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Toward a Bottom-Up Approach to Assessing Sovereign Default Risk

by Edward I. Altman, New York University Stern School of Business, and Herbert A. Rijken, Vrije University Amsterdam¹

During the past three years, bank executives, government officials, and many others have been sharply criticized for failing to anticipate the global financial crisis. The speed and depth of the market declines shocked the public. And no one seemed more surprised than the credit rating agencies that assess the default risk of sovereign governments as well as corporate issuers operating within their borders.

Although the developed world had suffered numerous recessions in the past 150 years, this most recent international crisis raised grave doubts about the ability of major banks and even sovereign governments to honor their obligations. Several large financial institutions in the U.S. and Europe required massive state assistance to remain solvent, and venerable banks like Lehman Brothers even went bankrupt. The cost to the U.S. and other sovereign governments of rescuing financial institutions believed to pose “systemic” risk was so great as to result in a dramatic increase in their own borrowings.

The general public in the U.S. and Europe found these events particularly troubling because they had assumed that elected officials and regulators were well-informed about financial risks and capable of limiting serious threats to their investments, savings, and pensions. High-ranking officials, central bankers, financial regulators, ratings agencies, and senior bank executives all seemed to fail to sense the looming financial danger.

This failure seemed even more puzzling because it occurred years after the widespread adoption of advanced risk management tools. Banks and portfolio managers had long been using quantitative risk management tools such as Value at Risk (“VaR”). And they should also have benefited from the additional information about credit risk made publicly available by the new market for credit default swaps (“CDS”).

But, as financial market observers have pointed out, VaR calculations are no more reliable than the assumptions underlying them. Although such assumptions tend to be informed by statistical histories, critical variables such as price volatilities and correlations are far from constant and thus difficult to capture in a model. The market prices of options—or of CDS

contracts, which have options “embedded” within them—can provide useful market estimates of volatility and risk. And economists have found that CDS prices on certain kinds of debt securities increase substantially before financial crises become full-blown. But because there is so little time between the sharp increase in CDS prices and the subsequent crisis, policy makers and financial managers typically have little opportunity to change course.²

Most popular tools for assessing sovereign risk are effectively forms of “top-down” analysis. For example, in evaluating particular sovereigns, most academic and professional analysts use macroeconomic indicators such as GDP growth, national debt-to-GDP ratios, and trade and budget deficits as gauges of a country’s economic strength and well-being. But, as the recent Euro debt crisis has made clear, such “macro” approaches, while useful in some settings and circumstances, have clear limitations.

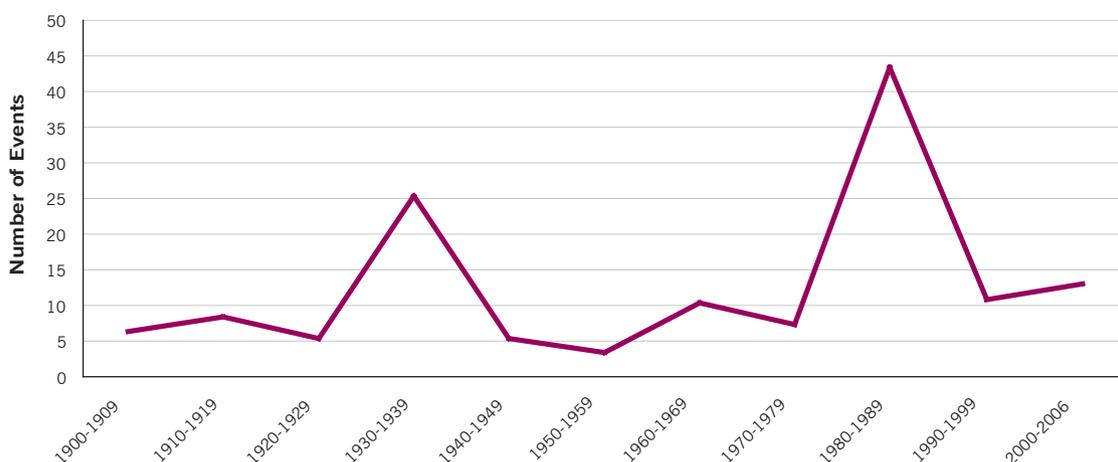
In this paper, we present a totally new method for assessing sovereign risk, a type of “bottom-up” approach that focuses on the financial condition and profitability of an economy’s private sector. The assumption underlying this approach is that the fundamental source of national wealth, and of the financial health of sovereigns, is the economic output and productivity of their companies. To the extent we are correct, such an approach could provide financial professionals and policy makers with a more effective means of anticipating financial trouble, thereby enabling them to understand the sources of problems before they become unmanageable.

