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A Time-Series Postmortem on Eurozone Financial Integration and the Debt Crisis: Modeling and Policy Implications

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ABSTRACT

Multivariate cointegration tests on daily 10-year sovereign bond yields show the decline in Eurozone financial integration occurred in three stages before September 15, 2008 and involved at most six of the original 11 countries. Long-memory factors indicate sovereign yields in Germany, the Netherlands and Finland drove the cointegrated systems. Models of yield spreads confirm that different approaches are necessary to explain cointegrated versus non-cointegrated yields spreads. The debt crisis is examined using daily yield spreads, Baa-Aaa spreads and CDS fee spreads. After June 30, 2010, yield and CDS fee spreads were nearly equal in several countries and Baa-Aaa spreads had returned to their 2007 levels. Thus, mostly fiscal fundamentals reflected in CDS fees spreads explain yield spreads. After mid-2010, Granger causality tests show greater evidence that CDS fee spreads "cause" yield spreads. Cointegration and error correction models show more explicitly that CDS fee spreads "drive" yield spreads, with little evidence of the reverse. Thus, the disparate fiscal fundamentals across Eurozone countries drive sovereign yields.

JEL Classifications: *F36, E43*

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I. INTRODUCTION

The official integration of Eurozone financial markets was mostly a matter of membership in 1999 and resulted in sovereign yields converging across Eurozone countries, but yield spreads quickly diverged during the financial crisis. Using established time-series methods and more technical definitions of integration, the decline in financial integration is shown to have occurred in three stages during 2007-2008 and effectively ended September 15, 2008 with the announced bankruptcy of Lehman Brothers. The sovereign debt crisis followed closely behind the financial crisis. The debt crisis is modeled here using daily 10-year sovereign yield spreads, U.S. Baa-Aaa corporate bond spreads and credit default swaps (CDS) fee spreads.[1] The results suggest different approaches to modeling yields and yield spreads across the original 11 Eurozone countries. Also, since mid-2010 the degree of fiscal integration has driven the degree of financial integration.

Financial markets in two or more countries are integrated if sovereign bonds in the countries pay the same interest rate (Jappelli and Pagano, 2010), with a similar result for equities. Implicit in this definition is that yields are cointegrated, since non-cointegration means interest rates across countries drift apart for extended periods of time, violating the one-price condition. Thus, cointegrated sovereign yields with zero mean bond spreads represent financial integration. Cointegrated yields with small but statistically significant yield spreads suggest a weaker form of integration. Yields spreads that are non-cointegrated over time indicates the lack of integration.

Daily data are necessary to analyze day-to-day market dynamics across the Eurozone. Unfortunately, the use of daily data excludes important variables, such as quarterly government deficit- and debt-to-GDP ratios. However, using daily yields spreads, Baa-Aaa bond spreads and CDS fee spreads, together with the time-series techniques of cointegration, error correction, long-memory components and Granger causality, important insights can be obtained into modeling and interpreting day-to-day market dynamics involving sovereign yields and CDS fee spreads, plus the increased dependence between Eurozone fiscal fundamentals and financial integration.

Of particular interest in analyzing the financial crisis are the specific time intervals over which sovereign yields are cointegrated and the mean spreads versus Germany that occurred during those intervals. The three periods of cointegration identified during 2007-2008 show that sovereign yields for at most six of the original 11 Eurozone countries responded to one another and not just global and individual-country risks identified in previous studies. Compared to the August 1 and August 7, 2007 breakpoints used in previous studies, the analysis here shows that the cointegration of Eurozone sovereign yields first ended on July 26, although this is a minor point. The results also show a substantial shock to yield spreads occurred on February 18, 2008, a more important and previously overlooked date, as yield spreads and cointegration tests show that the disruption on February 18, 2008 was larger than that in late July and early August.

Yield spreads increased rapidly after September 15, 2008. From September 15, 2008 to June 30, 2010, both Baa-Aaa spreads and CDS fee spreads appear to explain variations in yield spreads. However, from July 1, 2010 to March 31, 2012, daily yield spreads are roughly equal to CDS fee spreads for five countries (having mean differences of .30 percent or less). Baa-Aaa spreads had returned to their 2007 levels by late 2009. Models of yield spreads in both levels and differences confirm that Baa-Aaa spreads had little impact on yield spreads after June 30, 2010. Thus, CDS fees reflected mostly individual-country factors such as fiscal fundamentals. Granger causality and cointegration/error correction tests show that CDS fee spreads drive yield spreads. Thus, the degree of fiscal integration appears to drive the degree of financial integration.

The paper is organized as follows. Section II discusses recent related research. Section III includes the detailed analysis of the Eurozone financial crisis. The debt crisis is then addressed in Section IV, followed by summary remarks and suggestions for future research in Section V.

