

Sovereign Default Risk Assessment From The Bottom-Up

Edward I. Altman*
And
Herbert Rijken**

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***Max L. Heine Professor of Finance, NYU Stern School of Business, ealtman@stern.nyu.edu.**
****Professor of Finance, Vrije University, Amsterdam, the Netherlands, hrijken@feweb.vu.nl.**
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Abstract

We propose a totally new approach toward assessing sovereign risk by examining rigorously the health and aggregate default risk of a nation's private corporate sector. Models such as our new Z-Metrics™ approach can be utilized to measure the median probability of default of the non-financial sector cumulatively for five years, both as an absolute measure of corporate risk vulnerability and a relative measure compared to other sovereigns and to the market's assessment via the now liquid credit-default-swap market. Specifically, we measure the default probabilities of listed corporate entities in nine European countries, and the U.S.A., as of 2009 and 2010. These periods coincide with the significant rise in concern with sovereign default risk in the Euro country sphere. We conclude that our corporate health index of the private sector measured at periods prior to the explicit recognition by most credit professionals, not only gave an effective early warning indicator but provided a mostly appropriate hierarchy of relative sovereign risk. Policy officials should, we believe, nurture, not penalize, the tax revenue paying and jobs generating private sector when considering austerity measures of distressed sovereigns.

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JEL classification: F34, F36

1. Introduction

Periodically, sovereign economic conditions spiral out of control and require a massive debt restructuring and/or bailout accompanied by painful austerity programs for the country to function again in world commerce and financial markets. Recent instances have involved several Latin American countries in the 1980s, Southeast Asian nations in the late 1990s, Russia in 1998 and Argentina in 2000. These are examples of situations when a nation's severe problems not only impacted their own people and markets but created seismic financial tremors which extended beyond their borders. In 2010, we are experiencing this with the situation in Greece and several of its southern European neighbors.

The dire condition of these nations usually first manifests as a surprise to most, including the agencies that rate the default risk of sovereigns and the companies that reside in these suddenly threatened nations. It was not long ago that Greek debt was investment grade and Spain was Aaa (June 2010)¹. In 1996, South Korea was considered one of the so-called "Asian Tigers" with an AA- rating, one of the best credit ratings possible. Within one year, South Korea was downgraded to BB-, one of the so-called "junk" rating categories, and would have defaulted if not for a \$50 billion bailout from the IMF.

Academics and market practitioners have not had an impressive record of predicting serious sovereign financial downturns or of providing adequate early warnings of impending economic and financial problems. These analysts generally use the traditional macroeconomic indicators, such as GDP growth, debt levels relative to GDP, trade and financial deficits,

¹ On April 27, 2010, Standard & Poor's Ratings Services lowered its long- and short-term credit ratings on the Hellenic Republic (Greece) to non-investment grade BB+ and B, respectively and on June 14, 2010, Moody's downgraded Greece debt to Ba1 from A2 (4 notches), while Spain was still Aaa and Portugal was A1. Both of the latter were recently downgraded. S&P gave similar ratings.

unemployment, productivity, etc. to assess sovereign health. While no absolute guarantee of providing the magic formula for early warning transparency of impending doom, we believe that one can learn a great deal about sovereign risk by analyzing the health and aggregate default risk of a nation's private corporate sector - a type of "bottom-up" analysis. Models such as my established Z-Score technique (1968), and more recently (2010) Risk Metrics' Z-Metrics™ system, can provide an important additional measure of sovereign vulnerability. We will investigate the latter system with respect to the current European Union sovereign debt crisis.

The ensuing discussion is organized as follows. Section 2 will briefly document the modern history of sovereign financial crises. Section 3 will explore the extensive academic and practitioner literature on sovereign risk, with an emphasis on those empirical studies that assess the ability to predict and explain sovereign defaults and crises. Section 4 will explain our new Z-Metrics system for individual, non-financial firm probability of default estimation, leading to its application in Section 5 to the current European Union's debt crisis. Section 6 will explore our findings and implications for bailout strategies and future research.

2. Modern History Sovereign Crises

It is fair to say that sovereign debt crises occur frequently and are not restricted to emerging market countries. Figure 1 shows a partial list of "advanced" countries' dates of financial crises (first year of the crisis). If we had included a number of currently sophisticated Asian countries as advanced countries, the period 1997-1999 would be prominent. Overall, Latin America seems to have had more recent bond and loan defaults than any other region of the world (see Figure 2).

FIGURE 1

Financial Crises, Advanced Countries 1870-2010

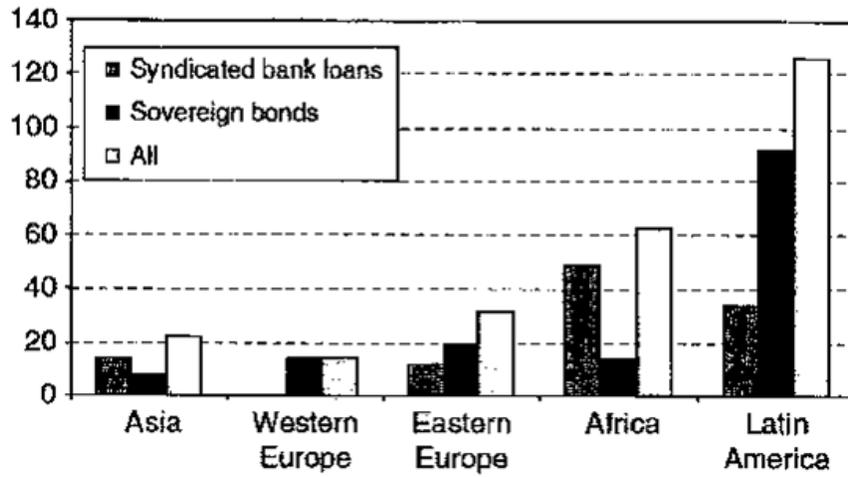
Crisis events (first year)

Austria	1893, 1989
Brazil	1898, 1902, 1914, 1931, 1939
Canada	1873, 1906, 1923, 1983
Czechoslovakia	1870, 1910, 1931, 2008
China	1921, 1939
Denmark	1877, 1885, 1902, 1907, 1921, 1931, 1987
DEU	1880, 1891, 1901, 1931, 2008
GBR	1890, 1974, 1984, 1991, 2007
Greece	1870, 1894, 1932, 2009
Italy	1887, 1891, 1907, 1931, 1930, 1935, 1990
Japan	1942
Netherlands	1897, 1921, 1939
Norway	1899, 1921, 1931, 1988
Russia	1918, 1998
Spain	1920, 1924, 1931, 1978, 2008
Sweden	1876, 1897, 1907, 1922, 1931, 1991
USA	1873, 1884, 1893, 1907, 1929, 1984, 2008

Source: IMF Global Financial Stability Report (2010), Reinhart and Rogoff (2010), and various other sources, such as S&P's economic reports.

FIGURE 2

Number of Sovereign "Defaults" 1824 - 2004



Source: Compilation by I. Walter, NYU Stern School of Business.

In this paper, we will concentrate on public corporate data in 2010 for a group of nine European countries to illustrate our main points about assessing sovereign health going forward. In doing so, we will refer to difficult sanctions to governments, such as Greece and Ireland, for them to qualify for bailouts and subsidies. The implication from our analysis is that we should be careful to promote, not destroy, private enterprise valuations.