In the pages that follow, we introduce Z-Metrics™ as a practical and effective tool for estimating sovereign risk. Developed in collaboration with RiskMetrics Group, now a subsidiary of MSCI Inc., Z-Metrics is a logical extension of the Altman Z-Score technique that was introduced in 1968 and has since achieved considerable scholarly and commercial success. Of course, no method is infallible, or represents the best fit for all circumstances. But by focusing on the financial health of private enterprises in different countries, the system described here promises at the very least to provide a valuable complement to, or reality check on, standard “macro” approaches.

1. The authors would like to thank Dan Balan of RiskMetrics Group, a subsidiary of MSCI Inc., for computational assistance, as well as Matthew Watt, MSCI Inc. Mr. Watt’s contributions to the article include major roles in the derivation of the Z-Metrics model and the analysis of CDS spreads.

2. See, for example, Hekran Neziri’s “Can Credit Default Swaps Predict Financial Crises?” in the Spring 2009 *Journal of Applied Economic Sciences*, Volume IV/Issue 1(7). Neziri found that CDS prices had real predictive power for equity markets, but that the lead time was generally on the order of one month.

Figure 1 **Sovereign Credit Events, 1900-2006**



Source: Reinhart and Rogoff (2010)

But before we delve into the details of Z-Metrics, we start by briefly reviewing the record of financial crises to provide some historical perspective. Next we attempt to summarize the main findings of the extensive academic and practitioner literature on sovereign risk, particularly those studies designed to test the predictability of sovereign defaults and crises.

With that as background, we then present the new Z-Metrics system for estimating the probability of default for individual (non-financial) companies and show how that system might have been used to anticipate many developments during the current EU debt crisis. In so doing, we make use of the most recent (2009 and 2010) publicly available corporate data for nine European countries, both to illustrate our model's promise for assessing sovereign risk and to identify the scope of reforms that troubled governments must consider not only to qualify for bailouts and subsidies from other countries and international bodies, but to stimulate growth in their economies.

More specifically, we examine the effectiveness of calculating the median company five-year probability of default of the sovereign's non-financial corporate sector, both as an absolute measure of corporate risk vulnerability and a relative health index comparison among a number of European sovereigns, and including the U.S. as well. Our analysis shows that this health index, measured at periods prior to the explicit recognition of the crisis by market professionals, not only gave a distinct early warning of impending sovereign default in some cases, but also provided a sensible hierarchy of relative sovereign risk. We also show that, during the current European crisis, our measures not only compared favorably to standard sovereign risk measures, notably credit

ratings, but performed well even when compared to the implied default rates built into market pricing indicators such as CDS spreads (while avoiding the well-known volatility of the latter).

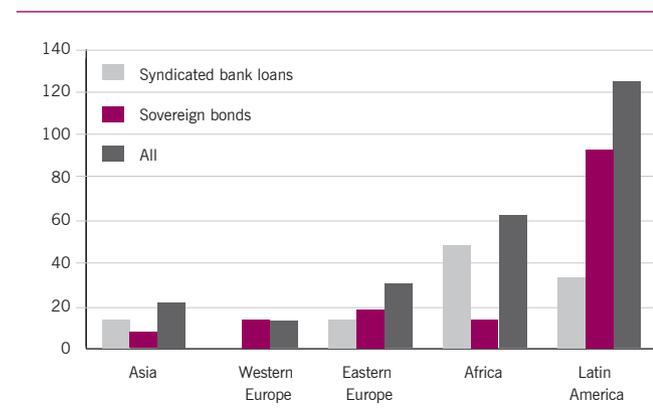
Our aim here is not to present a "beauty contest" of different methods for assessing sovereign risk in which one method emerges as the clear winner. What we are suggesting is that a novel, bottom-up approach that emphasizes the financial condition and profitability of a nation's private sector can be effectively combined with standard analytical techniques and market pricing to better understand and predict sovereign health. And our analysis has one clear implication for policy makers: that the reforms now being contemplated should be designed, as far as possible, to preserve the efficiency and value of a nation's private enterprises.

Modern History of Sovereign Crises

When thinking about the most recent financial crisis, it is important to keep in mind how common sovereign debt crises have been during the last century, and how frequently such debacles have afflicted developed economies as well as emerging market countries. Figure 1 shows a time series of sovereign credit risk events from 1900-2006 (from Reinhart and Rogoff (2010)). Overall, Latin America seems to have had more bond and loan defaults than any other region of the world (as can be seen in Figure 2).

The clear lesson from Figures 1 and 2 is that sovereign economic conditions appear to deteriorate relatively frequently. Often this then requires massive debt restructurings and/or bailouts accompanied by painful austerity programs. Recent examples include several Latin American countries in the 1980s, Southeast Asian nations in the late

Figure 2 Number of Sovereign “Defaults” 1824–2004



Source: I. Walter, NYU Stern School of Business and Smith and Walter (2003).