II. LITERATURE REVIEW

The results here extend and update the results in several recent studies on Eurozone financial integration. Pozzi and Wolswijk (2012) use weekly data to examine the time-varying financial integration of bond markets, focusing on Belgium, France, Italy, Germany and the Netherlands during 1995-2009. They derive an international capital asset pricing model (ICAPM) for government bonds. Risk premiums are driven by a country-specific factor and a common factor, which has a time-varying idiosyncratic impact on premiums. They allow for gradual convergence from the full ICAPM through the vanishing of the idiosyncratic factors and also allow for gradual equalization of the common factor. They conclude that the idiosyncratic factors were nearly eliminated by 2006, but reappeared due to the financial crisis in 2007. Thus, Pozzi and Wolswijk (2012) emphasize that adjustments in risk premiums were gradual and time-varying during the financial crisis. Bernoth and Erdogan (2012) use quarterly data to examine sovereign yield spreads across 10 EMU countries and also conclude that time-varying parameters gradually change and capture market reactions to loosening fiscal policies over time.

Favero and Missale (2012) use weekly yield spreads to assess the rationale for a common Eurobond jointly guaranteed by Eurozone members. They find default risk is the main driver of yield spreads and fiscal fundamentals matter in pricing default risk as it interacts with other countries' yield spreads. Using vector autoregression, they show that there is a relationship between yield spreads and fiscal fundamentals, but it is nonlinear and there is instability over time of the impact of the global spread variable on domestic spreads. They partition the data into sub-periods of roughly equal length; the "calm" period of August 2005 to August 2007, the financial crisis period of August 2007 to August 2009, and the euro-debt crisis of September 2009 to August 2011. They find that the coefficients of global spreads are unstable over time. As discussed below, the results here reinforce and extend Favero and Missales (2012) findings.

Maltritz (2012) takes a Bayesian approach to analyzing sovereign yield spreads, given the lack of consensus about the key determinants of yield spreads in the Eurozone, using annual panel data for 1999-2009 for Austria, Belgium, Finland, France, Greece, Ireland, the Netherlands, Italy, Portugal, and Spain. Maltritz (2012) experiments with 14 variables in explaining yield spreads and presents results for the entire period 1999-2009 and the pre-crisis period 1999-2007. The lack of degrees of freedom prevents an analysis of the post-crisis period. Maltitz (2012) finds that the most likely drivers of yield spreads are fiscal variables such as budget balance and government debt, plus external variables, such as terms of trade, trade balance and openness. Maltitz's (2012) evaluation of risks is more specific than that identified in previous studies and adds insights into the findings here involving default risk reflected in CDS fee spreads. At the same time, Maltitz (2012) pools data for the six countries found here to have cointegrated yields prior to September 15, 2008 with countries having non-cointegrated yields. Thus, additional insights are provided here by separating cointegrated and non-cointegrated countries.

Beirne (2012) analyzes spreads between the Euro Overnight Index Average (EONIA) and the minimum bid rate in open market operations of the ECB. Beirne's (2012) pre- and post-crisis sample periods are nearly identical to those determined here quantitatively. Specifically, using daily data, Beirne (2012) defines the pre-crisis period as June 29, 2006 to August 6, 2007, the Pre-Lehman Collapse period as August 7 to September 14, 2008 and the Post-Lehman Collapse period as September 15, 2008 to October 22, 2009. The main difference here is that, in Beirne's (2012) Pre-Lehman Collapse period, a separate shock to financial integration on February 18, 2008 is not included. Beirne's (2012) main finding is that, up until the Post-Lehman period, the EONIA spread was small and positive. Thereafter, the liquidity surplus from the fixed rate full allotment tendering arrangement in refinancing operations drove the widening of the spread.

The main purpose of this paper is not to chronicle specific events in the Eurozone crises, but rather to quantitatively identify breakpoints in the financial and debt crises and to assess the roles of global risk, default risk and cointegration among sovereign yields. Nevertheless, August 7, 2007 is generally accepted as the start date of the financial crisis. On that day, BNP Paribus suspended withdrawals from its three investment funds and suspended the calculation of net asset values. On August 9, central banks acknowledged the need to respond to the August 7 events.[2]

The July 26, 2007 breakpoint identified here occurred seven trading days before August 7. The July 26 date no doubt reflects other financial events occurring at that time. For example, the St. Louis Federal Reserve website noted above lists July 24, 2007 as the date of an SEC filing where Countrywide Financial Corporation warned of "difficult conditions." Also, on July 31 Bear Stearns liquidated two hedge funds invested in various types of mortgage-backed securities. As for the February 18, 2008 breakpoint that occurred several months later, Reuters (2008) and the St. Louis Federal Reserve website indicate that the nationalization of Northern Rock, the fifth largest mortgage bank in the U.K., was the most important financial event that day.

As mentioned above, the findings here reinforce and extend Favero and Missale's (2012) VAR results. The main contributions here result from analyzing the day-to-day market dynamics during the Eurozone financial and debt crises. First, using cointegration, error correction, and long-memory components analyses, the February 18, 2008 financial breakpoint is identified. Second, it is shown that the cointegrated sovereign yields for Germany, France, the Netherlands and Finland must be modeled and interpreted differently than other Eurozone countries. Also like Favero and Missale (2012), during the debt crisis default risk is shown to be the main driver of yield spreads and that fiscal fundamentals drive default risk. This result is based on a 100 trading day window, moving day-by-day from September 15, 2008 to March 31, 2012, monitoring the cointegration/error correction dynamics between yield and CDS fee spreads for five countries.