3. Literature Review

The sovereign risk and related default probability literature is extensive with a fairly continuous supply of both academic and practitioner studies. Excellent primers on assessing sovereign risk can be found in Babbel (1996)², Chambers (1997), Beers, et al (2002) - the latter two from S&P - Smith and Walter (2003), and Frenkel, Karmann and Scholtens (2004). A number of studies have attempted to predict sovereign defaults or rescheduling, starting from Frank and Cline's (1971) classic study and they include statistical classification and predicting methods like discriminant analysis (e.g., Frank and Cline (1991), Grinols (1976), Sargen (1977), and Morgan (1986); logit analysis (e.g., Feder and Just (1977), Feder, Just and Ross (1981), Cline (1983), Schmidt (1984), and Morgan (1986) with a number of similar econometric techniques also having been applied, and finally the use of contingent claim analysis by Gray, Merton and Bodie (2006, 2007). The latter studies proposed a new approach to measure, analyze and manage sovereign risk based on Merton's classic "structural" approach (1974) adapted to sovereign balance sheets. It attempts to forecast credit spreads and to evaluate the impact of market risks and risks transferred from other sectors. Relying on market indicators of sovereign

² Babbel's (1996) study includes an excellent annotated bibliography by S. Bertozzi on external debt capacity which describes many of these studies. Babbel lists 69 potentially helpful explanatory factors for assessing sovereign risk, all dealing with either economic, financial, political, or social variables. Except for the political and social variables, all others are macroeconomic data and this has been the standard until the last few years.

health, this approach benefits and at the same time is subject to wide swings in risk assessment due to market volatility.

A number of recent studies have analyzed how a global or regional common risk factor largely determines the level of sovereign risk in the world, or in a region, such as Europe. Examples of these are Baek, Bandopadhyaya and Chan (2005) who showed that both an individual sovereign's risk factor and a common time-varying global factor affects market repricing of sovereign risk. Gerlach, Schulz and Wolff (2010) observe that aggregate risk factors drive banking and sovereign market risk spreads in the Euro area. Related to this, Sgherri and Zoli (2009) suggest that Euro area sovereign risk premium differentials tend to co-move over time and are mainly driven by a common time-varying factor. Finally, Longstaff, Pan, Pedersen and Singleton (2007) showed that sovereign credit spreads are surprisingly more related to such aggregate market indexes, such as the U.S. stock and high-yield bond markets and global capital flows, than they are to their own local economic measures. Their theme and that of the structural approach discussed earlier, is similar to Oshino and Saruwatari's paper (2005) which proposed a new approach to quantify sovereign risk using the stock market price index as a proxy for the equity value of the country. Our approach, discussed shortly, certainly utilizes stock market prices of individual companies, as well as a number of fundamental variables, in our assessment of corporate risk. We also observe the impact of the overall stock market performance in a country and its relationship with its private sovereign risk measure. This is particularly relevant in comparing our results in 2009 vs. 2010.

Several very recent papers focus on sovereign risk premiums and spreads. These include Haugh, Ollivaud and Turner's (2009) discussion of the importance of debt service relative to tax receipts in the Euro area; Hilscher and Nobusch (2010) emphasis on the volatility of terms of

trade; and Segoviano, Caceres and Guzzo's (2010) analysis of debt sustainability and the management of a sovereign's balance sheet.

Some research cite the information content from published credit ratings and related market statistics. Indeed, Remolona, Scatigna and Wu (2008) utilize sovereign credit ratings and historical default rates provided by rating agencies to construct a measure of ratings implied expected loss. The authors conclude that sovereign ratings, especially in emerging markets, provide an improved understanding of country risks for investment analytics.

Despite these efforts and the information content from published ratings, the recent crisis amongst European countries occurred when all rating agencies and, it would seem, available models for estimating sovereign risk indicated that Greece and Spain, and others now recognized high-risk countries, were still classified as investment grade³.

Chambers of S&P (1997) does mention the notion of a "bottom-up" approach but not to the assessment of sovereign risk, but to a corporate issuer located in a particular country. He advocates first an evaluation of an issuer's underlying creditworthiness to arrive at its credit rating and then considers the economic, business and social environment in which the entity operates. These latter factors, such as the size and growth and the volatility of the economy, exchange rates, inflation, regulatory environment, taxation, infrastructure and labor market conditions are factored in on top of the micro variables to arrive at a final rating of the issuer.

Our approach advocates going in the other direction, factoring in the health of the private sector - a different type of "bottom-up" analysis - on the vulnerability of the sovereign. The idea

³ To be fair, S&P in a *Reuter's* article, dated January 14, 2009, warned Greece, Spain and Ireland that their ratings could be downgraded further as economic conditions deteriorated. At that time, Greece was rated A1 by Moody's and A- by S&P. Interestingly, it was almost a full year later on December 22, 2009 that Greece was actually downgraded by Moody's to A2 (still highly rated), followed by further downgrades on April 23, 2010 (to A3) and finally to "junk" status (Ba1) on June 14, 2010. As noted earlier, S&P downgraded Greece to "junk" status about three months earlier.

for doing this was actually first observed in the works of Pomerleano of the World Bank (1998) in his study of the East Asian crisis of 1997.⁴ Among other factors, the author observed the average Z-Score (Altman, 1968) as a measure of “financial fragility” of eight Asian countries and, for comparison purposes, three developed countries and Latin America. Surprising to many observers, the Asian country with the highest fragility to financial distress based on the average Z-Score of listed, non-financial companies, as of the end of 1996, was South Korea, followed by Thailand and Japan and Indonesia. As noted earlier, Korea’s sovereign bond rating at that time was AA- (S&P) but within less than one year its rating plummeted to BB- and if not for the IMF bailout of \$50 billion, it is likely that Korea would have defaulted on its external, non-local currency debt. And, South Korea had been growing at double-digit rates for about a decade just prior to its demise. So, a traditional macroeconomic measure like GDP growth was misleading at the time. The World Bank concluded that its findings supported the view by Krugman (1998), and others, that crony capitalism and the associated strategy and policies of implicit guarantees coupled with poor banking regulation were the ingredients for an impending crisis to the nation’s banking system and its economy.⁵

Many policy makers and theorists of late have concentrated on the role of the banks and other financial institutions, the so-called “shadow banking system.” In a very recent report, Gennaioli, Martin and Rossi (2010) argue that the ability of governments to borrow and repay, as well as the severity of defaults depends on the development of private financial markets and particularly the financial sector’s ability to attract foreign capital. They conclude that strong financial institutions, by attracting more capital and leverage, provide an internal discipline for

⁴ Pomerleano’s “Note” is based on a longer article by the author (1997).

⁵ The excesses of corporate leverage and permissive banking were addressed successfully in the case of Korea and its economy was effectively restructured after the bailout.

the government to repay its debt. We will return to this topic when we discuss our empirical findings regarding the crisis in Europe today.

Almost all of the studies cited above were fairly optimistic as to the conceptual and practical benefits of an early warning system for sovereign crisis prevention. Sadly, they have either been ignored or have proven ineffective in forecasting most economic and financial crises and we still regularly observe these events (see our listing earlier).