1990s, Russia in 1998, and Argentina in 2000. In most of those cases, major problems originating in individual countries not only imposed hardships on their own people and markets, but had major financial consequences well beyond their borders. We are seeing such effects now as financial problems in Greece and other European countries not only affect their neighbors, but threaten the very existence of the European Union.

Such financial crises have generally come as a surprise to most people, including even those specialists charged with rating the default risk of sovereigns and the enterprises operating in these suddenly threatened nations. For example, it was not long ago that Greek debt was investment grade, and Spain was rated Aaa as recently as June 2010.³ And this pattern has been seen many times before. To cite just one more case, South Korea was viewed in 1996 as an “Asian Tiger” with a decade-long record of remarkable growth and an AA- rating. Within a year however, the country was downgraded to BB-, a “junk” rating, and the country’s government avoided default only through a \$50 billion bailout by the IMF. And it was not just the rating agencies that were fooled; most of the economists at the brokerage houses also failed to see the problems looming in Korea.

What Do We Know About Predicting Sovereign Defaults?

There is a large and growing body of studies on the default probability of sovereigns, by practitioners as well as academics.⁴ Many studies, starting with Frank and Cline’s 1971 classic, have attempted to predict sovereign defaults or rescheduling using statistical classification and methods like discriminant analysis as well as similar econometric techniques.⁵ And in a more recent development, some credit analysts have begun using the “contingent claim” approach⁶ to measure, analyze, and manage sovereign risk based on Robert Merton’s classic “structural” approach (1974). But because of its heavy reliance on market indicators, this approach to predicting sovereign risk and credit spreads has the drawback of producing large—and potentially self-fulfilling—swings in assessed risk that are attributable solely to market volatility.

A number of recent studies have sought to identify global or regional common risk factors that largely determine the level of sovereign risk in the world, or in a region such as Europe. Some studies have shown that changes in both the risk factor of individual sovereigns and in a common time-varying global factor affect the market’s repricing of sovereign risk.⁷ Other studies, however, suggest that sovereign credit spreads are more related to global aggregate market indexes, including U.S. stock and high-yield bond market indexes, and global capital flows than to their own local economic measures.⁸ Such evidence has been used to justify an approach to quantifying sovereign risk that uses the local stock market index as a proxy for the equity value of the country.⁹ Finally, several very recent papers focus on the importance of macro variables such as debt service relative to tax receipts and the volatility of trade deficits in explaining sovereign risk premiums and spreads.¹⁰

Several studies have also attempted to evaluate the effectiveness of published credit ratings in predicting defaults and expected losses, with most concluding that sovereign ratings, especially in emerging markets, provide an improved understanding of country risks for investment analytics.¹¹ Nevertheless, the recent EU debt crisis would appear to contradict such findings by taking place at a time when all the rating

3. 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 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.

4. One excellent primer on sovereign risk is Babbel’s (1996) study, which includes an excellent annotated bibliography by S. Bertozzi on external debt capacity that 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. Other works worth citing include two practitioner reports—Chambers (1997) and Beers, et al, (2002)—and two academic studies—Smith and Walter (2003), and Frenkel, Karmann and Scholtens (2004). Full citations of all studies can be found in References section at the end of the article.

5. Including Grinols (1976), Sargen (1977), Feder and Just (1977), Feder, Just and Ross (1981), Cline (1983), Schmidt (1984), and Morgan (1986).

6. Gray, Merton and Bodie (2006, 2007).

7. See Baek, Bandopadhyaya and Chan (2005). Gerlach, Schulz and Wolff (2010) observe that aggregate risk factors drive banking and sovereign market risk spreads in the Euro area; and in a related finding, Sgherri and Zoli (2009) suggest that Euro area sovereign risk premium differentials tend to move together over time and are driven mainly by a common time-varying factor.

8. See Longstaff, Pan, Pedersen and Singleton (2007).

9. See Oshino and Saruwatari (2005).

10. These include Haugh, Ollivaud and Turner’s (2009) discussion 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.

11. For example, Remolona, Scatigna and Wu (2008) reach this conclusion after using sovereign credit ratings and historical default rates provided by rating agencies to construct a measure of ratings implied expected loss.

agencies and, it would seem, all available models for estimating sovereign risk indicated that Greece and Spain—and others now recognized as high-risk countries—were still classified as investment grade.¹² What's more, although most all of the studies cited above have been fairly optimistic about the ability of their concepts to provide early warnings of major financial problems, their findings have either been ignored or have proven ineffective in forecasting most economic and financial crises.

