variables decribed in Section 1.

Initial Linear Regressions

Our goals in the first part of the analysis are to:

- Validate the influence of the explanatory variables on the country ratings
- Determine which variable demonstrates the highest explanatory power

To do so we use a combination of linear and multiple regressions. More specifically we use 3 different methodologies:

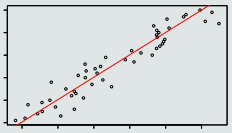
- Linear Regression of the rating (the dependent variable) against each of the explanatory variables separately (each a "Single Regression")
- Multiple Regression of the rating (the dependent variable) against all the explanatory variables ("All Factor Regression")
- Multiple Regression of the rating (the dependent variable) against a restricted set of explanatory variables which regroups all the variables that had proved stastistically significant in the Single Regressions (the "Reduced Factor Regression")

The Single Regressions results show (Table 3) that most variables explain rating changes in a statistically significant way (only 2 out of the 17 variables exhibit a Pvalue above 5%). However, some of the estimates for the variables, and more specifically their signs, are not as expected. For example the coefficient for DEBTGDP is negative, indicating that when the debt increases, the credit risk would be expected to decrease which is of course quite unintuitive.

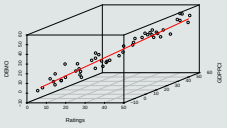
A few reminders on Regression Analysis

A statistical process for estimating the relationships among variables. It focuses on the relationship between a dependent variable and one or more explanatory variables

Linear Regression $(y = Est * x + \epsilon)$



Multiple Regression $(y = \sum_{i=1}^{n} Est_i * x_i + \epsilon)$



Estimate(Est): the coefficient for a specific explanatory variable that best fit the data
T-Value: the Estimate divided by its own standard error. Thus, it is used to test the hypothesis that the true value of the coefficient is non-zero i.e. to confirm that the explanatory variable really belongs in the model
P-Value: the probability of observing a T-value that is large or larger in magnitude when the explanatory variable does not in reality belong to the model. If the p-value is greater than 5%, this means that the coefficient may be only "accidentally" significant.
R2: the coefficient of determination indicates how well data points fit a model. It provides a measure of how well observed outcomes are replicated by the model.

	Est	Tvalue	Pvalue	r2
COMPETE	-4.292	-69.888	0.000	0.742
CORRUPT	-4.051	-56.762	0.000	0.655
CURRBALGDP	-1.402	-9.830	0.000	0.053
DEBTEXP	0.020	0.166	0.868	-0.001
DEBTGDP	-0.200	-1.663	0.097	0.001
DEMO	-3.082	-31.428	0.000	0.368
DEVCNTRY	-8.044	-45.089	0.000	0.545
DFLT	2.886	29.612	0.000	0.341
EXTDEBTGDP	-1.451	-12.401	0.000	0.083
FISCBALGDP	-0.596	-3.644	0.000	0.007
GDPGRWTH	1.036	8.558	0.000	0.041
GDPPCI	-3.865	-49.569	0.000	0.592
INFL	2.587	26.308	0.000	0.290
OPEN	-0.877	-7.313	0.000	0.030
POLITIC	2.564	23.775	0.000	0.250
RESERVGDP	1.136	9.582	0.000	0.051
UNEMP	1.389	11.456	0.000	0.071

Legend
Variable is Statistically Significant
Sign of the Estimate is economically counterintuitive

Table 3: All Countries: Single Regressions

The "All Factor Regression" and "Reduced Factor Regression" yield similar results which highlight potential colinearity between variables in the set.

In this second part of the analysis, we aim to isolate a set of variables that are statistically significant to explain rating changes that are not demonstrating a high colinearity. This would clarify the impact of each of the variables as well as isolate the most important of them and as such increase the robustness of the process.

Linear regression on a concentrated set

To deal with this colinearity issue, we use the following methodology to exclude the variables which do not add significant extra information to the set:

- First we rank the variables according to the absolute value of their T-Value in the Single Regressions (from higher to lower i.e. from most significant to less significant).
- We run a linear regression on the first two variables. If the signs are not as expected then we consider that the second variable is creating an issue and we therefore remove it before adding another variable. If the signs are fine we keep all of the variables.
- We continue the algorithm until all statistically significant variables have been tried.