III. THE DECLINE IN EUROZONE FINANCIAL INTEGRATION, 2007-2008

The first objective of this study is to scan daily sovereign yields over the years 2007-2012 for all fully integrated multivariate cointegrated systems within the original Eurozone countries. Daily 10-year sovereign yields are used for April 1, 2007 to March 31, 2012 for each of the 11 countries except Luxembourg.[3] In the extreme, it might be found that all 10 countries' yields are financially integrated over the entire 2007-2012 period (i.e., having cointegrated yields and yield spreads versus Germany that are statistically insignificant) or, at the other extreme, not one pair of countries have cointegrated yields over any extended time interval. This is done by first examining the 2007-2012 period day-by-day using bivariate cointegration tests, then testing for multivariate cointegration involving the most likely countries and time intervals.

Pairwise cointegration tests are conducted by regressing each country's yield spread versus Germany on a constant term β_0. This forces the cointegration parameter β_1 in the cointegration regression $R10_{i,t} = \beta_0 + \beta_1 R10_{GM,t} + e_t$ to be 1.0, where $R10_{i,t}$ is the 10-year government bond rate for each country i other than Germany (GM). There are several reasons for restricting β_1 to be 1.0. First, it is the appropriate value for the cointegrating parameter. If a system of n interest-rate series is fully integrated with $r = n - 1$ cointegration vectors, the parameters in each vector sum to zero. By substitution, this leads to the result that, except for differences in means, the n interest-rate series are equal, which is consistent with financial integration. In Gonzalo and Granger's (1995) example of interest rates, the $r = n - 1$ cointegrating vectors sum to near zero, but they do not test the zero-sum condition, as is done here. For other examples of integrated bond yields, including hypothesis tests, see Patel and Shoesmith (2004).

Second, regressing one bond yield on another can produce misleading results. For example, regressing yields for the Netherlands on Germany's rates for April 1, 2007 to July 25, 2007 (the first cointegrated period), the β_1 estimate (standard error) is 1.020 (.009), the CRDW = 1.014 and the augmented Dickey-Fuller (ADF) test statistic δ for the cointegration equation errors is -4.94 (see Dickey and Fuller, 1979 and 1981). Thus, both CRDW and ADF tests indicate cointegration, but the hypothesis of $\beta_1 = 1$ is rejected and the coefficient of 1.020 means yield spreads gradually expand while interest rates increase and shrink when interest rates fall, both inconsistent with financial integration. Finally, forcing $\beta_1 = 1$, the constant β_0 becomes the mean yield spread over the estimation interval, which is of interest in evaluating financial integration.

In the bivariate tests, for practical reasons, only the CRDW statistic is used to test for cointegration. With more than 11,300 bivariate cointegration tests conducted in the study, the CRDW offers a convenient, familiar and comparable measure to test for cointegration across countries and time intervals. In comparison, the ADF test statistic δ is sensitive to the number of lagged Δe_t included in each test and, therefore, provides less useful information in judging the relative degree of cointegration across large numbers of cases.

As for the multivariate tests, by definition, a vector x_t of n time series, each I (1), is said to be cointegrated if there is an $n \times r$ vector α such that $z_t = \alpha\, x$ is stationary. With r cointegration vectors, there are n - r remaining unit root combinations, which are called common trends. Following Gonzalo and Granger (1995), each individual series in x_t is adjusted to have a mean of zero, which is computationally equivalent to including an unrestricted intercept.[4] While this eliminates yield spreads across countries, the spreads are reported with the bivariate results.

Again following Gonzalo and Granger (1995), the common long-memory factors (f_t) of a cointegrated system are obtained by decomposing the vector of n interest rates x_t into its permanent and transitory (stationary) components. The permanent component f_t represents the I(1) factors accounting for the long-run trend. With r cointegration vectors, there are $k = n - r$ common factors corresponding to the $n - r$ common trends. In the systems tested here, $r = n - 1$ cointegrating vectors, resulting in $k = 1$ common factor. The common factors f_t are computed as $f_t = \gamma_{\perp}' x_t$, where $\gamma_{\perp}$ is $k \times n$ and $\gamma_{\perp}' \gamma = 0$. Gonzalo and Granger (1995) describe the detailed computations required to obtain the common factors. The coefficients in each column vector of $\gamma_{\perp}'$ are interpreted as weights in establishing the long-run trend.

Table 1 shows the bivariate cointegration results for April 1, 2007 to September 14, 2008 using yield spreads plus the multivariate results. Starting with April 1, 2007, increasingly longer time intervals were tested for each country to determine the longest time interval over which the most countries' yields are cointegrated with German yields using CRDWs. At the same time, the country combinations and time intervals with the strongest bivariate results were tested using the multivariate approach by Johansen (1988) and Johansen and Juselius (1990), the objective being to identify multivariate systems including as many countries' yields as possible over the longest time intervals. (Note that without the guidance of the bivariate results, the number of country combinations and time intervals becomes unmanageable.) Only five yield spreads prove to be possibilities; those for France, Italy, Spain, the Netherlands and Finland.[5]

These five countries' bivariate results are shown at the top of Table 1 for April 1 through July 25, 2007. Multivariate tests indicate that over this time interval yields for Germany, France, Spain, the Netherlands and Finland are cointegrated at the .10 level, with Italy included only at the .20 level. Thus, of the 10 Eurozone countries examined, at most six countries' sovereign yields are cointegrated through July 25, 2007 at the .10 level, Italy being the next-closest possibility. Extending the time interval one more trading day, Spain exits the group as well. Extending the time interval two days results in cointegration failing at the .10 level, even if including only Germany, France, the Netherlands and Finland. Thus, July 25, 2007 is identified as the first significant break point, with only five countries included.

