Transparent and Unique Sovereign Default Risk Assessment

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Abstract

We propose a 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 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 liquid credit-default-swap market. Specifically, we measure the default probabilities of listed corporate entities in ten European countries, and the U.S.A., covering the recent global financial crisis period and the subsequent European sovereign crisis, the latter of which is still with us today, in 2013. We conclude that our transparent corporate health index measured at periods prior to the explicit recognition by most credit professionals, not only gave an effective early warning indicator but provided an appropriate hierarchy of relative sovereign risk. We argue that a more complete assessment of the health of a sovereign by utilizing publicly available firm financial data, as well as the standard macroeconomic data approach, provides greater transparency as to a nation's fundamentally based default likelihood. 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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During the past five 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 as well as an overhaul of the regulatory and legal framework in many of the world's most important economies.

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, in many countries, the new Basel II guidelines were either already in place totally or in a transition state. 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.[1]

Most popular tools for assessing sovereign risk are effectively forms of "top-down"

analysis. For example, in evaluating specific 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 and lacked the transparency and early warning

attributes to be truly useful in limiting the impact of sovereign crises.

In this paper, we expand upon our new method for assessing sovereign risk, a type of

"bottom-up" approach that focuses on the financial condition, profitability, and solvency of an

economy's private sector. The assumption underlying this approach is that the fundamental

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[1] 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.

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, with enhanced transparency 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 the Risk Metrics 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, our system promises at the very least to provide a valuable complement to, or reality check on, standard "macro" approaches.

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 our 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 (2008 - 2012) publicly available corporate data for ten 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

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subsidies from other countries and international bodies, but to stimulate growth in their economies.

More specifically, we examine the effectiveness of calculating the median and 75th percentile 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 most 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). Indeed, our 75th percentile measure, clearly showed that countries like Greece, Portugal, Spain and Italy were in much worse shape in 2008 and 2009 than the implied probabilities of default from the closely watched CDS market indicated, and that only in 2010 did the CDS market raise more concern than our firm fundamental approach. Interestingly, both measures seem to be converging in late 2012.

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, including banks as well as non-financial firms, can be effectively combined with standard analytical techniques and market pricing to better understand and predict sovereign health. Our analysis has one clear implication for policy makers: that the reforms

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now being contemplated should be designed, as far as possible, to preserve the efficiency and value of a nation's private enterprises, especially as austerity measures become less and less popular with important electorates, like Italy in 2013.

What's more, our firm default measure will be applied to listed companies in each of our European and USA samples and, as such, the results are clearly transparent using models that are now certainly available to most Central Banks and professional analysts, although these models may not be exactly the one we use – "Z-Metrics."

Modern History 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 150 years—and how frequently such debacles have afflicted developed economies as well as emerging market countries. Figure 1 shows a partial list of financial crises (identified by the first year of the crisis) that have occurred in "advanced" countries. Overall, Latin America seems to have had more recent bond and loan defaults than any other region of the world (as can be seen in Figure 2). But if we had included a number of now developed Asian countries among the "advanced" countries, the period 1997-1999 period would be much more prominent.

The clear lesson from Figures 1 and 2 is that sovereign economic conditions appear to spiral out of control with almost predictable regularity and then require 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 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 southern 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.[2] 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 county'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.

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[2] 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.

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
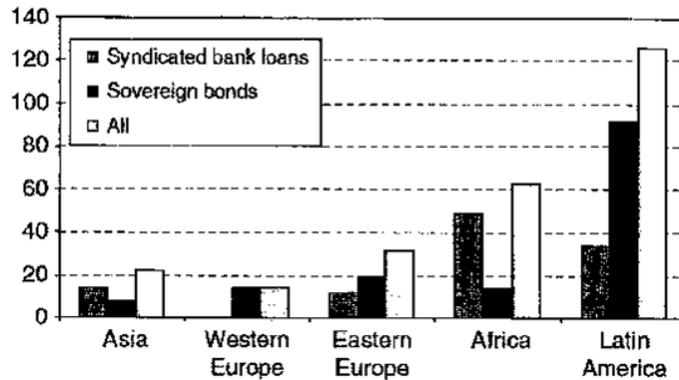
Source: Compilation by Ingo Walter, NYU Stern School of Business

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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.[3] A large number of studies, starting with Frank and Cline's 1971 classic, have attempted to predict sovereign defaults or rescheduling using statistical classification and predicting methods like discriminant analysis as well as similar econometric techniques.[4] And in a more recent development, some credit analysts have begun using the "contingent claim" approach[5] 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.[6] 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

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[3] 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 work 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.

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

[5] Gray, Merton and Bodie (2006, 2007)

[6] 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.

capital flows than to their own local economic measures.[7] 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.[8] 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.[9]

A number of 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.[10] Nevertheless, the recent EU debt crisis would appear to contradict such findings by taking place at a time when all the rating 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.[11] 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 or researchers have taken a somewhat different "bottom-up" approach by emphasizing the health of the private sectors supporting the

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[7] See Longstaff, Pan, Pedersen and Singleton (2007).
[8] See Oshino and Saruwatari (2005).
[9] 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.

[10] 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.
[11] 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.

sovereigns. For example, a 1998 World Bank study of the 1997 East Asian crisis[12] 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.[13]

The Z-Metrics™ Approach[14]

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 our new Z-Metrics approach. This methodology might be called a new generation of the original Z-Score

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[12] 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, 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.