4. The Z-Metrics™ Approach⁶

To address the assessment of credit risk of companies, we partnered with *RiskMetrics Group* in 2009 (now part of MSCI, Inc.), resulting in our new Z-Metrics approach. Our methodology is what might be called a new generation of the original Z-Score model (Altman, 1968). Our objective was to assess the credit risk of non-financial enterprises by developing up-to-date credit scoring and probability of default metrics for enterprises both public and private, large and small, on a global basis. Starting with a large sample of non-financial sector firm data over the period 1989-2008, involving more than 250,000 quarterly and annual firm financial statements and associated market prices and macroeconomic data observations, we utilized a multivariate logistic regression structure to construct our models. We used the criterion of a “credit event,” which is defined here to be either a formal default or bankruptcy legal event, whichever comes first, to segregate firms into cohorts. Those firms which have had a credit event within a given timeframe (i.e., 1 year or 5 years) were assigned to the “distressed” or “credit event” group; those that did not incur a credit event were assigned to the non-distressed group. It is based on these cohorts that we have built our model to predict performance.

⁶ For more details, see Altman, et al, 2010 “The Z-Metrics™ Methodology for Estimating Company Credit Ratings and Default Risk Probabilities,” *RiskMetrics Group*, continuously updated, available from <http://riskmetrics.com/Z-Metrics>.

We emphasize that our results will be applicable across the complete spectrum of credit quality and ratings from the lowest to the highest default risk categories. The result is a robust model with high default/non-default classification and predicted accuracy. Whenever possible, we compare our output with publicly available credit ratings and existing models. The accuracy ratios and observed results on samples of individual defaulting firms using our new approach clearly outperform existing methodologies, including the Z-Score model.

Objectives of our Z-Metrics™ Models

- To construct an accurate, logical and robust credit-scoring model based on large and representative samples of non-financial companies that have either suffered a serious negative credit event or have remained healthy.
- To assign a point in time probability of default (PD) over one-year and five-year horizons based on a firm's credit score.
- To assign a unique Z-Metrics credit rating, given the PD, to each firm representing the full spectrum of creditworthiness; one that is easily mapped to familiar credit terminology.
- To provide stressed PDs and ratings under various scenarios.

We expect, however, that our U.S. model will also be immediately available to publicly-held firms in most other developed nations. Indeed, we utilize the large publicly-held firm U. S. model to evaluate the default risk of European companies in our analysis.

Variables Assessed

- We analyzed over 50 fundamental financial statement variables covering such performance characteristics at solvency, leverage, size, profitability, interest coverage, liquidity, asset quality, investment, dividend payout, and financing results.
- In addition to point-in-time measures, we analyzed the trends in many of the variables mentioned above.

- We also included equity market price and return variables and their volatility patterns, adjusted for market movements. These variables have typically been used in structural, distance-to-default measures, such as the KMV (Crosbie, KMV, 1999) model (now Moody's KMV). As noted earlier, Gray, et. al. (2007) adapted this analysis for sovereigns.
- Macro-economic variables are included to capture the time-series variation of default probabilities over time. Since most firms have a higher probability of default in stressed periods, e.g., at the end of 2008, we wanted to capture heightened or lower probabilities by examining such variables as GDP growth, unemployment, credit spreads, inflation, among others. As such, our model has explicitly evaluated some of the traditional sovereign risk variables in our assessment of private firm creditworthiness.
- In all cases, we carefully examined the complete distribution of variable values, especially in the credit-event sample. This enabled us to devise transformations on the variables to either capture the nature of their distributions or to reduce the influence of outliers. These transformations included logarithmic functions, first differences and dummy variables if the trends or levels of the absolute measures were positive/negative.
- The final model included 13 fundamental, market value and macroeconomic variables.

Sample Characteristics

- Our first model's original sample consisted of over 1,000 U.S. or Canadian non-financial firms that suffered a credit event ("credit event sample") and a control sample of thousands of firms that did not suffer a credit event, roughly a ratio of 1:15. After removing those firms with insufficient data, the credit event sample was reduced to 638 firms for our public firm sample and 802 observations for our private firm sample.
- The one-year (12 months) model is based on data from financial statements and market data approximately one year prior to the credit event and includes macroeconomic data. The five-year model includes up to five annual financial statements prior to the event.

Public and Private Firm Models

Our emphasis in this application will be on the Z-Metrics publicly-owned firm model. In addition, we construct essentially a private firm model, although the data is from publicly-held companies and we replace market value with book value of equity. The application of our privately-held firm model will be useful for analysts who are interested in non-public firms.

Z-Metrics Model Construction and Tests

Logit Model Estimation

- We estimate our credit scoring model based on a standard logit-regression functional form whereby:

$$CS_{i,t} = \alpha + \sum B_j X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$CS_{i,t}$ = Z-Metrics credit score of company i at time t

B_j = variable parameters (or weights)

$X_{i,t}$ = set of fundamental, market based and macroeconomic variables for firm i quarter observations

$\varepsilon_{i,t}$ = error terms (assumed to be identically and independently distributed)

$CS_{i,t}$ is transformed into a probability of default by $PD_{i,t} = \frac{1}{1 + \exp(-CS_{i,t})}$

- Comparisons are made with the actual issuer ratings. To ensure a fair comparison, credit scores are converted to agency equivalent (AE) ratings by ranking credit scores and by matching exactly the actual Agency rating distribution with the AE rating distribution at any point in time.
- We also compare our Z-Metrics results to the well established Altman Z''-score (1995) model.⁷

Accuracy Ratios

One of the key success determinants of any credit risk model is how well the model classifies firms into high risk (low ratings) levels based on data from before some critical credit

⁷ Altman's original Z-score model (1968) is well-known by practitioners and scholars alike and is considered by many as the traditional benchmark for bankruptcy prediction. It was built, however, over 40 years ago and is primarily applicable to publicly-held manufacturing firms. A more generally applicable Z''-score variation was popularized in 1995 (Altman, Hartzell and Peck, 1995) as a means to assess the default risk of non-manufacturers as well as manufacturers, and was first applied to emerging market credits. Both models are discussed in Altman and Hotchkiss (2006) and will be compared in several tests to our new Z-Metrics model. Further, the Altman Z-score models do not translate easily into a probability of default rating system, as does the Z-Metrics system.

event takes place. In our model's estimation, the objective is to attain high levels of accuracy (low levels of errors) to classify, and ultimately to predict, firms which default on their obligations and/or go bankrupt. The standard measure for these assessments is the so-called "accuracy ratio," which measures the proportion of credit-event firms correctly predicted to go bankrupt or non-bankrupt based on different credit score cut-off levels. In essence, the objective is to maximize the Type I and Type II accuracy levels (minimize errors) for test and holdout samples of firm. Our results (Figure 3) show superior Type I accuracies at all cutoff levels of scores and bond rating equivalents compared to actual bond ratings and Z-Scores (see the Z-Metrics white paper for detail).