The multivariate results for April 1 through July 25, 2007 in Table 1 show the maximal-eigenvalue ($\hat{\lambda}_{max}$) statistics and eigenvectors ($\hat{V}$) for bond yields from the five countries. The $\hat{\lambda}_{max}$ statistics indicate the system is fully integrated (r = 4) at the .10 level.[6] The cointegration vectors are normalized so that the German coefficient is 1.0. The null hypothesis that the coefficients of each of the four cointegration vectors sum to zero cannot be rejected at the .05 level; $\chi^2(4) = .877$. As mentioned, adding Italy to the system results in a fully integrated (r = 5) system, but only at the .20 level. Table 1 also shows the last column vector $\hat{M}$, which contains the long-memory factor weights for the single common trend. Hypothesis tests show that the factor weights for France and Spain are jointly insignificant at the .05 level; $\chi^2(2) = 1.216$. Thus, yields for Germany, the Netherlands, and Finland drive the system. This period represents the peak of Eurozone financial integration, with cointegration among five countries and spreads of only .049, .053, .041 and .045 percent, respectively, although all are statistically significant at the .01 level.

Table 1
Daily: CRDWs, mean spreads and multivariate cointrgration and long-memory tests

Bivariate Analysis: CRDWs and Mean Spreads vs. Germany						
Time Interval	France	Italy	Spain	Netherlands	Finland	obs
Three cointegrated intervals:						
Apr. 1 – July 25, 2007	1.313*/.049$_{m}$	.618*/.217$_{m}$	1.443*/.053$_{m}$	0.922*/.041$_{m}$	1.001*/.045$_{m}$	80
Aug. 13 – Feb. 17, 2008	0.650*/0.108	.103/0.305	0.362$^{\#}$/0.113	0.822*/0.092	0.962*/0.088	121
Apr. 14 – Sep. 14, 2008	0.574*/0.197	.093 /0.549	0.180 /0.296	0.570*/.199	0.618*/0.256	110

Multivariate Analysis: Cointegration and Long-Memory Components										
April 1, 2007 – July 25, 2007										
$\hat{\lambda}_{max}$ stat.	58.204*	37.593*	20.752$^{\#}$	12.107$^{\#}$	2.278					
	Eigenvectors ($\hat{V}$)^{s}					Eigenvectors ($\hat{M}$)				
Germany	1.000	1.000	1.000	1.000	-1.640	-	-	-	-	-1.524
France	-1.483	1.938	-3.622	0.975	-2.878	-	-	-	-	-0.450^{z}
Spain	1.890	-0.703	-0.546	0.111	0.146	-	-	-	-	0.373^{z}
Netherlands	0.813	1.100	1.826	-2.253	5.859	-	-	-	-	2.357
Finland	-2.214	-3.332	1.334	0.148	-2.463	-	-	-	-	-1.512
August 13, 2007 – February 17, 2008										
$\hat{\lambda}_{max}$ stat.	46.190*	19.591$^{\#}$	14.196$^{\#}$	2.245						
	Eigenvectors ($\hat{V}$)^{s}					Eigenvectors ($\hat{M}$)				
Germany	1.000	1.000	1.000	0.639			-	-	-	-0.296
France	0.241	0.208	-5.874	0.963			-	-	-	-0.093^{z}
Netherlands	3.851	-1.142	4.626	-2.162			-	-	-	-0.406
Finland	-5.091	-0.056	0.226	-0.433			-	-	-	-0.352
April 14, 2008 – September 14, 2008										
$\hat{\lambda}_{max}$ stat.	41.370*	18.180*	12.497$^{\#}$	2.498						
	Eigenvectors ($\hat{V}$)^{s}					Eigenvectors ($\hat{M}$)				
Germany	1.000	1.000	1.000	0.017			-	-	-	-2.257
France	-9.824	-0.074	-0.263	1.239			-	-	-	1.054^{z}
Netherlands	8.642	-1.071	-0.159	1.465			-	-	-	2.577
Finland	0.231	0.174	-0.617	-1.814			-	-	-	-0.849^{z}

*Indicates significance at the .01 level, $^{+}$ at .05 and $^{\#}$ at .10; the subscript $_{m}$ indicates the smallest spread vs. Germany's 10-year government bond rate over the three time intervals. Like Gonzalo and Granger (1995), λ_{max} critical values are taken from Osterwald and Lenum (1992), Table 1.1*. ^{s}Indicates that, jointly, each of the first *n-1* eigenvectors sum to zero at the .05 level. In order, the test statistics are $\chi^2(4) = .877$, $\chi^2(3) = .285$, and $\chi^2(3) = 2.599$. ^{z}Indicates that the factor weights are jointly insignificant at the .05 level. In order of cases, $\chi^2(2) = 1.216$, $\chi^2(1) = .0006$, and $\chi^2(2) = 4.705$. In the same order, the remaining factor weights under the zero restrictions are 1.379 -2.447 1.866, -.290 -.375 -.351, and 2.717 -3.220.