[13] Afterwards, the World Bank and other economists such as Paul Krugman concluded that 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.

[14] For more details, see Altman, et al, 2010 "The Z-Metrics™ Methodology for Estimating Company Credit Ratings and Default Risk Probabilities," *RiskMetrics Group*, (now MSCI), available from http://msci.com/Z-Metrics.

model of 1968. Our 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.

In building our 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.[15] 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

financing results. 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 model[16] 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.[17]

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[15] 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.

[16] Developed by Crosbie in 1998 and adapted for sovereigns by Gray in 2007.

[17] 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, 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 our primary emphasis was on applying Z-Metrics to publicly traded companies, we also created a private firm model by using data from public companies and replacing market value with book value of equity.)

The next step was to use a logit specification of the model (described in the Appendix) that we used 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.

To test the predictive power of the model and the resulting PDs, we segregated all the companies in our sample 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).

Our test results show considerable success in predicting defaults across the entire credit spectrum from the lowest to the highest default risk categories. Where possible, we compared our output with that of publicly available credit ratings and existing models. The so-called "accuracy ratio" measures how well our model predicts which companies do or do not go bankrupt on the basis of data available before bankruptcy. 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).
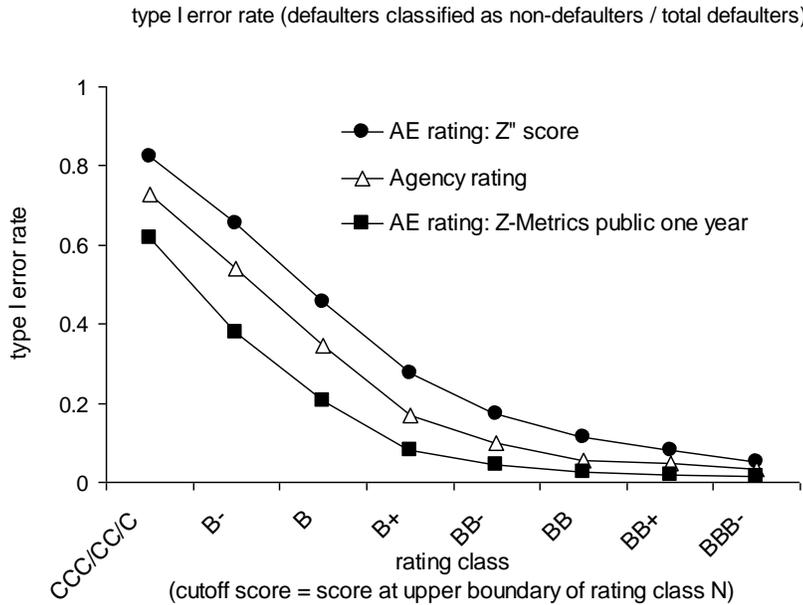
As can be seen in Figure 3, our results, which include tests on actual defaults during the period 1989-2009, show much higher Type I accuracy levels for the Z-Metrics model than for either the bond rating agencies or established models (including an older version of Z-Scores). At the same time, our tests show equivalent Type II accuracies at all cutoff levels of scores.[18]

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, we tested the model against actual bankruptcies occurring in 2009, or what we refer to as our "out-of-sample" data. As with the full test sample results shown in Figure 3, our Z-Metrics results for the "out of sample" bankruptcies of 2009 outperformed the agency ratings and the 1968 Z-score and 1995 Z"-score models using both one-year and five-year horizons.

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[18] 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.

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

type I error rate (defaulters classified as non-defaulters / total defaulters)

rating class
(cutoff score = score at upper boundary of rating class N)

A "Bottom-Up" Approach for Sovereign Risk Assessment

Having established the predictive power of our updated Z-score methodology, our 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 our 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 ten key European countries over the time periods, end of 2008-2011 and as of Q3 in 2012 in Figure 4 for the 50th percentile (median) and

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75th percentile (Figure 5). People clearly recognized the crisis and concern for 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 2008 and 2009. By contrast, as can be seen in Figures 4 and 5, which shows our Z-Metric median PD estimates alongside sovereign CDS spreads over both periods,[19] our PD estimates were uniformly higher (more risky) in 2008 and 2009 than early in 2010, even if the world was more focused on Europe's problems in the latter year. In this sense, our Z metrics PD might be viewed a**s** providing a leading indicator of possible distress. It should be noted that the statistics in Figures 4 and 5 report only on the non-financial private sector, while those in Figure 7 include results from our banking credit risk model, as well, but only for 2010. We will return to our Combined non-financial and financial sector results at a later point.

Our non-financial private sector PDs for the median company (Figure 4) and the 75th percentile company (Figure 5) showed that countries like Greece, Portugal, and, to some extent, Spain and Italy, had private sector risk profiles considerably worse than the other European countries, and the U.S.A., as early as 2008, and certainly at the end of 2009. Indeed, most countries had extremely risky profiles during the great financial crisis at the end of 2008, but many improved after we emerged from this crisis in 2009 - - but not Greece and Portugal. At the same time, we will show (Figure 6) that the primary capital market indicator of sovereign default probabilities, the CDS market, was not concerned at all with countries like Greece, Portugal,

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[19] 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.

Spain and Italy in 2008 and 2009, and only showed higher PDs in 2010, long after our approach gave unmistakable signals of the chasm between the so-called PIIGS countries and the rest of Europe.