Stability of the Models

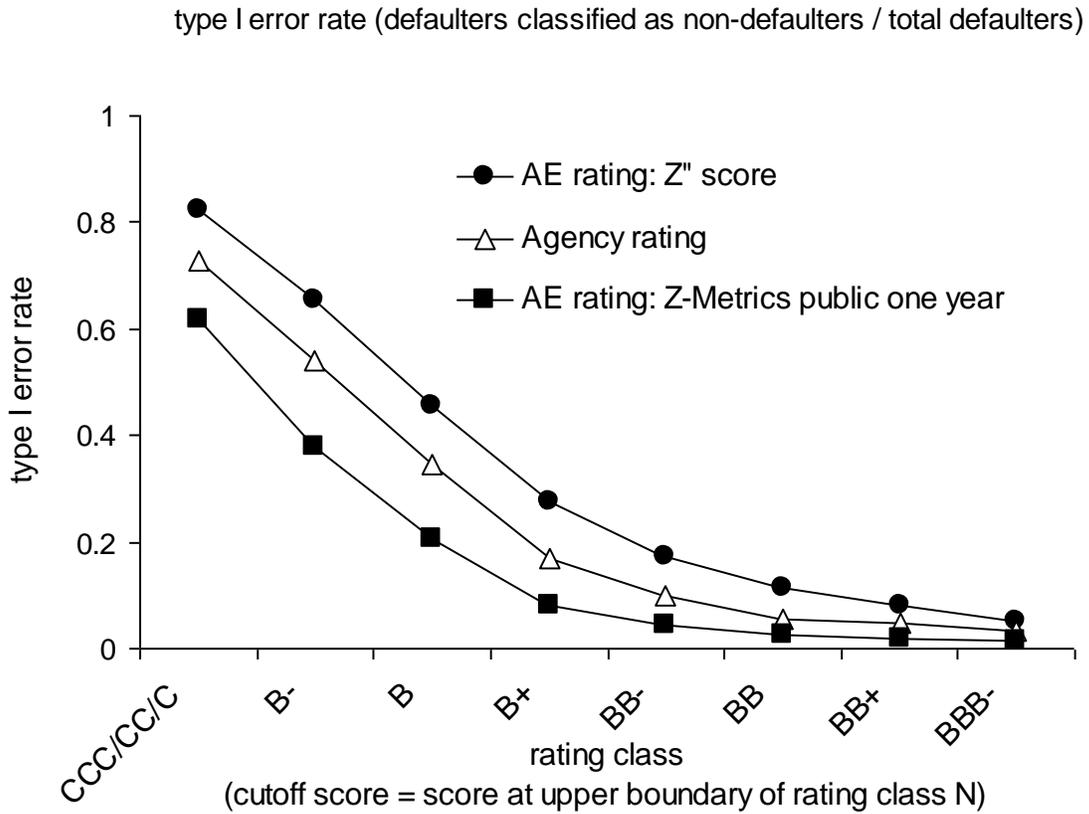
We assessed the stability of the Z-Metrics models by observing the accuracy ratios for our tests in the in-sample and out-of-sample periods and also by observing the size, signs and significance of the coefficients for individual variables. The accuracy ratios were very similar between the two sample periods and the coefficients and significance tests were extremely close.

Prediction Results – 2009 Defaults/Bankruptcies

Perhaps the most important robustness tests of credit scoring models are how well they *predict* critical events based on samples of firms which were not used to build the model, and particularly if the events took place subsequent to the building of the model(s). An associated test is how well the model compares to other methods which are available and where the data and comparable results are transparent, again outside the test sample period. These results are indicative of the models' predictive accuracy for both our public and private Z-Metrics models for one-year and five-year horizons and also comparative tests with Agency ratings and the Z-score and Z"-score models. Z-Metrics model results are displayed in terms of AE ratings,

FIGURE 3

Type I error for Agency ratings Z"-score, and Z-Metrics agency equivalent (AE ratings (1989-2008): one year prediction horizon for publicly owned firms



probabilities of default and also our own rating system. These results can be found in the Z-Metrics White Paper, mentioned in footnote #6.

5. The “Bottom-Up” Approach for Sovereign Risk Assessment

By using our Z-Metrics default probabilities for individual firms and aggregating these probabilities by country, one can compute both a median default probability and rating for each country and use these as one assessment of the overall health of the nation’s private sector. The recent situation in Europe is importantly instructive.

We have selected nine key European countries to examine as of two time period intervals prior to the height of the recent European sovereign debt crisis. The periods of analysis include the first six months of 2009 and the first four months of 2010. The clear recognition of the crisis and the concern over a European Union collapse was in June 2010, when Greece’s debt was downgraded to non-investment grade and both Spain and Portugal also were downgraded to a lower rating, albeit still amongst the top three rating categories. Clearly, however, the credit market recognized the Greek and Irish problems prior to June 2010 and as we will show, ascribed a high implied probability of default during the first half of 2010 and, although less so, even in 2009. To capture the essence of our model’s PD estimates, we observe the median PDs based on the population of listed non-financial companies. For the sovereign CDS spread, and our model’s estimates, we observe the median level for the six-month/four-month periods.⁸

Figure 4 shows the median Z-Metrics’ PD estimates for listed European stock companies for the two time periods described above and also the median implied default probability from CDS spreads. To avoid outlier problems, we utilized the daily medians over the first six months

⁸ The median CDS spread is based on the daily observations in the six/four-month periods. The median Z-Metrics PD is based on the median company PDs each day and then we calculated the median for the period. The results are very similar to simply averaging the median PDs as of the beginning and ending of each sample period.

of 2009 and the first four months of 2010. We observed these risk measures for nine European countries as well as the United States. It is of great interest to examine the differential PDs not only across different countries, but also between the two time periods. These comparisons indicate not only sovereign risk differences but also the impact of differential asset values as determined primarily by market values of the outstanding equity securities of the companies.

In the first-third of 2010, our Z-Metrics' 5-year PDs for European corporate default risk placed Greece (10.60%) and Portugal (9.36%) in the highest risk categories (ZC-ratings), followed by Italy (7.99%), Ireland (6.45%) and Spain (6.44%), all in the ZC category, then Germany and France (both about 5.5% - ZC+), with the U.K. (3.62%) and the Netherlands (3.33%) at the lowest risk levels (ZB- and ZB). The U.S.A. compares fairly well at 3.93% (ZB-). For the most part, this risk hierarchy is logical since most analysts would place countries like Greece and Portugal amongst the most risky in Europe and France, Germany and the Netherlands amongst the least risky. There were a few surprises, with the U.K. demonstrating a fairly healthy private sector and Germany and France perhaps not as healthy as one might have

Figure 4

**Financial Health of the Private, Non-Financial Sector: Selected European Countries and U.S.A. in 2010/2009
(Z-Metrics PD Estimates and Implied PDs from CDS Spreads)**

Country	No. of Listed Companies		Z-Metrics PD Estimates: Five-Year Public Model*				Five-Year Implied PD from CDS Spread **†	
	2010	2009	2010 Median PD	2009 Median PD	2010 Std. Dev.	2009 Std. Dev.	2010	2009
Netherlands	61	60	3.33%	5.62%	7.52%	9.33%	2.83%	6.06%
United Kingdom	442	433	3.62%	5.75%	11.60%	12.70%	6.52%	8.13%
U.S.A.	2226	2171	3.93%	6.97%	9.51%	15.15%	3.28%	4.47%
France	297	294	5.51%	7.22%	9.72%	12.34%	3.75%	4.05%
Germany	289	286	5.54%	7.34%	13.10%	15.16%	2.67%	3.66%
Spain	82	78	6.44%	7.39%	9.63%	11.26%	9.39%	8.07%
Ireland	28	26	6.45%	7.46%	16.29%	16.30%	12.20%	17.00%
Italy	155	154	7.99%	10.51%	10.20%	14.11%	8.69%	11.20%
Portugal	30	30	9.36%	12.07%	7.25%	12.44%	10.90%	7.39%
Greece	79	77	10.60%	11.57%	14.40%	12.99%	24.10%	13.22%

* Based on median Z-Metrics PDs from January 1 – June 30, 2009 and January 1 – April 30, 2010.