The final results can be found in Table 4. This analysis seems to remove some variables that were linked to one another in the set. For example, Corruption and Competitiveness seemed to lead to colinearity issues.

It also appears that in this regression on a concentrated set of explanatory variables, the R2 is still relatively high at 0.80 despite its lower number of variables (this compares to 0.83 and 0.81 in the first two multiple regressions). As expected, the signs are correct in the table and all the variables but one are significant.

Overall, we consider that this reduced number of variables still delivers a good explanation of the ratings changes while staying consistent with the expected sensitivity of the variable versus the creditworthiness of a country.

	Est	Tvalue
COMPETE	-2.255	-20.357
DEVCNTRY	-1.251	-4.649
GDPPCI	-1.279	-7.465
DFLT	0.826	12.065
INFL	0.410	6.415
POLITIC	-0.016	-0.224
EXTDEBTGDP	0.399	4.308
FISCBALGDP	-0.302	-3.760
OPEN	-0.280	-4.049

Legend
Variable is Statistically Significant
Sign of the Estimate is economically counterintuitive

Table 4: All Countries: Final Regression

2.2 Analysis on the Developed Countries universe

Our universe contains an heterogeneous set of countries. Depending on their development stage, it seems reasonable to assume that the same economic data would have a significantly different impact. To confirm this hypothesis, we split the country universe in two parts: developed countries and emerging countries and we run the same analysis as for the full universe. Our objective is to determine if the set of the optimal explanatory variables would significantly vary between the three country universes.

As discussed previously, to divide the countries, we decided to use the IMF definition of Advanced Economies over time (DEVCNTRY) as our guide.

Calculating the 3 linear regressions as for the full universe, we get similar results:

- Most of our chosen variables are statistically significant (Pvalue<5%). Only EXTERDEBTGDP and OPEN appear not to be for Developed countries.
- In both single and multiple regressions, most variables are statistically relevant but with varying signs.

Using the methodology described in Section 2.1 to deal with the potential colinearity and remove the variables that do not add extra information to the set, produces interesting results (Table 5).

	Est	Tvalue
COMPETE	-1.705	-11.011
GDPPCI	-0.139	-1.152
UNEMP	0.952	5.458
GDPGRWTH	-0.717	-4.333
DFLT	1.955	6.705
DEBTGDP	0.717	8.855
INFL	2.198	6.540

Legend
Variable is Statistically Significant
Sign of the Estimate is economically counterintuitive

Table 5: Developed countries: Final Regression

The R2 in this reduced regression is still quite high (0.64) despite the lower number of variables (this compares to 0.79

and 0.78 in the first two multiple regressions using all the variables). Also all signs are economically consistent and only GDPPCI does not appear statistically significant.

2.3 Analysis on the Emerging Countries universe

We finally consider in this section the results of the same analysis ran on the two previous universes but limited to the emerging countries universe.

We get similar results on the initial regressions:

- Most of our chosen variables are statistically significant (Pvalue<5%). Only CURRBALGDP appears not to be
- In both single and multiple regressions, most variables are statistically relevant but with varying signs

Using the methodology described in Section 2.1 to deal with the potential colinearity and remove the variables that do not add extra information to the set, produces interesting results (Table 6).

	Est	Tvalue
COMPETE	-1.252	-8.946
DFLT	0.815	13.081
GDPPCI	-4.759	-11.567
DEBTEXP	0.410	2.589
INFL	0.439	7.581
DEBTGDP	0.735	5.809
RESERVGDP	-0.426	-5.736
DEMO	0.031	0.356
GDPGRWTH	-0.478	-7.163

Legend
Variable is Statistically Significant
Sign of the Estimate is economically counterintuitive

Table 6: Emerging countries: Final Regression

In this reduced regression, the R2 is still quite high at 0.68 despite the lower number of variables (this compares to 0.66 in the two multiple regressions using all variables). Also, all signs are economically consistent and only DEMO does not appear statistically significant.