In addition to these studies, a handful of researchers have taken a somewhat different “bottom-up” approach by emphasizing the health of the private sectors supporting the sovereigns. For example, a 1998 World Bank study of the 1997 East Asian crisis¹³ used the average Z-Score of listed (non-financial) companies to assess the “financial fragility” of eight Asian countries and, for comparison purposes, three developed countries and Latin America. Surprising many observers, the average Z-Score for South Korea at the end of 1996 suggested that it was the most financially vulnerable Asian country, followed by Thailand, Japan, and Indonesia. As noted earlier, Korea's sovereign bond rating in 1996 was AA- (S&P). But within a year, Korea's rating dropped to BB-; and if not for the IMF bailout of \$50 billion, the sovereign would almost certainly have defaulted on its external, non-local currency debt. A traditional macroeconomic measure like GDP growth would not have predicted such trouble since, at the end of 1996, South Korea had been growing at double-digit rates for nearly a decade.¹⁴

The Z-Metrics™ Approach¹⁵

In 2009, we partnered with RiskMetrics Group with the aim, at least initially, of creating a new and better way of assessing the credit risk of *companies*. The result was the new Z-Metrics approach. This methodology might be called a new generation of the original Z-Score model of 1968. The objective was to develop up-to-date credit scoring and probability of default metrics for both large and small, public and private, enterprises on a global basis.

12. 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.

13. See Pomerleano (1998), which is based on a longer article by the author (1997). Taking a somewhat similar approach, many policy makers and theorists have recently focused on the so-called “shadow banking system.” For example, Gennaioli, Martin and Rossi (2010) argued that the financial strength of governments depends on private financial markets and its ability to attract foreign capital. They concluded that strong financial institutions not only attract more capital but their presence also helps encourage their governments to repay their debt.

Chambers of S&P (1997) also mentions the idea of a “bottom-up” approach but not to the assessment of sovereign risk, rather 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.

In building the Z-Metrics models, we used multivariate logistic regressions and data from a large sample of both public and private U.S. and Canadian non-financial sector companies during the 20-year period 1989-2008.¹⁶ We analyzed over 50 fundamental financial statement variables, including measures (with trends as well as point estimates) of solvency, leverage, size, profitability, interest coverage, liquidity, asset quality, investment, dividend payout, and new financings. In addition to such operating (or “fundamental”) variables, we also included equity market price and return variables and their patterns of volatility. Such market variables have typically been used in the “structural distance-to-default measures” that are at the core of the KMV model¹⁷ now owned by Moody's.

In addition to these firm-specific, or micro, variables, we also tested a number of macro-economic variables that are often used to estimate sovereign default probabilities, including GDP growth, unemployment, credit spreads, and inflation. Since most companies have a higher probability of default during periods of economic stress—for example, at the end of 2008—we wanted to use such macro variables to capture the heightened or lower probabilities associated with general economic conditions.¹⁸

The final model, which consists of 13 fundamental, market value, and macroeconomic variables, is used to produce a credit score for each public company. (And as discussed later, although the primary emphasis was on applying Z-Metrics to publicly traded companies, we also created a model for privately-held firms by using data from public companies and replacing market value with book value of equity.)

The next step was to use a logit regression specification of the model (described in the Appendix) to convert the credit scores into probabilities of default (PDs) over both one-year and five-year horizons. The one-year model is based on data from financial statements and market data approximately one year prior to the credit event, and the five-year model includes up to five annual financial statements prior to the event.

14. Afterwards, the World Bank and other economists such as Paul Krugman concluded that crony capitalism and the associated implicit public guarantees for politically influential enterprises coupled with poor banking regulation were responsible for the crisis. 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.

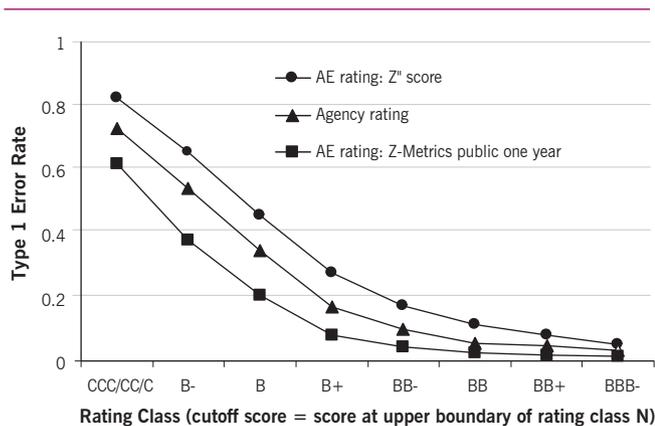
15. For more details, see Altman, et al, 2010 “The Z-Metrics™ Methodology for Estimating Company Credit Ratings and Default Risk Probabilities,” *RiskMetrics Group*, continuously updated, available from <http://www.msci.com>.

16. Our first model's original sample consisted of over 1,000 U.S. or Canadian non-financial firms that suffered a credit event 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.

17. Developed by Crosbie in 1998 and adapted for sovereigns by Gray in 2007.

18. 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.

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**



To test the predictive power of the model and the resulting PDs, companies in the sample were put into cohorts according to whether they experience credit events that include either formal default or bankruptcy (whichever comes first). All companies that experienced a credit event within either one year or five years were assigned to the “distressed” or “credit event” group (with all others assigned to the non-distressed group).