**Assuming a 40% recovery rate; based on the median CDS spread observed for first six months of 2009 and first three months of 2010.

†PD Computed as $1 - e^{(-5\%s/(1-R))}$

Sources: RiskMetrics Group (MSCI), Markit, Compustat.

thought. Perhaps the U.K.'s relative strong showing is somewhat driven by the fact that our risk measure does not include financial sector firms, which comprised about 35% of the market values of listed U.K. corporates and were in poor financial condition in recent periods. Also there are several very large, healthy multinational entities in the U.K. index. The CDS/5-year market's assessment of U.K. risk was harsher in 2010 with the median of the first four months days implying a 6.52% probability of default, about double our Z-Metrics median level.⁹ Greece also had a much higher CDS implied PD at 24.10% compared to 10.60% for Z-Metrics. Of course, the choice of the median Z-Metrics PD is arbitrary and there are 50% of the listed companies with higher PDs than 10.60%.

We also observe that several countries had a relatively high standard deviation of Z-Metrics PDs, indicating a longer tail of very risky companies. These countries include Ireland, Greece and, surprisingly again, Germany, based on 2010 data. So, while almost everyone considers Germany as the benchmark-low risk country in Europe (e.g., its 5-year CDS spread was just 2.67% in 2010, even lower than the Netherlands (2.83%)), we are more cautious, at least based on a broad measure of private sector corporate health.

2010 vs. 2009

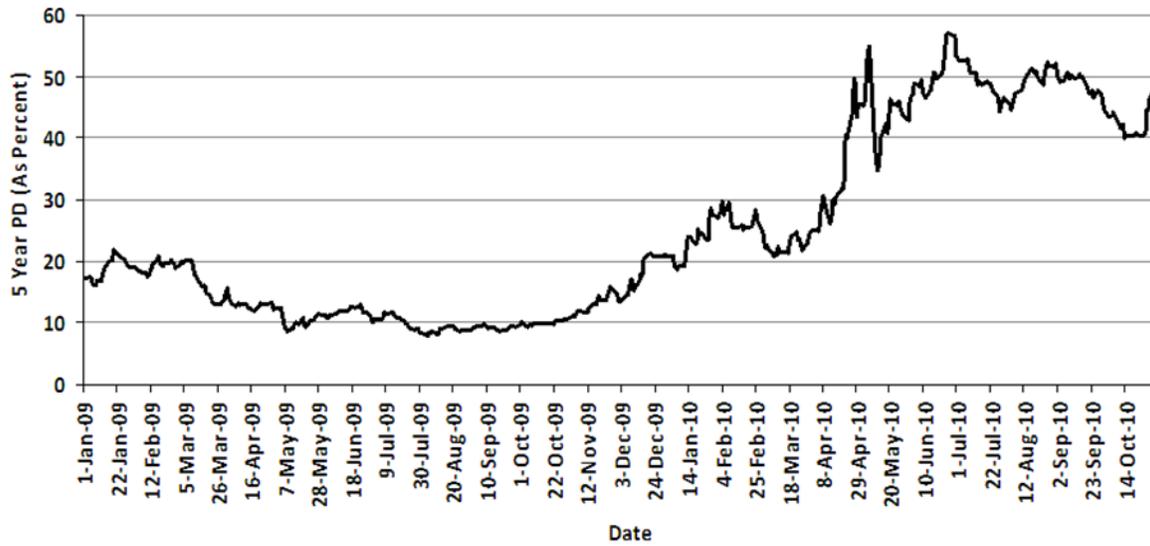
In Figure 4, we can also examine how our two risk measures (Z-Metrics PDs and CDS spread implied PDs) differed between the first six months of 2009 and the first four months of 2010. Note that in all cases, our 2009 PD estimates are uniformly higher (more risky) than early in 2010, even if the world was more focused on Europe's problems in the later year. We believe the main reason for the higher PDs was the significant impact of the stock market, which is a

⁹ Greece's implied PD from CDS premiums spiked to as high as 57.1% in June 25, 2010 before setting lower in recent months as the threat of an immediate default seemed to subside. There was, however, a late spike in October 2010. See Figure 5 for a recent two-year time-series on the Greek CDS implied PDs.

FIGURE 5

Five Year Implied Probabilities of Default (PD) From CDS Spreads

Greece, Jan 2009 to Oct 2010



Source: Markit

powerful variable in the Z-Metrics model - - and also in many other default probability models (e.g., Moody's KMV). Recall that the stock markets were at very low levels at the end of 2008 and into the early months of 2009, while there was a major recovery later in 2009 and in early 2010.

Figure 6 shows the percent increase in median 2010 stock market index levels for our nine European countries and the USA compared to 2009 levels. Note that most all countries enjoyed increases of greater than 20% between the first six months of each year. Only Greece had a relatively low increase (5.5%), consistent with its modest improvement in its Z-Metrics PD (-8.4%). Figure 9 also shows the sovereigns' percent improvement in PDs (lower risk) in 2010, which are, for the most part, consistent with stock market index values. Note that Ireland stands out in that while its stock market index value increased by 26.2%, its corporate sector only enjoyed a modest improvement (-7.4%) in Z-Metrics' median PD. Perhaps this was due to the earlier austerity measures taken in Ireland compared to other shaky European nations. As noted before, there are many other variables, mainly fundamental measures of corporate health and macroeconomic conditions, included in the Z-Metrics model which are not impacted by stock prices.

FIGURE 6

Median Percent Change in Various Country Stock Market Index Values and Z-Metrics' PDs Between the First Six Months of 2010 Vs. 2009

Country	Index	Median Percent Change (2010 vs. 2009)*	Median Z-Metrics Percent Change (2010 vs. 2009)
France	CAC40	24.1%	-23.6%
Germany	DAX	31.8%	-24.5%
Greece	ASE	5.5%	- 8.4%
Ireland	ISEQ	26.2%	- 7.4%
Italy	FTSEMIB	18.2%	-24.0%
Netherlands	AEX	34.4%	- 25.3%
Portugal	PSI-20	17.8%	-22.4%
Spain	IBEX35	20.9%	-12.9%
UK	FTSE100	27.8%	-37.6%
USA	S&P500	31.9%	-43.6%

*Median of the various trading day stock index values and PDs, first six months of 2009 vs. First six months of 2010.

Sources: Z-Metrics Model calculations from RiskMetrics (MSCI) Group, Bloomberg for stock index values.

Comparing PD Results Based on Privately Owned vs. Publicly Owned Firm Models

As we discussed, the Z-Metrics PDs show a consistent improvement in 2010 compared to 2009 across all countries listed in Figure 4. And, as also noted, we believe that this improved, lower PD situation reflects, primarily, the positive trend in stock market prices (Figure 6). To further assess these trends and influences, we now compare PDs using our private-firm model vs. the public-firm approach discussed up to now. Essentially, the private and public firm models are the same except we use book value of equity value and its volatility instead of market values. This should strip-out the capital market influence on our credit risk measure.