The median non-financial, industrial sector PDs at the end of 2009 had Greece as the worst (11.9%), followed by Portugal (8.2%), Italy (7.7%) and Spain (5.9%). Then came Germany and France (both about 4.5%), with Ireland (3.0%) the Netherlands (2.7%) and Sweden (3.1%) showing the least risky profiles in 2009. The U.S.A. also had a relatively low risk private sector profile, with a median PD of 3.3%.

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 U.K.'s relatively strong showing might have resulted from the fact that our risk measure 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 might have skewed results a bit. The CDS/5-year market's assessment of U.K. risk was harsher than that of our Z-Metrics index in 2010, with the median of the daily CDS spreads during the first four months implying a 6.5% probability of default, about double our Z-Metrics median level. Greece also had a much higher CDS implied PD at 24.1%, as compared to 11.9% 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 11.9%.)

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,

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Greece and, surprisingly, Germany, based on 2009 and 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 5 shows the same pattern of our non-financial private sector results, only we utilize the 75th percentile measure instead of the median. To be clear, the 75th percentile PDs indicate that 25% of the firms had a 5-year PD of at least the indicated percentile and represent the highest risk quartile for each country. We feel that this percentile still includes a substantial proportion of the corporate sector and is perhaps a clearer indicator of a country's private sector vulnerability to financial distress. We will show the time series from 2008-2012 of this indicator compared to CDS spread implied PDs, shortly.

Note that Greece's 75th percentile firm went from a PD of 27.6% in 2009 to almost 50% in 2012, Portugal also deteriorated from 12.3% in 2009 to 32.3% in 2012 and Italy and Spain's 75th percentile plummeted to about 25% in 2012 (Q3). While all countries in Europe show considerably higher 75th percentile PDs than their median levels, no other country approaches the "big-four" of the most risky nations, especially as of our latest reading in 2012 (6/30). As we will now observe, the continued deterioration of countries like Italy and Spain in 2012 are in contrast to improved market indicators, e.g., CDS spreads, for all of PIIGS countries in the second half of 2012.

FIGURE 4

Financial Health of the Corporate, Non-Financial Sector: Selected European Countries and
U.S.A. in 2008 – 2012 (6/30)

Z-Metrics PD Estimates*: Five-Year Public Model						
		Median PD				
Country	Listed Companies (2011)	6/30/12	Y/E 2011	Y/E 2010	Y/E 2009	Y/E 2008
Sweden	167	2.7%	2.7%	2.6%	3.1%	6.7%
U.K.	553	2.8%	4.6%	3.7%	4.5%	7.3%
Ireland	28	3.1%	3.0%	1.8%	3.0%	7.9%
Netherlands	85	3.5%	3.1%	2.5%	2.7%	5.0%
U.S.A.	2235	3.6%	4.8%	3.8%	3.3%	4.5%
Germany	398	3.8%	4.6%	3.9%	4.5%	7.6%
France	377	5.3%	6.6%	4.0%	4.6%	7.2%
Spain	91	8.5%	10.6%	7.1%	5.9%	8.6%
Italy	178	11.6%	11.9%	7.7%	7.7%	11.3%
Portugal	36	12.5%	15.1%	9.9%	8.2%	16.6%
Greece	112	28.3%	26.7%	18.7%	11.9%	16.7%

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
Sources: RiskMetrics Group (MSCI), Markit, Compustat.

FIGURE 5

Financial Health of the Corporate, Non-Financial Sector: Selected European Countries and U.S.A. in 2008 – 2012 (6/30)

Z-Metrics PD Estimates*: Five-Year Public Model						
		75th Percentile PD				
Country	Listed Companies (2011)	6/30/12	Y/E 2011	Y/E 2010	Y/E 2009	Y/E 2008
Sweden	167	6.3%	9.6%	6.8%	8.0%	13.5%
U.K.	553	6.3%	9.7%	5.7%	9.3%	16.6%
Netherlands	85	7.0%	8.7%	5.7%	6.7%	15.7%
Ireland	28	7.3%	6.3%	8.6%	11.0%	27.5%
Germany	398	10.8%	11.2%	9.7%	11.9%	22.2%
France	377	11.0%	14.8%	8.5%	10.3%	19.2%
U.S.A.	2235	11.2%	11.7%	8.0%	11.5%	19.5%
Spain	91	25.0%	20.1%	13.2%	12.7%	18.4%
Italy	178	25.4%	26.4%	14.1%	18.1%	27.1%
Portugal	36	32.3%	24.9%	20.1%	12.3%	26.6%
Greece	112	47.0%	50.5%	40.1%	27.6%	31.0%

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
Sources: RiskMetrics Group (MSCI), Markit, Compustat.

CDS Implied PDs

Figure 6 shows the CDS implied PDs for the "Big-Five" European high-risk countries, the so-called PIIGS, from the start of 2009 to March 2013, including the period after the European Union's comprehensive rescue plan was first announced (July 21, 2011) for Greece and a contingent plan for other countries. Note that while the PDs, based on CDS spreads and

assuming a 40% recovery rate,[20] all came down from their highs in 2011, they again spiked

upward in late 2011 and really were elevated until the ECB announced in July 2012 that it would

do whatever would be necessary to bolster the prices of the sovereign bonds of the most

vulnerable European countries, including the relatively large Southern countries like Spain and

Italy.