2.4 Conclusion

The 3 sets of macro economic factors resulting from the analysis on the 3 Country universes separately are significantly different as demonstrated below. This highlights that developed and emerging countries are impacted differently by economic data. Therefore, in the next part of the paper, we focus on 2 distinct scoring sets (one for developed and one for emerging countries).

Before moving forward, we also ran the above analysis on the raw data (instead of the normalized data) to validate that our results were robust (the details of the Analysis are in the file "Fundamental Scoring for Fixed Income - Annex with Raw Data.pdf"). Overall, results show stability and the R2 remains relatively unchanged by the use of the Raw Data[7].

Variables	Global	Developed	Emerging
COMPETE	COMPETE	COMPETE	COMPETE
CORRUPT			
CURRBALGDP			
DEBTEXP			DEBTEXP
DEBTGDP		DEBTGDP	DEBTGDP
DEMO			
DEVCNTRY	DEVCNTRY		
DFLT	DFLT	DFLT	DFLT
EXTDEBTGDP	EXTDEBTGDP		
FISCBALGDP	FISCBALGDP		
GDPGRWTH		GDPGRWTH	GDPGRWTH
GDPPCI	GDPPCI		GDPPCI
INFL	INFL	INFL	INFL
OPEN	OPEN		
POLITIC			
RESERVGDP			RESERVGDP
UNEMP		UNEMP	

Table 7: Factor List per Region

R-Square	Global	Developed	Emerging
Using Z-Score	0.8	0.65	0.68
Using Raw Data	0.8	0.64	0.63

Table 8: R2 of the concentrated set of variables

[7]We have also ran the analysis on the Z-scored Dataset adding EDU. This created a dataset starting only in 2006 but this allowed us to test the interest of including EDU in the final factor list and to test the robustness of the factor list when removing the first 4 years of data. Overall, EDU does not bring further information due to its correlation with COMPETE and CORRUPT (the details of the Analysis are in the file "Fundamental Scoring for Fixed Income - Annex with EDU.pdf").

3 Scoring Methodology

3.1 Methodology

Having isolated the most significant explanatory variables for the developed countries and emerging countries, we propose a scoring methodology that allows us to rank countries by their relative creditworthiness/ability to repay their debt. The methodology is as follows:

- Gather the publicly available data (See Table 1),
- Normalize the data by using a Cross-sectional Z-Score,
- Adjust the sign between variable with the expected effect of the increase of the value of a variable. By convention, a high Z-Score is a negative signal and is a sign of poor creditworthiness i.e. a Z-score highly positive should come from a low DEBTGDP but from a high Competitiveness,
- Calculate the **Risk Score** as the average of the Z-Score for all the explanatory variables.

$$\frac{\sum_{i=1}^{n} ZScore[n]}{n}$$

Figure 2: 4 Steps of the Scoring Methodology

As a reminder, the explanatory variables used to create the Risk Score are below:

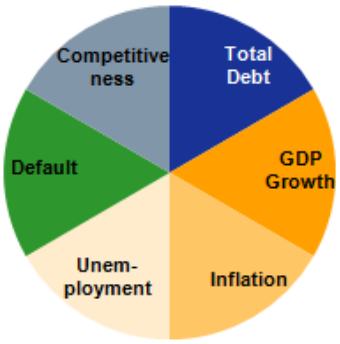


Figure 3: Developed Countries

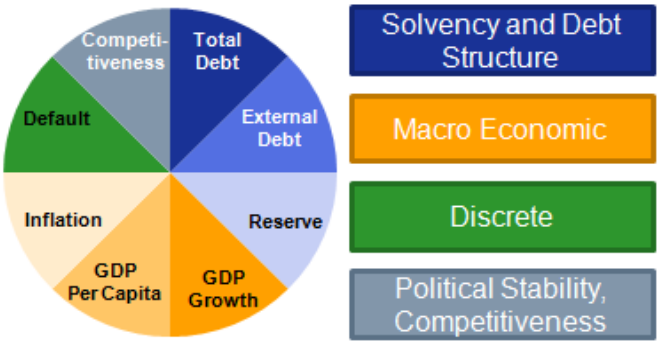


Figure 4: Emerging Countries

3.2 Results

In order to illustrate the characteristics of our new scoring methodology, we calculate the "Risk Score" of the countries over time.