Figure 7 shows the public vs. private firm Z-Metrics models comparative PD (delta) results for 2010 and 2009. Eight of the ten countries displayed greater reductions in PDs in 2010 vs. 2009 for the public model compared to the private one. The overall average improvement in PDs for the public firm model was -1.91 percentage points compared to just -0.79% for our private firm model. These results are probably a function of positive stock market performance from the first six months of 2009 to the first three months of 2010. Also, improved economic conditions impacting traditional corporate performance measures contributed to the improved PDs. In two of these eight countries (the UK and France), not only did the public firm model show an improved (lower) PD, but the private firm model's PD actually got worse in 2010 vs. 2009 (positive delta in the last column of Figure 7).

In two cases (Greece and Spain) the private firm model's PDs actually improved more in 2010 vs. 2009 than did the public firm model. For these two risky countries, our results imply that traditional corporate performance measures (private firm model) improved more than those same measures combined with stock market values (public firm model) results. Indeed, despite the fact that Greece's private firm model PDs

were clearly the worst amongst our ten-country sample (highest median PDs) in both years (11.0% in 2010 and 13.9% in 2009), the delta (-2.90%) was the largest. Based on the public firm model, however, Greece's improvement in 2010 (-0.97%) was one of the weakest -- only Spain's -0.95% delta was smaller. This is consistent with Greece's relatively low stock market performance in 2009-2010 (+5.5%). Finally, interestingly, the USA recorded the lowest median PDs in both 2010 and 2009 based on the private firm model results.

FIGURE 7

Private Vs. Public Firm Model PDs in 2010 and 2009

<u>Country</u>	<u>No. Listed Companies</u>		<u>Public-Firm Z-Metrics Model</u>			<u>Private-Firm Z-Metrics Model</u>		
	<u>2010</u>	<u>2009</u>	<u>PDs 2010</u>	<u>PDs 2009</u>	<u>Delta*</u>	<u>PDs 2010</u>	<u>PDs 2009</u>	<u>Delta*</u>
Netherlands	61	60	3.33%	5.62%	-2.29%	5.25%	6.00%	-0.75%
U.K.	442	433	3.62%	5.75%	-2.13%	6.48%	5.97%	+0.49%
U.S.A.	2226	2171	3.93%	6.97%	-3.04%	4.28%	4.80%	-0.52%
France	297	294	5.51%	7.22%	-1.71%	7.33%	7.19%	+0.14%
Germany	289	286	5.54%	7.34%	-1.80%	6.29%	7.56%	-1.27%
Spain	82	78	6.44%	7.39%	-0.95%	8.06%	9.32%	-1.26%
Ireland	28	26	6.45%	7.46%	-1.01%	6.31%	6.36%	-0.05%
Italy	155	154	7.99%	10.51%	-2.52%	8.14%	9.07%	-0.89%
Portugal	30	30	9.36%	12.07%	-2.71%	8.73%	9.62%	-0.89%
Greece	79	77	<u>10.60%</u>	<u>11.57%</u>	<u>-0.97%</u>	<u>11.03%</u>	<u>13.93%</u>	<u>-2.90%</u>
Average			<u>6.28%</u>	<u>8.19%</u>	<u>-1.91%</u>	<u>7.19%</u>	<u>7.98%</u>	<u>-0.79%</u>

*Negative sign means improved credit risk.
Sources: Figure 4 and Riskmetrics (MSCI).

Correlation of Sovereign PDs: Recent Evidence on Z-Metrics vs. Implied CDS PDs

We thought it interesting to compare our Z-Metrics 5-year median PDs for our sample of nine European countries with both the contemporary and lagged by one year PDs implied from the sovereign premiums CDS market. The contemporary PD correlation in the first third of 2010 was extremely high at $r = 0.82$. This was a period when it was becoming quite evident that certain European countries were in serious financial trouble and the likelihood of default was not trivial. If we go back to the first-half of 2009, the correlation drops to $r = 0.36$, although it is considerably higher at 0.62 if we do not include one country, Ireland. For Ireland, the CDS implied PD was considerably higher in 2009 (17.0%) than in 2010 (12.0%), while the Z-Metrics PD was relatively stable in the two years (7.46% and 6.45% respectively) - - see Figure 4.¹⁰ Finally, in 2010, whether we calculate the correlation with or without Ireland, the results are essentially the same (0.82 and 0.83).

An intriguing idea is to observe if the private sector health index we have created (Z-Metrics) has any predictive power with respect to capital market prices. To gain some insight into this relationship, we regressed our public firm model's 2009 Z-Metrics median, non-financial sector PDs for our sample against implied CDS PDs one year later in 2010. Admittedly, our sample is quite small (10 countries) and the analysis is just for one time-series comparison (2009 vs. 2010). The latter, however, was a crucial and highly visible sovereign

¹⁰ No doubt the CDS market was reacting quite strongly to the severe problems in the Irish banking sector in 2009, while Z-Metrics PDs were not impacted by the banks. This implies a strength of the CDS measure, although the lower CDS implied PD in early 2010 was not impressive in predicting the renewed problems of Irish banks and its economy in the fall of 2010.

debt crisis period, whereas prior years' measures were not volatile either for Z-Metrics or CDS implied PDs.¹¹

Figure 8 shows our one-year lagged relationship between Z-Metrics and CDS implied PDs. We observe that the cross section correlation between the two was quite high $r = 0.69$ and the $R^2 = 0.48$. As such, the 2009 corporate health index for our European and USA sample explained about one-half of the variation in the capital market CDS results one year later in 2010.¹² It is not surprising that a quantitative index of corporate health does not explain the majority of sovereign spread changes. Many other factors such as political and social events as well as macroeconomic conditions impact capital market perceptions as well. And, our corporate health measure does not include a sometimes critical element in assessing sovereign health - - the financial sector. We will explore this issue further.