Results show considerable success in predicting defaults across the entire credit spectrum from the lowest to the highest default risk categories. Where possible, Z-Metrics results were compared to results of publicly available credit ratings and existing models. The accuracy ratio, as applied here, measures how well a model predicts which companies do or do not suffer a credit event on the basis of data available before such events. The objective can be framed in two ways: (1) maximizing correct predictions of defaulting and non-defaulting companies (which statisticians refer to as “Type I” accuracy) and (2) minimizing wrong predictions (“Type II” accuracy).

As can be seen in Figure 3, Z-Metrics performance, which was tested against actual credit events during the period 1989-2009, shows much higher much higher Type I accuracy levels for the Z-Metrics model than for either the bond rating agencies or established models (including an older version of Z-Scores). At the same time, Z-Metrics test results show equivalent Type II accuracies at all cutoff levels of scores.¹⁹

Perhaps the most reliable test of credit scoring models is how well they predict critical events based on samples of

companies that were not used to build the model, particularly if the events took place after the period during which the model was built (after 2008, in this case). With that in mind, the model was tested against actual bankruptcies in 2009, which were treated as a hold-out sample. As with the full test sample results shown in Figure 3, Z-Metrics results for the hold-out sample credit events of 2009 outperformed the agency ratings and the 1968 Z-score and 1995 Z"-score models using both one-year and five-year horizons.

A “Bottom-Up” Approach for Sovereign Risk Assessment

Having established the predictive power the Z-Metrics methodology, the next step was to use that model (which, again, was created using large publicly traded U.S. companies) to evaluate the default risk of European companies. And after assuring ourselves that the model was transferable in that sense, we then attempted to assess the overall creditworthiness of sovereign governments by aggregating Z-Metrics default probabilities for individual companies and then estimating both a median default probability and credit rating for different countries.

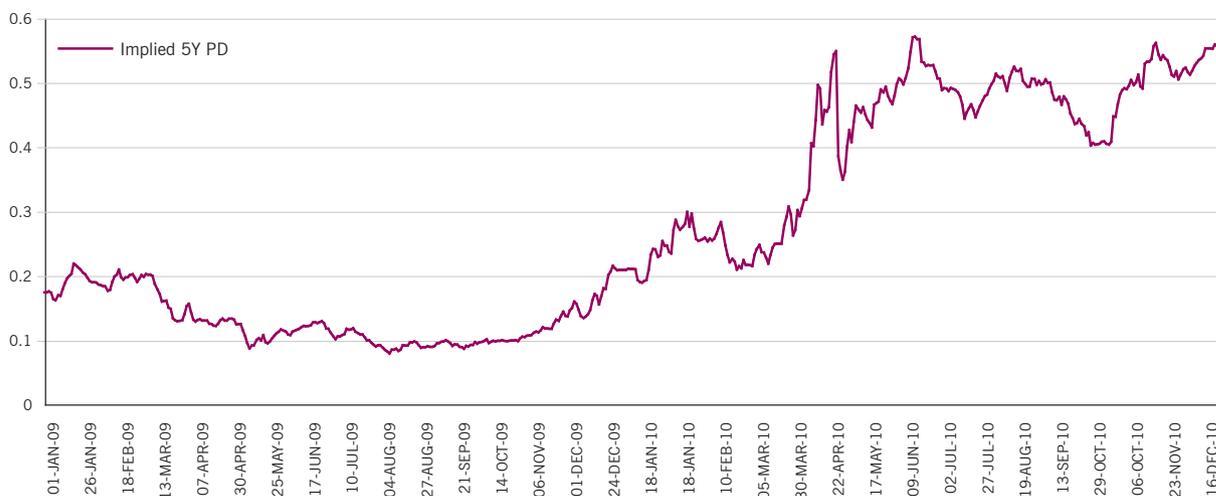
In conducting this experiment, we examined nine key European countries over two time periods before the height of the recent European sovereign debt crisis. The periods were the first six months of 2009 and the first four months of 2010. People clearly recognized the crisis and concern over the viability of the European Union in June 2010, when Greece’s debt was downgraded to non-investment grade and both Spain and Portugal were also downgraded. Credit markets, particularly CDS markets, had already recognized the Greek and Irish problems before June 2010. Market prices during the first half of 2010 reflected high implied probabilities of default for Greece and Ireland, but were considerably less pessimistic in 2009 (see Figure 4). By contrast, as can be seen in Figure 5, which shows Z-Metrics median PD estimates alongside sovereign CDS spreads over both periods,²⁰ our PD estimates were uniformly higher (more risky) in 2009 than early in 2010, even if the world was more focused on Europe’s problems in the latter year. In this sense, the Z metrics PD might be viewed as providing a leading indicator of possible distress.