Continuing to examine Eurozone yield spreads day-by-day to identify extended periods of cointegration, the second cointegrated time interval starts August 13, 2007, only 12 trading days after July 25, and extends through February 17, 2008 (121 days). In the multivariate results shown in Table 1, Spain is eliminated to obtain a fully integrated system of r = 3 cointegrating vectors at the .10 level. Thus, Italy and then Spain drop from the list of countries with cointegrated yields. The null hypothesis that the coefficients of each of the three cointegration vectors sum to zero cannot be rejected at the .05 level; $\chi^2(3) = .285$. Hypothesis tests on the single vector of long-memory factor weights for the four countries show that the factor weight for France is insignificantly different from zero; $\chi^2(1) = .0006$. Thus, yields for Germany, the Netherlands, and Finland continued to drive the system of interest rates. The bivariate results in the second line of Table 1 confirm the exit of Italy, weak results for Spain and the near doubling of yield spreads.

For the last period of cointegrated yields during 2007-2008, April 14 to September 14, 2008, the $\hat{\lambda}_{max}$ statistics again indicate a fully integrated system for the bond yields for Germany, France, the Netherlands, and Finland (r = 3 at .10). The null hypothesis that the coefficients of the three cointegration vectors sum to zero again cannot be rejected at the .05 level; $\chi^2(3) = 2.599$. In this case, hypothesis tests on the single vector of long-memory factor weights for Germany, France, the Netherlands, and Finland show that the factor weights for both France and Finland are jointly insignificant at the .05 level; $\chi^2(2) = 4.705$. Thus, interest rates for only Germany and the Netherlands drove the last system of four sovereign yields. The third line of Table 1 shows bivariate results consistent with the multivariate results, plus much higher average yield spreads.

After September 15, 2008, any measureable financial integration within the Eurozone was nearly over. Continuing to examine the post-Lehman era on a day-by-day basis through March 31, 2012, only one other cointegrated period involving more than two countries' yields is identified, a 98 trading-day interval in 2010 (June 22 to November 4), when sovereign yields for Germany, the Netherlands and Finland were again cointegrated. Bond rates for Germany and the Netherlands drove the system once more. Periods of bivariate cointegration between Germany and each of the Netherlands and Finland also occurred, as discussed in the next section.

Figure 1 illustrates the timing of cointegration among sovereign yield spreads and the Baa-Aaa spread. The top graph shows daily yield spreads for France, Spain, the Netherlands, and Finland. Because of the marginal results for Italy, it is included in the bottom graph with the other countries' yield spreads where cointegration is not indicated; that is, Belgium, Austria, Portugal and Ireland. The February 18, 2008 break point appears to be more significant in terms of yield spreads than the first one in late July. September 15, 2008 is the next obvious break point. These observations are confirmed by the results in Table 1. For example, in the case of France, the mean yield spread increases from a relatively small but statistically significant .049 percent through July 25, 2007 to .108 during the second interval starting on August 13, 2007, followed by an even larger increase to .197 in the last interval beginning April 14, 2008.

The bottom graph in Figure 1 shows yield spreads for Italy, Belgium, Austria, Portugal and Ireland. The data for these countries show the lack of cointegration with Germany and better reflect the description that the decline in Eurozone financial integration was gradual, as described by Bernoth and Erdogan (2012) and Pozzi and

Wolswijk (2012) in their articles on time-varying parameters. These five countries' yield spreads also appear to be more appropriate for splitting samples, provided that February 18, 2008 is included. Also apparent in the bottom graph is a 31 trading-day period of negative yield spreads for Austria (June 5 to July 19, 2007). Given the distorting effects of these values and to save space, Austria is excluded from the next exercise.

Figure 1

Daily yield spreads (left scale) and Baa-Aaa spreads (right scale)