FIGURE 6

Five Year Implied Probabilities of Default (PD) from Capital Market CDS Spreads,*
January 01, 2009 – March 04, 2013
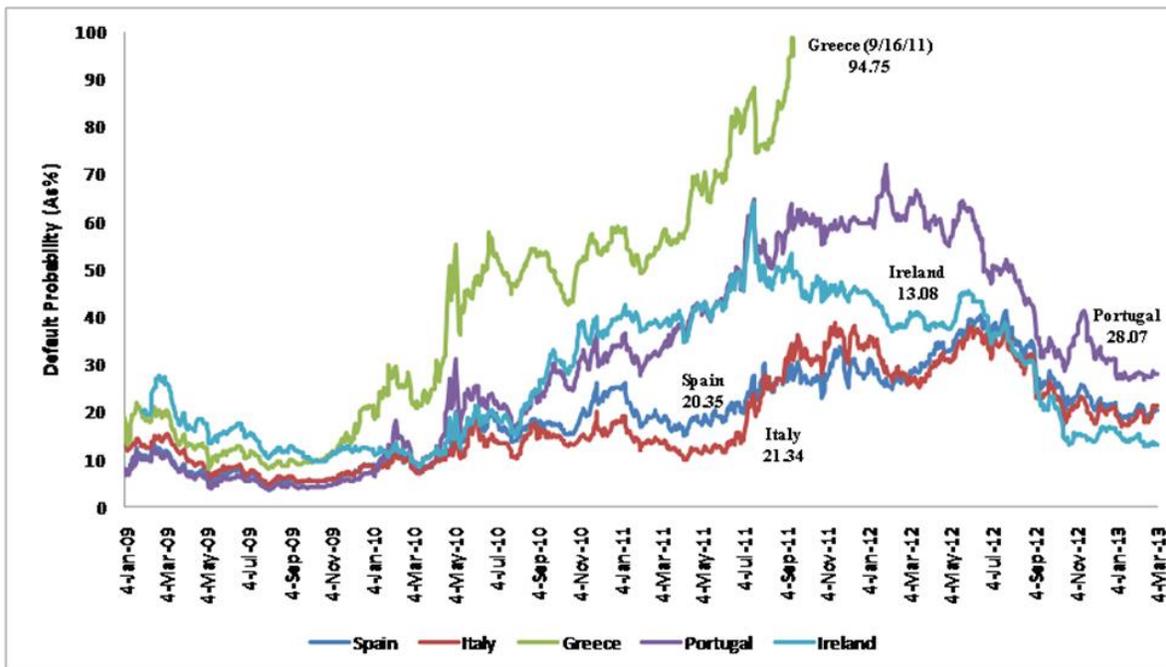
  * Assumes 40% Recovery Rate. PD computed as $1-e^{(-5*s/(1-R))}$. ** On July 19, 2011, PDs for all countries
peaked as follows: Greece 88.22, Portugal 64.74, Ireland 64.23, Spain 27.54, and Italy 23.74.
Sources: Bloomberg and NYU Salomon Center.

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[20] Note that the implied PD for Greece is not shown after 2011. This is due to the assumption of a 40% recovery,
which was clearly too high compared to market expectations. Even with a 20% recovery assumption, Greece's PD
would be well over 90%.

Bank PDs as a Supplement to our Analysis

No private sector analysis would be complete, especially in its relevance to sovereign health assessment, without a thorough and comprehensive treatment of the financial sector. Our private sector treatment is complicated, however, by the relative lack of success of banking early warning systems, as painfully demonstrated by the systems failures amongst global banks, as well as smaller bank failures, during and after the global financial crisis of 2008-2009. We are now working on a new approach to bank insolvency predictions but this model is not available at this point in time. A further complication is the lack of publicly held banks in many of the European countries of late, including such semmingly healthy sovereigns, like the Netherlands (with just two publicly owned, not state owned, entities). As noted above, we are working on a model which, we hope, will deal with these two issues.[21]

Figure 7 does attempt to illustrate how we plan to include a Banking PD model with our non-financial PD model, discussed earlier. We propose to utilize a weighted average PD model of these two sectors to assess the overall PD and relative ranking of various sovereigns. The weightings, however, can be tricky since it is not clear what should be the basis for the relative importance of the Non-Financial vs. Financial sectors. Even in countries where the banking sector was or is the primary reason for a nation's financial and economic problems, e.g., Ireland or Spain, the weighting based on a seemingly critical variable, like the market value of the firm, may be problematic if the country is dominated by a few very large banks (like Spain) with still a relatively low aggregate market value, or whereby banks have very few listed entities, like the Netherlands, Sweden and Portugal. What would be helpful is a model that could include

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[21] A European Commission Working Paper by E. Altman, F. Campolongo, Y. Cizel and H. Rijken (2013), "Estimating the Probability of Default of Western European Banks" is dealing with these issues.

privately held, including state owned banks, as well as publicly owned banks, - - a solution we are still working on.

Back to Figure 7, we do attempt to quantify and rank the median PD level for our 12 country sample as of year-end 2010 for the Combined non-financial and financial sectors. The results are not surprising in that Greece, Portugal, Ireland, Italy and Spain still show the most problematic private sector PDs and rankings. We will have more to say about the Irish case which had the unusual situation of a very healthy non-financial sector PD (ranked third) but its woeful banking sector (ranked last) completely overwhelmed what seemingly was a positive private sector indicator. As noted above, we will revisit, in a subsequent paper, the banking sector PD estimation when we are more confident about the accuracy and robustness of our prediction model.