For the first four months of 2010, the Z-Metrics’ five-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 came Germany and France (both about 5.5% - ZC+), with the U.K. (3.62%)

19. 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.

20. 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.

Figure 4 Greece Five Year Implied Probabilities of Default (PD) from CDS Spreads



Source: Markit. Assuming a 40% recovery rate, PD computed as $1 - e^{(5^* \times (1-R))}$.

and the Netherlands (3.33%) at the lowest risk levels (ZB– and ZB). The U.S. looked comparatively strong, at 3.93% (ZB–).

For the most part, these results are consistent with how traditional analysts now rank sovereign risks. Nevertheless, there were a few surprises. The U.K. had a fairly healthy private sector, and Germany and France were perhaps not as healthy as one might have thought. The UK's relatively strong showing might have resulted from the fact that the Z-Metrics data at this time did not include financial sector firms, which comprised about 35% of the market values of listed U.K. corporates and were in poor financial condition. And several very large, healthy multinational entities in the U.K. index could also have skewed results a bit. The CDS/5-year market's assessment of U.K. risk was harsher than that of the Z-Metrics index in 2010, with the median of the daily CDS spreads during the first four months implying a 6.52% probability of default, about double our Z-Metrics median level.²¹ Greece also had a much higher CDS implied PD at 24.10%, as compared to 10.60% for Z-Metrics. (And, of course, our choice of the *median* Z-Metrics PD is arbitrary, implying as it does that fully 50% of the listed companies have PDs higher than 10.60%.)

We also observed that several countries had relatively high standard deviations of Z-Metrics PDs, indicating a longer tail of very risky companies. These countries included Ireland, Greece and, surprisingly, Germany, based on 2010 data. So, while almost everyone considers Germany to be the benchmark-low risk country in Europe (for example, its 5-year CDS spread was just 2.67% in 2010, even lower than

the Netherlands (2.83%), we are more cautious based on our broad measure of private sector corporate health.

Figure 6 shows, for each of our nine European countries and the U.S., the percentage increases in median stock market index levels and sovereign PD levels between the first six months of 2009 and the first six months of 2010. As can be seen in the figure, most countries enjoyed increases of greater than 20%. Only Greece had a relatively low increase (5.5%), consistent with its modest improvement in its Z-Metrics PD (-8.4%). Figure 6 shows the percentage improvement (lower risk) in sovereigns' PDs in 2010, which are largely consistent with the increases in stock market index values. Note that Ireland stands out in that while its stock market index value increased by 26.2%, its corporate sector experienced only a modest improvement (-7.4%) in its Z-Metrics' median PD. This may be attributable to the earlier austerity measures taken in Ireland, as compared to those in other distressed European nations. But likely more important were changes in the many other variables in the Z-Metrics model that are not affected by stock prices, particularly the fundamental measures of corporate health.

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

As shown in Figures 5 and 6, then, the improvement (reduction) in Z-Metrics PDs in 2010—a period in which most EU sovereigns appeared to be getting riskier—looks attributable in large part to the stock market increases in almost all countries. But to the extent such increases could conceal

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

Country	No. of Rated Companies		Z-Metrics PD Estimates: Five-Year Public Model*				Five-Year Implied PD from CDS Spread**†	
			2010		2009		2010	2009
			(1/1 - 4/30)	(1/1 - 6/30)	(1/1 - 4/30)	(1/1 - 6/30)	(1/1 - 4/30)	(1/1 - 6/30)
	2010	2009	Median PD	Median PD	Std. Dev.	Std. Dev.		
Netherlands	61	60	3.33%	5.62%	7.52%	9.33%	2.83%	6.06%
UK	442	433	3.62%	5.75%	11.60%	12.70%	6.52%	8.13%
U.S.	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 the 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.

Figure 6 **Median Percentage 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%
US	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.

a deterioration of a sovereign's credit condition, some credit analysts might prefer to have PD estimates that do not make use of stock market data.

With this in mind, we applied the Z-Metrics model for privately held firms to evaluate the same nine European countries and the U.S. The private and public firm models are the same except for the substitution of equity book values (and volatility of book values) for market values. This adjustment is expected

to remove the capital market influence from our credit risk measure.