Latest Risk Score and Ranking

We list below the scores on both the Developed and Emerging Universe as of our last Risk Score calculation date i.e. August 2013 (Table 9 and 10).

The developed countries ranking illustrates a few ideas about the perceived relative strength of those countries:

- Switzerland, Australia ant the Nordic exhibit the best Risk Scores

Switzerland	-0.93	Netherlands	-0.11
Sweden	-0.67	United.Kingdom	0.09
Norway	-0.64	Belgium	-0.08
Australia	-0.44	France	0.01
Israel	-0.37	Czech.Republic	0.05
Germany	-0.35	Ireland	0.15
Luxembourg	-0.31	Iceland	0.30
Canada	-0.29	Slovenia	0.32
Denmark	-0.28	Italy	0.54
United.States	-0.25	Portugal	0.57
Austria	-0.23	Spain	0.77
Finland	-0.19	Cyprus	0.81
Estonia	-0.16	Greece	1.96
Japan	-0.11		

Table 9: Ranking of Developed Countries according to Risk Score

- PIIGS are the worst scored countries in that universe with the exception of Ireland which is showing signs of amelioration
- In the Eurozone, Germany shows the best Risk Score

It is also interesting to note that the countries with the highest weights in traditional Fixed Income indices such as Japan, United States, United Kingdom do not rank favourably with this methodology.

Kuwait	-1.00	Georgia	-0.26	Armenia	0.13
China	-0.93	Russia	-0.21	Vietnam	0.13
Korea	-0.90	Mauritius	-0.18	Uruguay	0.18
Malaysia	-0.82	Costa.Rica	-0.18	Honduras	0.20
Chile	-0.71	FYR.Macedonia	-0.13	South.Africa	0.20
Thailand	-0.67	Poland	-0.13	Jordan	0.25
Bahrain	-0.66	Mexico	-0.09	Nigeria	0.27
Latvia	-0.47	Turkey	-0.09	Ukraine	0.32
Bulgaria	-0.46	Tunisia	-0.08	El.Salvador	0.40
Panama	-0.45	Colombia	-0.05	Ecuador	0.47
Azerbaijan	-0.41	Romania	-0.04	Brazil	0.50
Kazakhstan	-0.40	Hungary	-0.02	Argentina	0.64
Peru	-0.40	Moldova	-0.00	Dominican.Republic	0.66
Lithuania	-0.38	Indonesia	-0.00	Nicaragua	0.67
Trinidad.and.Tobago	-0.38	Slovak.Republic	0.03	Egypt	1.14
Philippines	-0.30	Bosnia.and.Herzegovina	0.09	Pakistan	1.32
Bolivia	-0.30	Morocco	0.10	Venezuela	1.75
Paraguay	-0.29	Croatia	0.12	Jamaica	1.81

Table 10: Ranking of Emerging Countries according to Risk Score

Focus on the PIIGS

Figure 5 shows the evolution of the Risk Score of the 5 PIIGS countries over time and in particular around the Euro Sovereign Crisis. As a counterpoint, the graph also depicts the Risk Score of Denmark.

It is clear from the figure that as early as 2007, the PIIGS's Risk Score started to deteriorate (first in Ireland, then in a second stage in Greece and Spain).

Having a closer look at Ireland (Figure 6), we can see that the Risk Score deteriorated sharply in 2007, well in advance of any rating changes. Also, it appears that even if its rating has been stable for 2 years, its Risk Score is improving compared to its highest point, highlighting some improvement in Ireland that have yet to be incorporated in its rating.