Note also that the weighted-average PD model's rankings are very similar to the rankings based on the CDS implied PDs (last column in Figure 7). The main discrepancy is that of Belgium, which ranked eighth based on its CDS PD compared to third based on our weighted-average PD. Italy's CDS PD's ranking was two rankings better (7) based on its CDS implied PD compared to our weighted-average PD (9).

FIGURE 7

Weighted Average Median Five-Year (PD) for Listed Non-Financial* and Banking Firms**
(Europe and U.S.), 2010

Country	Non-Financial Firms		Banking Firms		Weighted Average (%)	Rank	CDS Spread PD (%)	Rank
	PD (%)	Weight	PD (%)	Weight				
Netherlands	2.5	0.977	11.1	0.023	2.70	1	2.03	1
Sweden	2.6	0.984	17.3	0.016	2.84	2	2.25	2
U.K.	3.7	0.977	15.5	0.023	3.97	3	4.73	6
Germany	3.9	0.983	13.1	0.017	4.06	4	2.50	3
France	4.0	0.986	14.0	0.014	4.14	5	4.51	5
U.S.A.	3.8	0.837	13.8	0.163	5.43	6	3.79	4
Spain	7.1	0.948	10.9	0.052	7.30	7	25.27	8
Italy	7.7	0.906	20.0	0.094	8.86	8	18.02	7
Portugal	9.9	0.971	12.1	0.029	9.96	9	34.05	9
Greece	18.7	0.921	30.1	0.079	19.60	10	59.14	10

*Based on the Z-Metrics Probability Model. **Based on Altman-Rijken Model (Preliminary).

**Comparing Private Sector Fundamental PDs with CDS Market Implied PDs**

Now that we have defined and empirically measured our new approach toward assessing sovereign PDs - - a type of "Bottom-Up" approach, - - we can compare our measure with market implied estimates. Figures 8-12 show the time series of the 75th percentile 5-year PD from our Z-Metrics model compared to the 5-year implied PD from CDS spreads over the period 2008-2012. In all cases, our 75th percentile PD was greater (worse) for all five PIIGS countries from the start of the time series at year-end 2008 until about mid-2010 when the CDS market's PD assessment first overtook our estimate. It was that point in 2010 that investors realized that not only countries like Greece and Portugal were exceptionally risky, but the very survival of the Eurozone was in jeopardy of falling apart. Our PD estimates showed extreme concern much earlier because our measures are not impacted by the likelihood, or not, of a political bailout by the stronger Eurozone countries, and especially by pronouncements by the ECB.

Note that the CDS estimates of sovereign defaults rose to as high as the mid-30% level for crucial countries like Spain and Italy in mid-2012 and only fell to the high teens after the ECB announced it would do whatever was necessary to reduce the cost of debt of the most vulnerable Southern European countries, e.g., Spain and Italy, by intervening directly into the secondary market and purchasing their sovereign bonds. This statement calmed the market starting in summer 2012 and this new confidence has lasted until early 2013 - - the time that we are writing this paper. Note, however, that our fundamental firm PDs have continued to increase in 2012, through the third quarter (the last date of our analysis), for four of the five most vulnerable countries, with the notable exception of Ireland.

The Irish case is quite interesting in that our PD measure has been considerably strong over the period 2008-2012, despite its obvious financial struggles, primarily due to its insolvent banking sector. Interestingly, our Irish forecast seems to have been prophetic in that the prices of their sovereign bonds have rebounded positively in 2012 and their CDS implied PDs have improved dramatically in 2012.
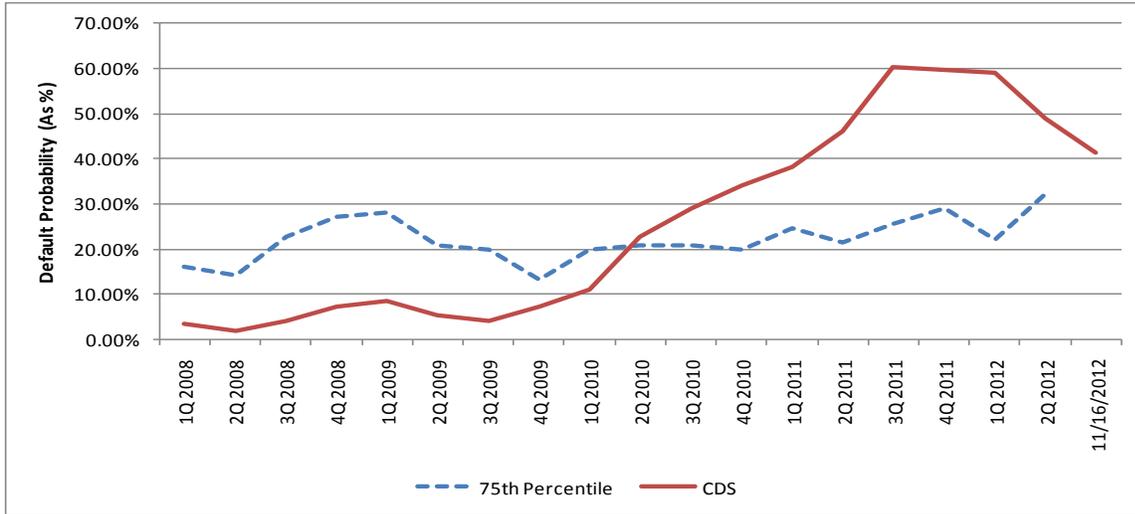
FIGURE 8