Figure 7 summarizes the comparative PD (delta) results for 2010 and 2009 results of the Z-Metrics models for publicly and privately held firms. For eight of the ten countries, use of the model for privately held firms showed smaller reductions in PDs when moving from 2009 to 2010 than did use of the public model. Whereas the overall average improvement in

Figure 7 **Private vs. Public Firm Model PDs in 2010 and 2009**

Country	No. Rated Companies		Public-Firm Z-Metrics Model			Private-Firm Z-Metrics Model		
	2010	2009	PDs 2010	PDs 2009	Delta ¹	PDs 2010	PDs 2009	Delta ¹
Netherlands	61	60	3.33%	5.62%	-2.29%	5.25%	6.00%	-0.75%
UK	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	10.60%	11.57%	-0.97%	11.03%	13.93%	-2.90%
Average			6.28%	8.19%	-1.91%	7.19%	7.98%	-0.79%

1. Negative sign means improved credit risk.
Sources: Figure 5 and Riskmetrics (MSCI).

PDs for the public firm model was a drop of 1.91 percentage points, the drop was 0.79% for the model for privately held firms. These results are largely the effect of the positive stock market performance in late 2009 and into 2010. But improvements in general macro conditions, along with their effects on traditional corporate performance measures, also helped improve (reduce) the PDs. Moreover, in two of these eight countries—the U.K. and France—not only did the public firm model show an improved (lower) PD, but the model for privately held firms' PD actually got worse (increased) in 2010 (as indicated by the positive delta in the last column of Figure 7).

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

As a final test of the predictive qualities of our approach, we compared the Z-Metrics five-year median PDs for our sample of nine European countries (both on a contemporary basis and for 2009) with the PDs implied by CDS spreads in 2010. The contemporary PD correlation during the first third of 2010 was remarkably high, with an R^2 of 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. But if we go back to the first half of 2009, the correlation drops

to an R^2 of 0.36 (although it would be considerably higher, at 0.62, if we excluded the case of Ireland). Ireland's CDS implied PD was considerably higher in 2009 than 2010 (17.0% vs. 12.0%), while the Z-Metrics PD was relatively stable in the two years (7.5% and 6.5% respectively).²² In 2010, whether we calculate the correlation with or without Ireland, the results are essentially the same (0.82 and 0.83).

Given the predictive success of Z-metrics in the tests already described, we were curious to find out whether it could be used to predict capital market (i.e., CDS) prices. So, we regressed the public firm model's 2009 Z-Metrics median, non-financial sector PDs against implied CDS PDs one year later in 2010. As can be seen in Figure 8, the correlation between Z-Metrics PDs and those implied by CDS one year later proved to be remarkably strong, with an r of 0.69 and R^2 of 0.48. In sum, the corporate health index for our European countries (plus the U.S.) in 2009 explained roughly half of the variation in the CDS results one year later.²³

Admittedly, this sample was quite small (10 countries) and the analysis is for only a single time-series comparison (2009 vs. 2010). Nevertheless, these two years spanned a crucial and highly visible sovereign debt crisis, whereas the PDs implied by prior years' Z-Metrics and CDS showed remarkably little volatility.²⁴

22. 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 potential 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.

23. Several other non-linear structures (i.e., power and exponential functions) for our 2009 Z-Metrics vs. 2010 CDS implied PDs showed similar results. In all cases, we are assuming a recovery rate of 40% on defaults in calculation of implied sovereign PDs.

24. 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.

Figure 8 2009 Z-Metrics PD vs. 2010 CDS Implied PD

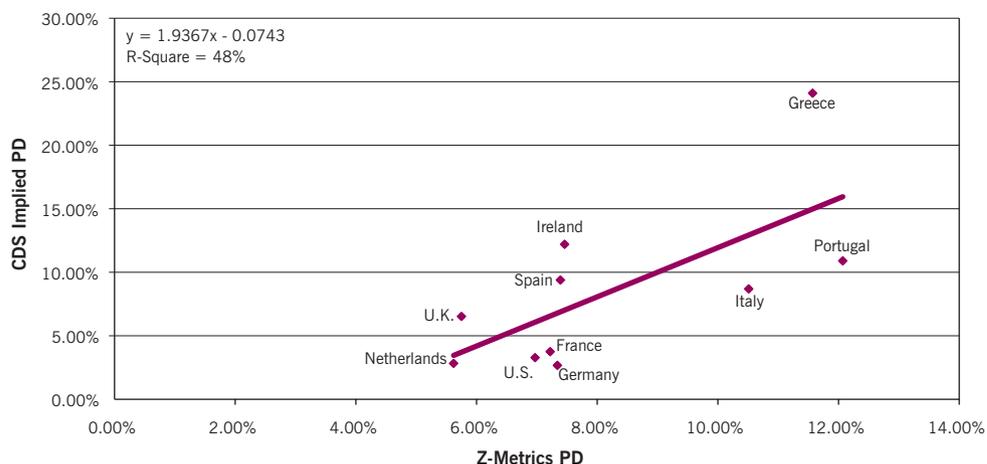


Figure 9 Relative Importance of the Financial Sector in Various Country Stock Market Listed Firms (2010)

Country	Market Value of Financial Sector Relative to Total (%)	Percent (%) of listed firms from Financial Sector
Netherlands (MSCI)	25.1%	19.1%
U.K. (All Shares)	28.0%	41.4%
U.S. (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%

Sources: MSCI, Bloomberg.