Financial Sector and Size of the Listed Stock Market Indexes

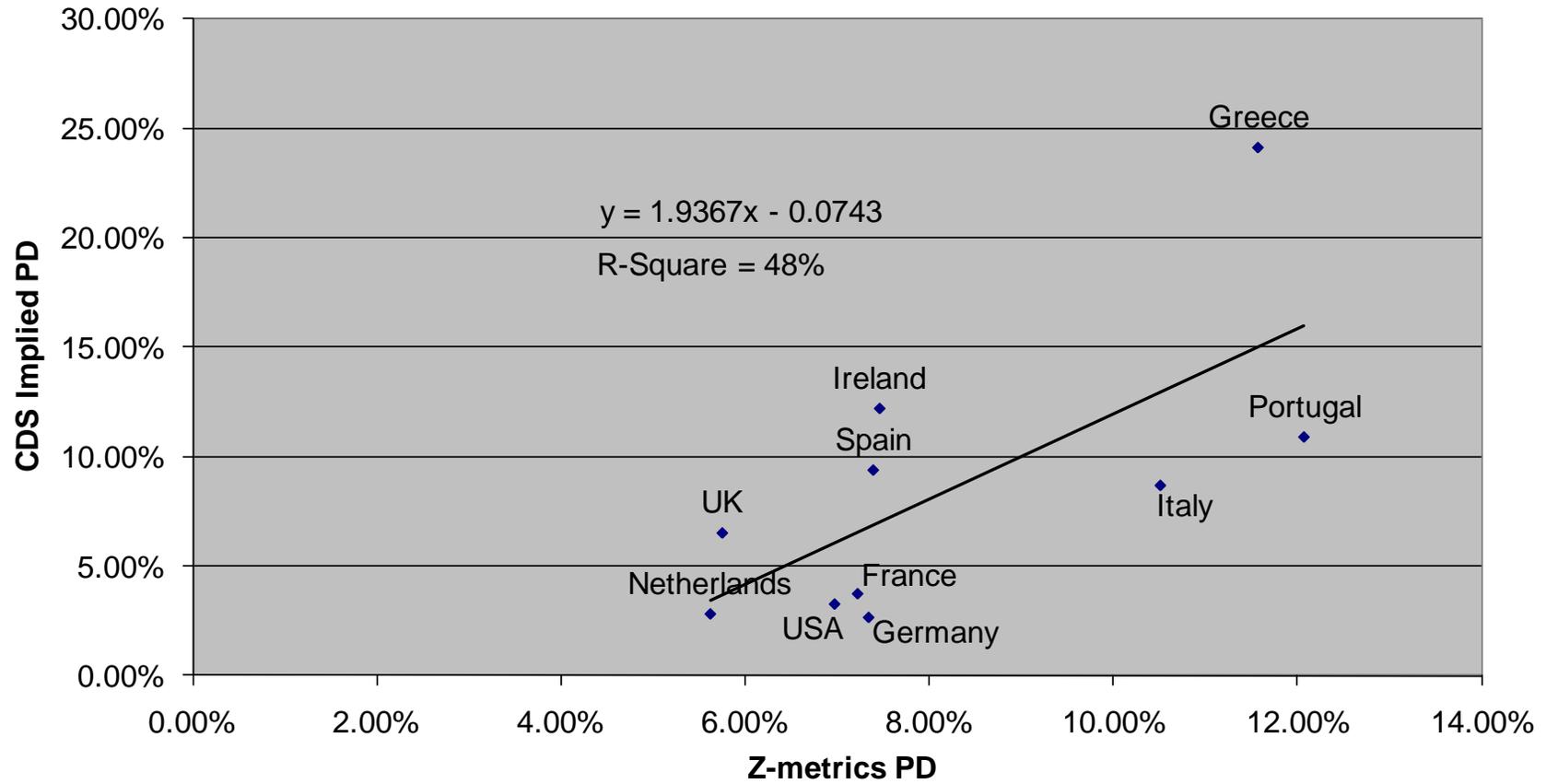
Two data related shortcomings of our sovereign health measure and cross section sample comparisons are the lack of the inclusion of the financial sector in our corporate health index and the relatively small size of listed companies in several of our European nations that make up our sample. The former is especially true in the case of the U.K. whose financial sector comprised 28% of listed companies (FTSE All Share Index) by market value and 41.4% by number of firms (second highest). We were surprised that the UK scored as high as it did in its absolute and relative Z-Metrics private sector health index while its CDS implied PD ranking was relatively worse. Indeed, the CDS PD was 6.52% in 2010 compared to just 3.62% based on the median Z-Metrics PD (Figure 4). The latter ranked second only to the Netherlands,

¹¹ The last time an entire region and its many countries had a sovereign debt crisis was in Asia in 1997-1998. Unfortunately, CDS prices were not prominent and the CDS market was illiquid at that time.

¹² Several other non-linear structures (i.e., power and exponential functions) for our 2009 Z-Metrics vs. 2010 CDS implied PDs showed similar results.

Figure 8

2009 Z-metrics PD vs. 2010 CDS Implied PD



another country whose financial sector is a relatively large component of its stock market index (25.1% and 19.0% respectively, see Figure 9). So, while the UK ranked second best in our corporate non-financial index, it ranked fifth (out of nine) based on its CDS implied PD.

Another example of this factor is Greece, which although it ranked last in terms of relative PDs, its CDS implied PD was about 2 ½ times greater than our non-financial median PD. No doubt, the market was concerned about the Greek financial sector and that sector comprised 73% of the listed companies' market value and 55.6% by number of firms. And, the financial sector was a prominent factor in the world's concern of sovereign health, in general, during the recent financial crisis.

Another potential shortcoming of our approach is that we are limited in our private sector corporate health assessments to data from only listed, publicly held firms. This is especially true for relatively small countries like Ireland (28), Portugal (30), Greece (79), Netherlands (61), and Spain (82), all with less than 100 listed non-financial companies (Figure 7). Since the private, non-listed segment is much larger in all of the countries, we are not clearly assessing the health of the vast majority of its firms and our sovereign health index measure is incomplete.¹³

While the size of the listed firm population is, no doubt, a factor in our calculations, there does not seem to be a systematic bias in our results. Yes, very small listings in Ireland, Portugal and Greece correlate well with the high PDs, but the country with the lowest PD (the Netherlands), also has a very small listed population. Perhaps an even more important factor is that the listed population in certain countries, like the U.K. and the Netherlands, is represented quite heavily by multinational firms who derive most of their income from outside their borders.

¹³ We suggest that complete firm financial statement repositories, such as those that usually are available in the sovereign's central bank be used to monitor the performance of the entire private sector.

FIGURE 9**Relative Importance of the Financial Sector in Various Country Stock Market Listed Firms (2010)**

<u>Country</u>	<u>Market Value of Financial Sector Relative to Total (%)</u>	<u>Percent (%) of Listed Firms from Financial Sector</u>
Netherlands (MSCI)	25.1%	19.1%
U.K. (All Shares)	28.0%	41.4%
U.S.A. (S&P 500)	14.1%	16.6%
France (MSCI)	19.1%	16.9%
Germany (MSCI)	18.3%	14.0%
Spain (MSCI)	51.1%	28.6%
Ireland ((MSCI)	5.0%	20.0%
Italy (MSCI)	31.6%	40.0%
Portugal (MSCI)	8.6%	22.2%
Greece (MSCI)	73.4%	55.6%

Source: MSCI, Bloomberg

6. Conclusion and Implications

The modern day prescription for bailouts of ailing sovereigns is a heavy dose of austerity measures to help bring the sovereign back to credibility and perceived solvency by foreign creditors. In the current case of Europe, Greece, Ireland, Spain, Portugal, Italy and the U.K., governments have already begun some of these painful measures while others, like France and Hungary, have either resisted or are having significant social unrest when austerity measures have been introduced. These measures typically require substantial cuts in cash benefits paid to public workers, increase in retirement age, and other reduced infrastructure costs, as well as increased taxes to companies and individuals. The objective is to lower the deficit relative to GDP and enhance the sovereign's ability to repay its foreign debt and balance its budget. In prescribing difficult sanctions to governments for them to qualify for bailouts and subsidies, we caution that such measures should not deteriorate or destroy private enterprise valuations. Indeed, these critical resources should be nurtured and promoted. A healthy private sector will provide critical tax revenues for the sovereign and jobs for its citizens. The goal is to allow private enterprises to pay their bills, expand (or at least maintain) their workforce, and return value to their shareholders and creditors. Raising taxes and inserting other new burdens could impede these goals and certainly will increase the default probabilities of firms. Certainly politicians, as well as World Bank, IMF and Central Bankers, understand these realities.