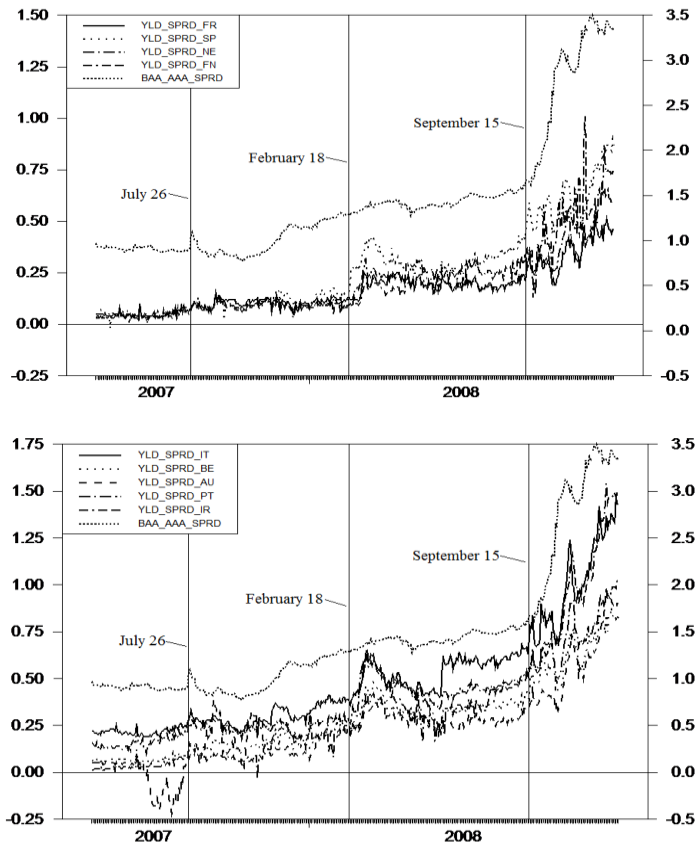


Table 2 illustrates the importance of the cointegration results in modeling yield spreads. Together with Table 1, the dynamics of the decline in financial integration are clearer. For each country in Table 2, three regressions are shown. The first includes only a constant and the Baa-Aaa spread (shown in Figures 1 and 2). The second regression includes the constant and dummy variables for the second and third cointegrated periods. The 19 trading days between the first two cointegrated periods and the 32 days between the second and third periods are treated as skipped/missing to focus the modeling of yield spreads over the three cointegrated periods (311 observations). The third regression includes the constant, two dummies and the Baa-Aaa spread.

Table 2
Regressions of Eurozone yield spreads on Baa-Aaa spreads and cointegrated-interval dummies, April 1, 2007-September 15, 2008

Dependent Variable: YLD_ SPRD_Country						
	France			Netherlands		
Constant	-1.01	0.49	0.41	-1.33	0.041	0.041
	(-11.03*)	(22.66*)	(4.63*)	(-14.36*)	(19.98*)	(5.03*)
8/13/2007-2/17/2008		0.059	0.058		0.051	0.051
Dummy variable		(21.32*)	(19.02*)		(19.42*)	(17.66*)
4/14/2008-9/14/2008		0.148	0.142		0.159	0.159
Dummy variable		(51.92*)	(24.33*)		(59.20*)	(28.92*)
Baa-Aaa	0.197		0.009	0.219		-0.001
Spread	(25.89*)		(1.01)	(27.64*)		(-0.07)
R-Squared	0.691	0.901	0.902	0.718	0.926	0.926
Durbin-Watson	0.240	0.709	0.709	0.205	0.728	0.707
	Finland			Spain		
Constant	-0.218	0.045	0.035	-0.275	0.053	-0.095
	(-17.32*)	(15.35*)	(2.94*)	(-23.74*)	(12.16*)	(-6.36*)
8/13/2007-2/17/2008		0.043	0.041		0.061	0.041
Dummy variable		(11.25*)	(9.88*)		(10.83*)	(7.94*)
4/14/2008-9/14/2008		0.211	0.204		0.243	0.155
Dummy variable		(54.23*)	(25.58*)		(42.63*)	(15.59*)
Baa-Aaa	0.310		0.011	0.382		0.163
Spread	(28.89*)		(0.872)	(38.71*)		(10.24*)
R-Squared	0.736	0.920	0.921	0.833	0.874	0.908
Durbin-Watson	0.217	0.737	0.751	0.273	0.321	0.444
	Italy			Belgium		
Constant	-0.249	0.217	-0.083	-0.261	0.069	-0.141
	(18.29*)	(32.75*)	(-4.24*)	(-24.38*)	(16.15*)	(-11.72*)
8/13/2007-2/17/2008		0.087	0.049		0.103	0.076
Dummy variable		(10.22*)	(7.21*)		(18.67*)	(18.31*)
4/14/2008-9/14/2008		0.332	0.152		0.268	0.142
Dummy variable		(38.05*)	(11.60*)		(47.58*)	(17.75*)
Baa-Aaa	0.541		0.332	0.407		0.232
Spread	(46.48*)		(15.80*)	(44.58*)		(18.06*)
R-Squared	0.878	0.845	0.916	0.869	0.886	0.926
Durbin-Watson	0.159	0.132	0.214	0.223	0.260	0.497

Table 2 (continued)

	Portugal			Ireland		
Constant	-0.177	0.160	-0.069	-0.408	0.036	-0.306
	(-12.35*)	(39.57*)	(-4.46*)	(-29.50*)	(4.98*)	(-14.77*)
8/13/2007-2/17/2008		0.085	0.074		0.110	0.066
Dummy variable		(16.44*)	(13.82*)		(11.78*)	(9.19*)
4/14/2008-9/14/2008		0.280	0.226		0.326	0.122
Dummy variable		(52.82*)	(22.07*)		(34.36*)	(8.83*)
Baa-Aaa	0.411		0.100	0.527		0.378
Spread	(33.44*)		(6.07*)	(44.62*)		(17.06*)
R-Squared	0.788	0.910	0.920	0.869	0.807	0.903
Durbin-Watson	0.167	0.316	0.357	0.348	0.239	0.456

Countries are ordered according to the bivariate results showing the strongest indications of cointegration with Germany. *Indicates significance at the .01 level, + at .05 and # at .10; 311 observations.