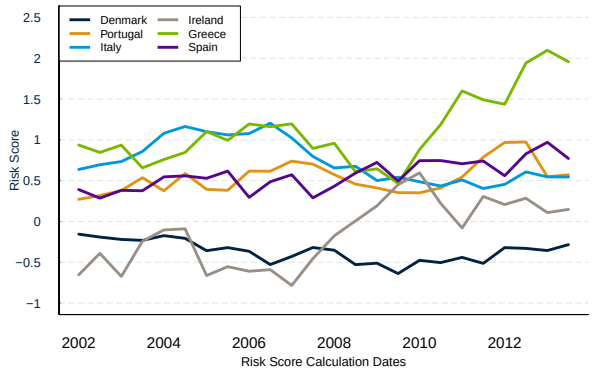


Figure 5: Denmark and the PIIGS Risk Score

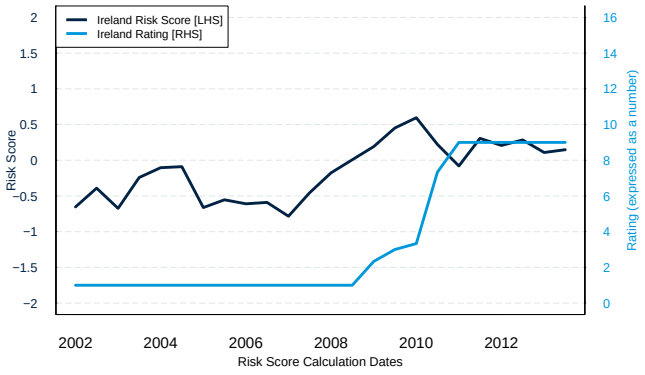


Figure 6: Ireland Risk Score and Rating

Focus on 2 emerging countries

Figure 7 illustrates the correlation between the Risk Score of China getting better and the rating of its sovereign debt improving.

In an opposite scenario, Figure 8 clearly illustrates how the Risk Score of Jamaica has been degrading over the last 10 years in line with the rating and how the Risk Score remained ahead of the rating changes.

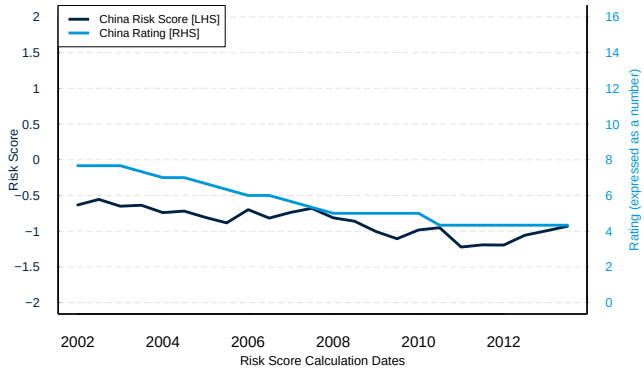


Figure 7: China Risk Score and Rating

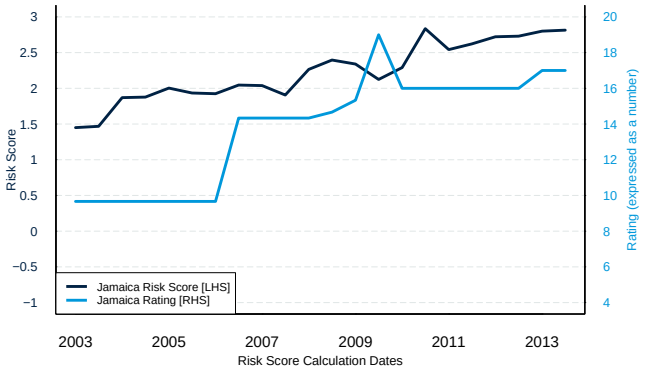


Figure 8: Jamaica Risk Score and Rating

Conclusion

In this paper, we have revisited the fixed income Smart Beta thematic and our analysis has led to the creation of a Risk Score to evaluates the perceived relative default risk of countries both in developed and emerging markets.