Greece: Five Year Implied Probabilities of Default (PD) from Sovereign CDS Spreads vs 75th Percentile Corporate PD, 2008-2012 (11/16)
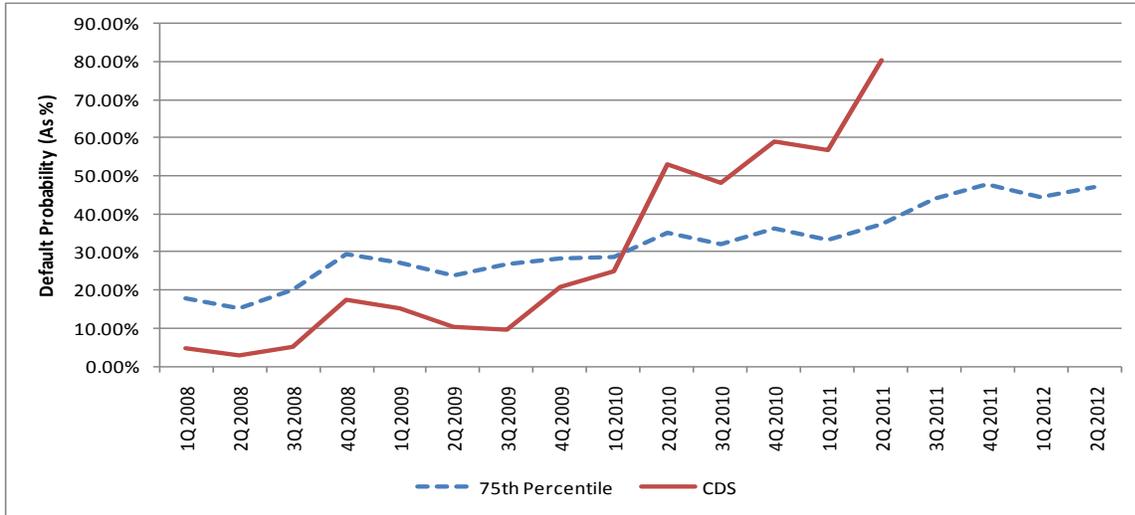
*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
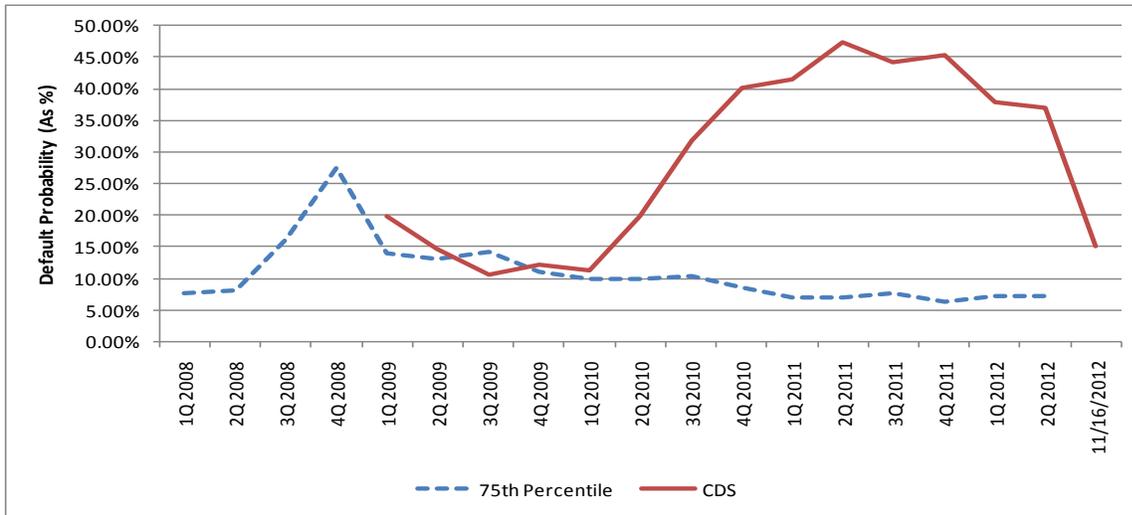Source: Bloomberg

FIGURE 9

Portugal: Five Year Implied Probabilities of Default (PD) from Sovereign CDS Spreads vs 75th Percentile Corporate PD, 2008-2012 (11/16)