Two Caveats: Financial Sector and Size of the Listed Stock Market Indexes

Our corporate health measure has two clear limitations that we plan to address in future work. First, as stated earlier, we did not include the financial sector in our corporate health index. Second, the sample sizes of listed companies in several of our European nations were relatively small. As shown in Figure 9, the financial sector in the U.K. comprised 28% of listed companies (in the FTSE All Share Index) by market value and 41.4% by number of firms (second highest). We were surprised that the U.K. scored as high as it did in its absolute and relative Z-Metrics private sector health index, given its CDS implied PD ranking. Indeed, as reported earlier in Figure 4, the CDS PD for the U.K. was 6.52% in 2010, as compared to just 3.62% based on the median Z-Metrics

PD. The latter ranked second best only to the Netherlands, another country whose financial sector is a relatively large component of its stock market index (25.1% by value and 19.0% by number of companies). So, while the U.K. 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, where the finance sector comprised 73% of the listed companies' market value. Although the Z-Metrics PD showed Greece as the riskiest country in our sample, the country's CDS implied PD was about 2½ times greater than our non-financial median PD. No doubt, the market was concerned about the Greek financial sector. And, of course, the weakness of the financial sector was a prominent factor in the world's concern about sovereign health during the recent financial crisis.

The second potential shortcoming of our approach is that we are limited in our private sector corporate health assessments to data from listed, publicly held firms. This is especially true for relatively small countries like Ireland (with just 28 rated companies), Portugal (with 30), Greece (79), Netherlands (61), and Spain (82). 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.²⁵

But if the size of the listed firm population is clearly a limitation in our calculations, there does not seem to be a systematic bias in our results. To be sure, the very small listings in Ireland, Portugal, and Greece appear heavily correlated with their high PDs, but the country with the lowest PD (the Netherlands) also has a very small listed population. Another potentially important factor is that the listed population in countries like the U.K. and the Netherlands is represented quite heavily by multinational corporations that derive most of their income from outside their borders.²⁶

Conclusion and Implications

As the price for bailing out distressed sovereigns, today's foreign creditors, especially the stronger European nations, are demanding a heavy dose of austerity. Several governments, including those of Greece, Ireland, Spain, Portugal, Italy, and the UK, have already enacted some painful measures. Others, such as France and Hungary, have either resisted austerity measures or faced significant social unrest when such measures have been proposed. These measures typically involve substantial cuts in cash benefits paid to public workers, increases in retirement age, and other reduced infrastructure costs, as well as increased taxes for companies and individuals. The objective is to reduce deficits relative to GDP and enhance the sovereigns' ability to repay their foreign debt and balance their budgets.

While recognizing the necessity of requiring difficult changes for governments to qualify for bailouts and subsidies,

we caution that such measures should be designed to inflict as little damage as possible on the health and productivity of the private enterprises that ultimately fund the sovereign. The goal should be to enable all private enterprises with clear going concern value to pay their bills, expand (or at least maintain) their workforces, and return value to their shareholders and creditors (while those businesses that show no promise of ever making a profit should be either reorganized or liquidated). For this reason, raising taxes and imposing other burdens on corporate entities is likely to weaken the long-run financial condition of sovereigns.²⁷

To better estimate sovereigns' risk of default, we propose that traditional measures of macroeconomic performance be combined with more modern techniques, such as the contingent claims analysis pioneered by Robert Merton and the bottom-up approach presented in these pages. Along with the intuitive appeal of such an approach and our encouraging empirical results, the probabilities of sovereign default provided by aggregating Z-Metrics PDs across a national economy can be seen, at the very least, as a useful complement to existing methods and market indicators—one that is not subject to government manipulation of publicly released statistics. Using our approach, the credit and regulatory communities could track the performance of publicly held companies and the economies in which they reside—and by making some adjustments, unlisted entities as well. And if sovereigns were also willing to provide independently audited statistics on a regular basis, so much the better.

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25. 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.

26. Results showing the percentage of "home-grown" revenues for listed firms across our European country sample were inclusive, however, as to their influence on relative PDs.

27. As Acharya, Dreschsler and Schnabl (2010) comment, bailouts which require increased taxation of the non-financial sector weakens their incentive to invest and can adversely affect the sovereign's own credit risk and severely limits the size of the efficient bailout.

Appendix: Logit Model Estimation of Default Probabilities

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

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

$CS_{i,t}$ = 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

$$PD_{i,t} = \frac{1}{1 + \exp(-CS_{i,t})}$$

We compare Z-Metrics results with 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 Z²⁸-score (1995) model.

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28. Altman's original Z-score model (1968) is well-known to practitioners and scholars alike. It was built, however, over 40 years ago and is primarily applicable to publicly-held manufacturing firms. A more generally applicable Z²-score variation was popularized later (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 com-

pared 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. Of course, entities that do not have access to the newer Z-Metrics system can still use the classic Z-score frameworks, although accuracy levels will not be as high and firm PDs not as readily available.

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