There are several important observations in Table 2. In the first regression for all countries, the Baa-Aaa spread is positive and significant at a high level of confidence, suggesting global risk is an important factor in yield spreads. In the second regression, the constant and the coefficients for the two dummy variables are all positive and significant, as expected, given that each country's yield spread increased over the three time intervals. However, there are two important differences for France, the Netherlands and Finland compared to the other five countries. For France, the Netherlands and Finland, the R^2 increases substantially by dropping the Baa-Aaa spread and including the two dummies, which is not true for the other five countries. (Note that each constant equals the first mean yield spread for the same country in Table 1, the constant plus the first dummy coefficient equals the second yield spread in Table 1, and the constant plus second dummy coefficient equals the third yield spread in Table 1.) At the same time, for France, the Netherlands, and Finland, the Durbin-Watson statistic (DW) increases to .709 or higher, roughly double the critical value required in the bivariate tests to conclude cointegration between each country's sovereign yield and that for Germany. Again, the same is not true for the other five countries. Lastly, the parameter estimates for the second cointegrated period confirm the second financial shock that occurred February 18, 2008.

The third regressions in Table 2 are most informative. Including the Baa-Aaa spread with the constant and the two dummies, the coefficients on the Baa-Aaa spreads are insignificant for France, the Netherlands, and Finland, but remain significant at high levels of confidence for the other five countries. Together with the multivariate cointegration results in Table 1, it is clear that a different market dynamic applies to sovereign yields for Germany, France, the Netherlands, and Finland. Specifically, rather than responding to global risks, investors evaluated sovereign yields for each of the four countries based on the yields in the other countries and possibly their economic fundamentals. The long-memory components results indicate particular attention was given to Germany, the Netherlands, and Finland during the first two cointegrated intervals and to only Germany and the Netherlands in the third. Thus, the political/economic factors that result in financial integration are most likely observable in Germany and the Netherlands.

IV. THE EUROZONE SOVEREIGN DEBT CRISIS

The Eurozone sovereign debt crisis followed closely behind the financial crisis. The debt crisis is analyzed here using daily yield, Baa-Aaa and CDS fee spreads. Data availability allows for the analysis of France, Italy, Spain, the Netherlands, Belgium, Austria, Finland, and Portugal. Thus, only Luxembourg (missing yields) and Ireland (missing CDS fees) are excluded. Figures 2a-2d show yield, CDS fee and Baa-Aaa spreads for the four countries of France, Italy, Finland and Portugal for the entire study interval of April 1, 2007 to March 31, 2012. CDS fee data are incomplete before September 15, 2008. Yield spreads and CDS fee spreads are nearly equal after July 1, 2010 for France, Italy, and Portugal and likewise for Austria and Belgium (not shown). The differences in means from July 1, 2010 to March 31, 2012 are for France .039 percent, Italy .303, Portugal .261, Austria .180 and Belgium .062 (all statistically significant at the .01 level). Although a bit arbitrary, partitioning the data at July 1, 2010 is mostly due to observation and to divide the post-Lehman period into early and late debt crisis periods of roughly equal lengths, having 442 and 451 observations, respectively.

CDS fee data for Finland and the Netherlands are similar. As mentioned above, sovereign yields for these two countries are cointegrated with German rates for 98 trading days, June 22 to November 4, 2010. Bivariate cointegration intervals are much longer for the two countries. For the Netherlands, yield spreads versus Germany indicate cointegration for June 22, 2010 to April 18, 2011 (almost 10 months, 222 trading days). Yield spreads for Finland indicate cointegration (Figure 2c) extending from October 16, 2009 to June 6, 2011 (nearly 20 months and 426 trading days). Thus, these two countries' yield spreads continue to reflect a strong tie to German rates and are not expected to have quantitative results that are similar to the other six countries.

Figure 2

Daily yield, CDS fee, and Baa-Aaa spreads (%)

Figure 2a (France)

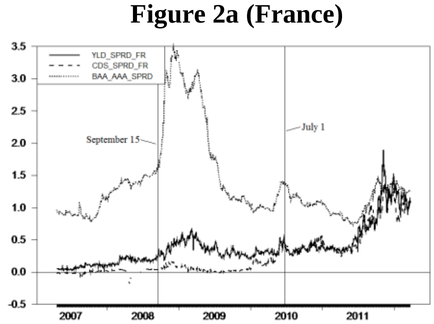


Figure 2b (Italy)

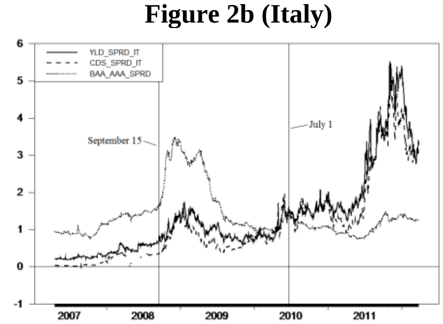


Figure 2c (Finland)

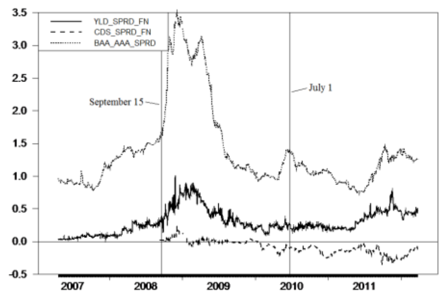
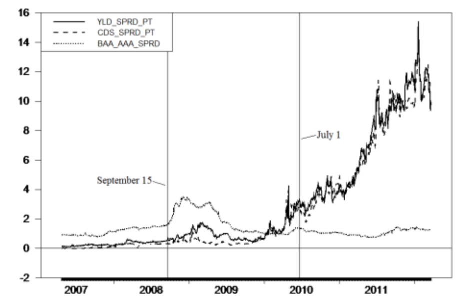