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
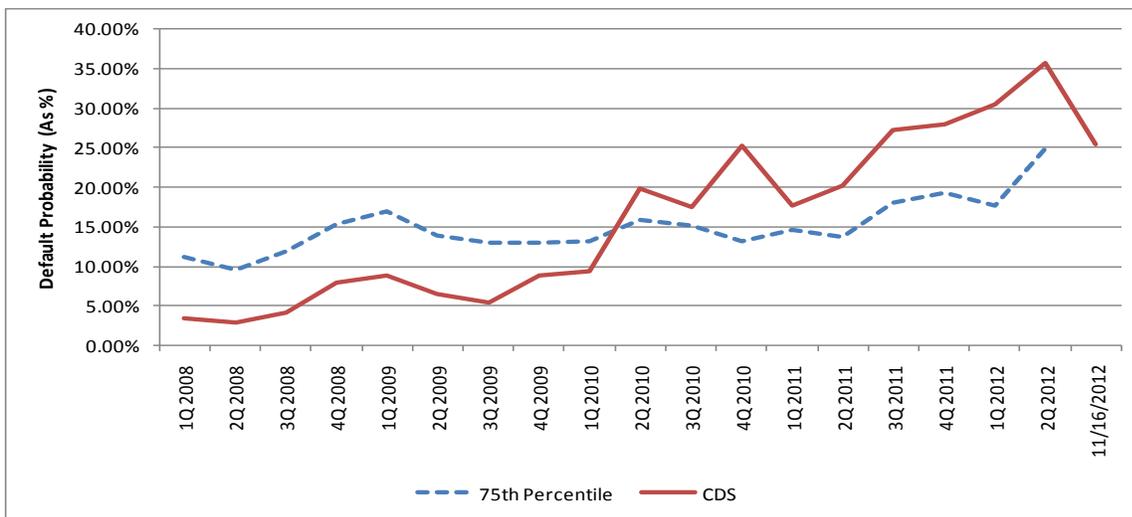Source: Bloomberg

FIGURE 10

Ireland: Five Year Implied Probabilities of Default (PD) from Sovereign CDS Spreads vs 75th Percentile Corporate PD, 2008-2012 (11/16)

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
Source: Bloomberg

FIGURE 11

Spain: Five Year Implied Probabilities of Default (PD) from Sovereign CDS Spreads vs 75th Percentile Corporate PD, 2008-2012 (11/16)

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
Source: Bloomberg

FIGURE 12
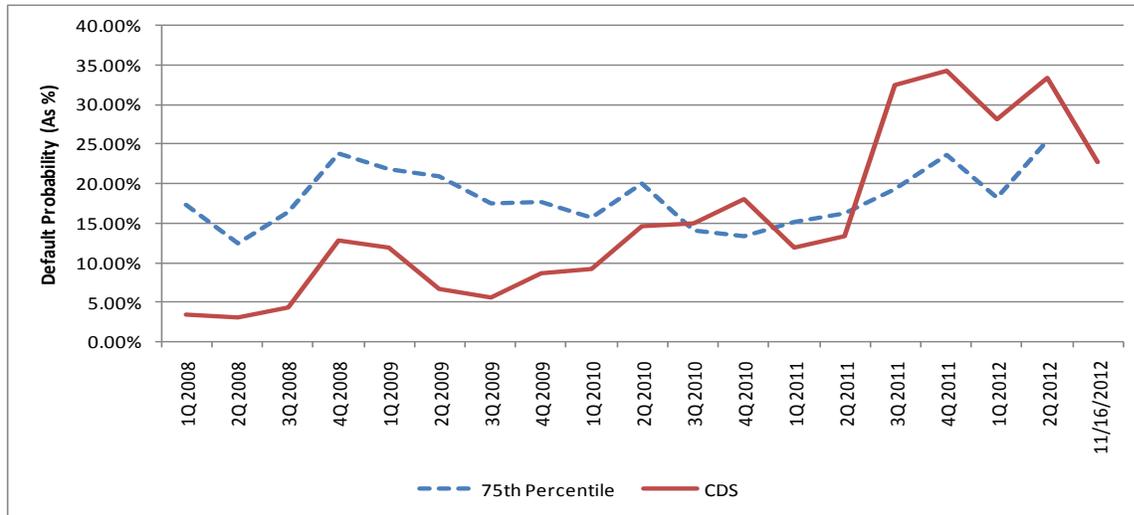
Spain: Five Year Implied Probabilities of Default (PD) from Sovereign CDS Spreads vs 75th Percentile Corporate PD, 2008-2012 (11/16)

*Assuming a 40% recovery rate (R); based on the median CDS spread (s). PD computed as $1-e^{(-5*s/(1-R))}$.
Source: Bloomberg

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

As shown in Figures 4 and 5, the improvement (reduction) in Z-Metrics PDs for most countries 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 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 our private firm Z-Metrics model 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 13 summarizes the results of our public vs. private firm Z-Metrics models comparative PD (delta) results for 2010 and 2009. For eight of the ten countries, use of the private firm model showed smaller reductions in PDs when moving from 2009 to 2010 than use of the public model. Whereas the overall average improvement in PDs for the public firm model was a drop of 1.91 percentage points, the drop was 0.79% for our private firm model. 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 private firm model's PD actually got worse (increased) in 2010 (as indicated by the positive delta in the last column of Figure 13).

FIGURE 13

Private Vs. Public Firm Model PDs in 2010 and 2099

Country	No. Listed Companies		Public-Firm Z-Metrics Model			Private-Firm Z-Metrics Model		
	PDs 2010	PDs 2009	PDs 2010	PDs 2009	Delta*	PDs 2010	PDs 2009	Delta*
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	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%

*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

As a final test of the predictive of our approach, we compared our 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

our public firm model's 2008 Z-Metrics median, non-financial sector PDs against implied CDS

PDs one year later in 2009. Admittedly, this sample was quite small (10 countries) and the

analysis is for only a single time-series comparison (2008 vs. 2009). 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.[23]

As can be seen in Figure 14, the correlation between our 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 2008 explained

roughly half of the variation in the CDS results one year later.[24]

A 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 listed companies), Portugal (with 30), Greece

(79), Netherlands (61), and Spain (82). Since the private, non-listed segment is much larger in

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[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] 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.