With respect to modeling sovereign risk, we propose that classical measures of macroeconomic performance be combined with more modern techniques, like contingent claims analysis and our bottom-up approach, to enhance explanatory and predictive results. Our results indicate that a bottom-up approach is an intuitively sound measure of a sovereign's financial state and one that is not subject to government's manipulation of publicly released performance

numbers. The credit and regulatory communities can track the performance of both publicly held companies, as well as unlisted entities, especially if the sovereign is willing and able to supply impartially audited statistical results on a regular basis.

References

- Abassi, B. and R. J. Taffler, 1982, "Country Risk: A Model of Economic Performance Related to Debt Servicing Capacity," WP #36, City University Business School, London.
- Altman, E. I., 1968, "Financial Ratios Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, v. 23, 4, September, 189.
- Altman, E. I. and E. Hotchkiss, 2006, *Corporate Financial Distress and Bankruptcy*, 3rd edition, John Wiley & Sons, NY and NJ.
- Altman, E. I., et. al., 2010, "The Z-Metrics™ Methodology for Estimating Company Credit Ratings and Default Risk Probabilities," *RiskMetrics Group*, NY, June, available from www.riskmetrics.com/Z-Metrics.
- Babbel, D. F., 1996, "Insuring Sovereign Debt against Default," *World Bank Discussion Papers*, #328.
- Baek, I. A. Bandopadhyaya and C. Du, 2005, "Determinants of Market-Assessed Sovereign Risk: Economic Fundamentals or Market Risk Appetite?" *Journal of International Money and Finance*, Vol. 24 (4), pp. 533-48.
- Beers, D., M. Cavanaugh and O. Takahira, 2002, "Sovereign Credit Ratings: A Primer," *Standard & Poor's Corp.*, NY, April.
- Bertozi, S., 1996, "An Annotated Bibliography on External Debt Capacity," in D. Babbel's "Insuring Sovereign Debt Against Default," *World Bank Discussion Papers* #328.
- Caouette, J., E. Altman, P. Narayanan and R. Nimmo, 2008, *Managing Credit Risk*, 2nd edition, John Wiley & Sons, NY.
- Chambers, W.J., 1997, "Understanding Sovereign Risk," *Credit Week*, Standard & Poor's January 1.
- Cline, W., 1983, "A Logit Model of Debt Restructuring, 1963-1982," *Institute for International Economics*, WP, June.
- Feder, G. and R. E. Just, 1977, "A Study of Debt Servicing Capacity Applying Logit Analysis," *Journal of Development Economics*," 4 (1).
- Feder, G. R. E. Just and K. Ross, 1981, "Projecting Debt Capacity of Developing Countries," *Journal of Financial & Qualitative Analysis*, 16 (5).
- Flynn, D., 2009, "S&P Cuts Greek Debt Rating as Global Crisis Bites," *Reuters*, January 14.

- Frank, C. R. and W. R. Cline, 1971, "Measurement of Debt Servicing Capacity: An Application of Discriminant Analysis," *Journal of International Economics*, 1.
- Frenkel, M., A. Karmann and B. Scholtens, eds., 2004, "Sovereign Risk and Financial Crises," Heidelberg and New York, *Springer*, xii, 258.
- Gennaioli, N., A. Martin and S. Rossi, 2010, "Sovereign Default, Domestic Banks and Financial Institutions," Working Paper, Imperial College, London, July.
- Gerlach, S., A. Schultz and G. Wolff, 2010, "Banking and Sovereign Risk in the Euro Area," *Deutsche Bundesbank*, Research Centre, Discussion Paper Series 1: Economic Studies: 2010.
- Gray, D. F., R. Merton and Z. Bodie, 2006, "A New Framework for Analyzing and Managing Macrofinancial Risk of an Economy," *IMF Working Paper*, October.
- Gray, D. F., R. Merton and Z. Bodie, 2007, "Contingent Claims Approach to Measuring and Managing Sovereign Credit Risk," *Journal of Investment Management*, vol. 5, No. 4, p.1.
- Grinols, E., 1976, "International Debt Rescheduling and Discrimination Using Financial Variables," *U.S. Treasury Dept.*, Washington, D.C.
- Haugh, D., P. Ollivaud and D. Turner, 2009, "What Drives Sovereign Risk Premiums?: An Analysis of Recent Evidence from the Euro Areas," *OECD*, Economics Department, Working Paper, 718.
- Hilscher, J. and Y. Nosbusch, 2010, "Determinants of Sovereign Risk: Macroeconomic Fundamentals and the Pricing of Sovereign Debt," *Review of Finance*, Vol. 14 (2), pp. 235-62.
- IMF, 2010, "Global Financial Stability Report," Washington, D.C.
- KMV Corporation, 1999, "Modeling Default Risk," *KMV Corporation*, R. Crosbie.
- Krugman, P., 1989, "Financing vs. Forgiving a Debt Overhang: Some Analytical Notes," *Journal of International Business Studies*, 17.
- Longstaff, F., J. Pan, L. Pedersen and K. Singleton, 2007, "How Sovereign is Sovereign Credit Risk?," *National Bureau of Economic Research, Inc.*, NBER Working Paper: 13658.
- Merton, R. C., 1974, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance*, 29, May, 449.
- Oshiro, N., Y. Saruwatari, 2005, "Quantification of Sovereign Risk: Using the Information in Equity Market Prices," *Emerging Markets Review*, Vol. 6 (4), pp. 346-62.

- Pomerleano, M., 1998, "Corporate Finance Lessons from the East Asian Crisis," *Viewpoint*, The World Bank Group, Note #155, October.
- Pomerleano, M., 1999, "The East-Asia Crisis and Corporate Finance – The Untold Micro Study," *Emerging Markets Quarterly*.
- Reinhart, M. and K. Rogoff, 2010, "*This Time is Different*," Princeton University Press, Princeton, NJ.
- Remolona, E. M. Scatigna and E. Wu, 2008, "A Ratings-Based Approach to Measuring Sovereign Risk," *International Journal of Finance and Economics*, Vol. 13 (1), pp. 26-39.
- Saini, K. and P. Bates, 1978, "Statistical Techniques for Determining Debt Servicing Capacity for Developing Countries: Analytical Review of the Literature and Further Empirical Results," *Federal Reserve Bank of New York Research Paper*, #7818.
- Sargen, H., 1977, "Economics Indicators and Country Risk Appraisal," Federal Reserve Bank of San Francisco, *Economic Review*, Fall.
- Schmidt, R., 1984, "Early Warning of Debt Rescheduling," *Journal of Banking and Finance*, 8.
- Segoviano, B., A. Miguel, C. Caceres and V. Guzzo, 2010, "Sovereign Spreads: Global Risk Aversion, Contagion or Fundamentals?," *IMF Working Paper*: 10/120, p. 29.
- Sgherri, S. and E. Zoli, 2009, "Euro Area Sovereign Risk During the Crisis," International Monetary Fund, IMF Working Papers: 09/222.
- Smith, R. and I. Walter, 2003, *Global Banking*, Oxford University Press, London.
- Trebesch, C., U. Das and M. Papaioannou, 2010, "Sovereign Default Risk and Private Sector Access to Capital in Emerging Markets," *IMP Working Paper*: October.