Such a score allows to rank countries according to their relative creditworthiness and to monitor their financial health over time. It is important to note that this score is relative to other countries in the universe only and so does not give any inklings on the absolute creditworthiness of a country or on the probability of its default.

It is however a tool that can be used to create a weighting methodology for an innovative new range of Fixed Income Indices.

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4 Appendices

This table summarizes all the explanatory variables studied in the 33 academic papers we have reviewed with the number of times they are found statistically significant and whether this is perceived to increase or decrease creditworthiness.

Variables	Pos	Neg	Und
Solvency and Debt Structure			
Debt/ GDP	14	0	1
Debt /Exports	6	0	2
Debt/Fiscal Receipts	1	0	0
External Debt /GDP	5	0	0
External Debt/Current Account	1	0	0
Foreign Debt/GDP	2	0	0
Debt Service/GDP	1	0	1
Debt Service/Debt	1	0	0
Debt Service/Exports	7	0	1
Debt Service/Reserves	0	0	1
Short Term Debt/Debt	0	0	1
Short Term Debt/Reserves	2	0	2
Reserves/GDP	0	6	0
Reserves/Debt	0	1	0
Reserves/Imports	0	4	1
Fiscal Balance/GDP	1	10	6
Current Account/GDP	4	7	8
Current Account/Exports	0	1	0
(Short Term Debt + Current Account Balance)/Foreign Exchange reserve	1	0	0
Issued amount	0	2	1
Maturity	1	1	1
Private Issue	2	0	0
Public Issue	0	1	0
Amortization/Reserves	2	0	0
Net Foreign Assets	0	0	1
Credit Rating Residual	0	1	0
Macro Economic			
Per Capita GDP/Income per Capita	0	12	2
GDP	1	1	0
Growth rate of GDP	0	18	5
Square of GDP Growth	1	0	0
Inflation	20	0	3
Lagged Inflation	1	0	0
Volatility of Inflation	1	0	0
(Exports+Imports)/GDP (openness)	0	5	0
Exports/GDP	0	1	1
Imports/GDP	0	0	1
Growth rate of Exports	0	2	1
Growth rate of Imports	1	0	0
Exports/Imports	0	2	0
Terms of Trade	0	1	0
Terms of Trade Volatility	3	0	0

X

Variables 1	Pos 1	Neg 1	Und 1
Investment/GDP (Propensity to invest)	0	3	0
Foreign Investment/GDP	0	1	0
Real Interest Rate	2	0	0
Real Exchange Rate	1	0	0
Real Exchange Rate Misalignement	3	0	1
Unemployment	1	0	1
State Fragility	1	0	0
Level of Technology (Mobile phone users)	0	1	0
External			
Internationa interet rates	1	1	1
Interest Rate (level, slope curvature)	1	0	0
US Long term Bond Yield	4	0	3
Long run LIBOR	2	0	0
Stock Returns	1	1	1
Stock Vol	1	0	1
Real Oil Price	0	0	1
Spread Variance	1	0	0
Covariance with EMBI	0	0	1
Global Risk Aversion	1	0	0
Market Risk Premium	1	0	0
Currency Mismatch	0	1	0
Contagion	0	1	0
Institutional Investor Rating	0	1	0
Spread between high and low rating bonds	0	0	1
Discrete Variables			
Has the Country defaulted in the Past ?	14	1	0
Is the country developed/industrialized ?	0	7	0
EU Accession	0	2	0
Presidential Year ?	1	0	0
LatAm Issuer	1	0	1
Israel Dummy	0	1	0
Country Location	1	0	0
Mexican Crisis	0	0	1
Brady Dummy	1	0	0
Political Stability and Competitiveness			
Government effectiveness	0	1	0
Measure of Corruption	2	0	0
Global Competitiveness	0	0	0
Old Age Dependency	0	0	0
Quality of Education	0	0	0
Political Risk Score	1	0	0
Basic Political Rights	0	1	0

Legend
Explanatory Variables considered in our study
Variable that appears significant in at least 2 studies with the same effect
Variable that appears significant in less than 2 studies

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