[24] 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.

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]

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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.

Figure

2008 Z-metrics PD vs. 2009 CDS Implied PD

$y = 1.9367x - 0.0743$

R-Square = 48%
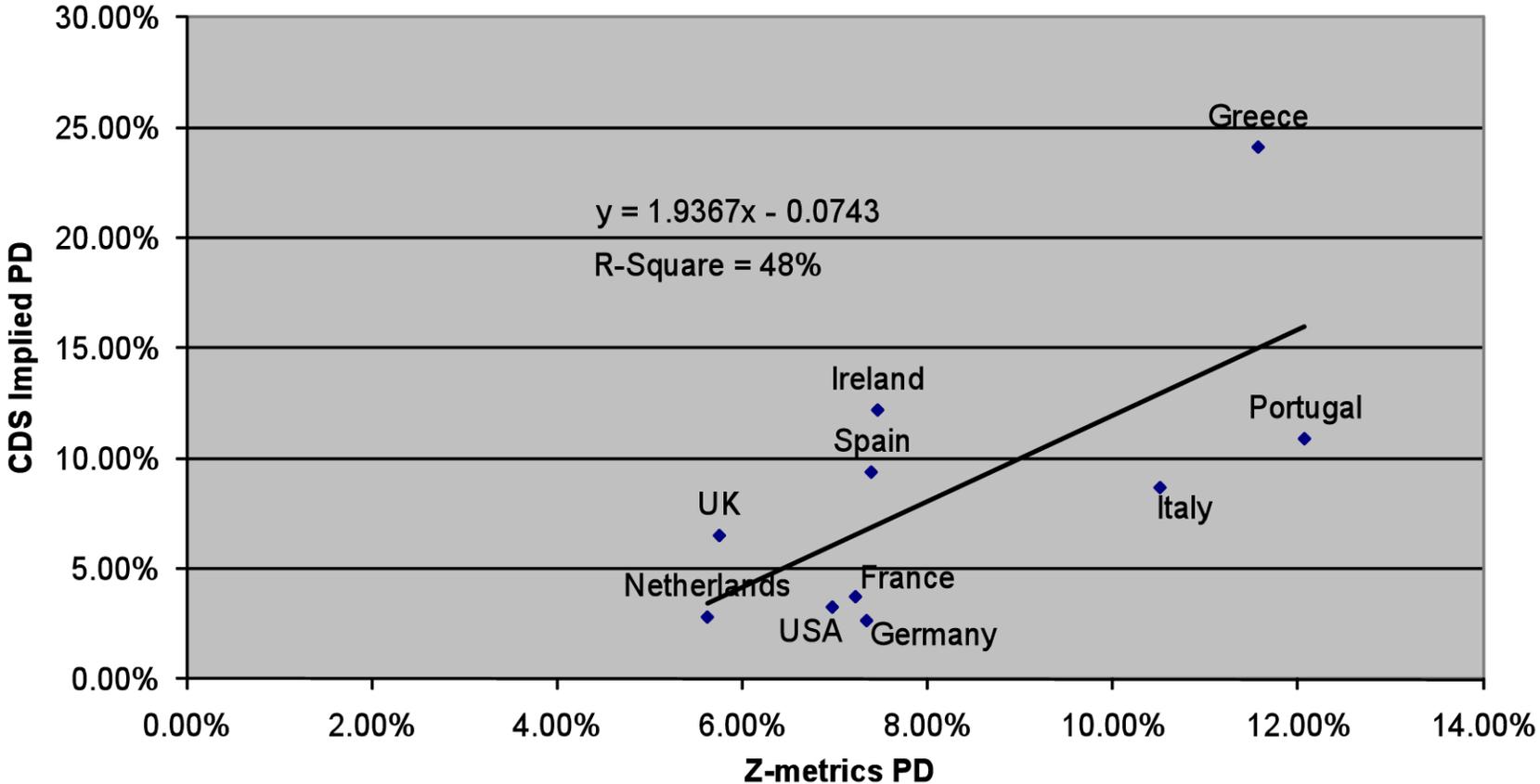
Source: Data from figure 4

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 U.K., have already enacted some painful measures. Others, such as France and Hungary, have either resisted austerity measures or faced significant social unrest when austerity 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 positive going concern values 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 restructured 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.

Austerity programs have other non-intended consequences and in one recent high profile case, Italy in 2013, resulted in a change in government. Electors voted out the technocrat government led by Mario Monti, and gave large popular support to heretofore unknown political parties which attacked reforms. Some of these austerity reforms were important and necessary,

yet hugely unpopular with Italian voters, despite their embrace by the most powerful European governments, particularly in Northern Europe.

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 our transparent PD estimates across a national economy can be seen, at the very least, as a useful complement to existing methods and market indicators—one that is, again, totally transparent and 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, analyze unlisted entities as well. And if sovereigns were also willing to provide independently audited statistics to the public on a regular basis, so much the better.

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APPENDIX: Logit Model Estimation of Default Probabilities

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

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

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

$$B_j \quad = variable\ parameters\ (or\ weights)$$

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

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

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

- 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 Z"-score (1995) model.[27]

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[27] 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 Z"-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 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. 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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