Figure 2d (Portugal)



There are three objectives for this section. First, yield spreads are modeled as functions of Baa-Aaa and CDS fee spreads for the periods September 15, 2008 to June 30, 2010 and July 1, 2010 to March 31, 2012. Given the results of the first regressions and the fact that yield and CDS fee spreads are virtually equal after June 30, 2010 for five countries, the second objective is to conduct Granger causality tests for the two time intervals to determine if yield spreads “cause” CDS fee spreads, the reverse, or if there is two-way causality. Third, to more explicitly model the market dynamics between yield and CDS fee spreads, cointegration and error correction models are estimated to determine the nature of the error correction processes that maintain the cointegration equilibria; that is, whether CDS fee spreads drive yield spreads or the reverse.

Table 3 shows regressions of yield spreads for the eight countries on Baa-Aaa spreads and CDS fee spreads in levels and first differences. For the models in levels ($YLD\_SPRD\_country_t$), the results confirm the observed relationships in Figures 2a-2d. For the first estimation interval of September 16, 2008 to June 30, 2010 and for each of the countries except Finland and Spain, coefficients for both Baa-Aaa bond and CDS fee spreads are positive and significant at all levels, showing that global risk is positively related to yield spreads, independently of default risk.

Also as observed in Figures 2a-2d, Table 3 shows that, for July 1, 2010 to March 31, 2012, the coefficients on Baa-Aaa spreads are insignificant or the wrong sign for all countries except Finland and Portugal. The magnitudes of the coefficients for CDS fee spreads also increase to roughly 1.0 (.99 to 1.48) for five of the eight countries, the exceptions being Spain, Finland, and the Netherlands. Another observation is that the R^2 increases for each country except the Netherlands and Finland and substantially in several cases. Thus, for the late debt crisis period, while global risks returned to 2007 levels and became insignificant in explaining yield spreads, the correlations between yield and CDS fee spreads became stronger.

While the results in levels agree with observations in Figures 2a-2d, each spread in Table 3 is I(1) and the errors are serially correlated. Thus, the regressions are re-estimated using first differences to correct for serial correlation, reduce the degree of multicollinearity, and avoid spurious results. The estimation results in differences ($\Delta YLD\_SPRD\_country_t$) show that, for both time intervals, all the coefficients on ΔBaa-Aaa spreads are insignificant at the .05 level. At the same time, for both time intervals, all of the coefficients on ΔCDS fee spreads are positive and significant at the

Table 3
Regressions of yield spreads, levels and first-differences, September 16, 2008 – March 31, 2012

Dependent Variable: YLD_SPRD_country$_t$								
	France		Italy		Spain		Netherlands	
Sample	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12
Constant	0.171	-0.026	0.310	0.596	0.806	0.883	0.163	0.265
	(18.54*)	(-0.72)	(16.19*)	(6.53*)	(18.17*)	(4.93*)	(16.63*)	(6.60*)
Baa–Aaa spread$_t$	0.088	-0.026	0.129	-0.569	0.031	0.417	0.058	0.025
	(21.81*)	(-0.64)	(17.32*)	(-5.56*)	(0.87)	(1.44)	(8.04*)	(0.65)
CDS fee spread$_t$	0.244	1.154	0.568	1.483	-0.004	0.212	0.803	0.390
	(7.26*)	(46.44*)	(27.77*)	(64.80*)	(-0.55)	(5.12*)	(18.75*)	(5.38*)
R-Squared	0.527	0.899	0.775	0.941	0.002	0.234	0.816	0.150
Durbin-Watson	0.197	0.195	0.165	0.205	0.039	0.039	0.226	0.078
	Belgium		Austria		Finland		Portugal	
Sample	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12
Constant	0.140	-0.392	0.159	0.461	-0.002	-0.036	0.071	-0.180
	(10.56*)	(-5.98*)	(14.44*)	(10.52*)	(-0.14)	(-1.21)	(1.79$^\#$)	(-1.21)
Baa–Aaa spread$_t$	0.141	0.131	0.085	-0.439	0.218	0.268	0.207	0.471
	(21.41*)	(1.91)	(12.04*)	(-8.40*)	(32.82*)	(8.65*)	(12.98*)	(2.86*)
CDS fee spread$_t$	0.668	1.231	0.482	1.402	-0.181	-0.432	0.822	0.989
	(23.75*)	(44.23*)	(26.97*)	(37.28*)	(-2.22$^+$)	(-4.89*)	(44.09*)	(99.71*)
R-Squared	0.777	0.864	0.839	0.867	0.791	0.292	0.817	0.964
Durbin-Watson	0.218	0.103	0.243	0.227	0.547	0.089	0.170	0.189
Dependent Variable: ΔYLD_SPRD_countryt								
	France		Italy		Spain		Netherlands	
Sample	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12
Constant	0.0003	0.001	0.001	0.001	0.004	0.002	-0.0003	0.001
	(0.22)	(0.26)	(0.27)	(0.18)	(1.20)	(0.32)	(-0.23)	(0.37)
ΔBaa–Aaa spread	-0.023	-0.068	0.040	0.093	-0.104	0.030	0.038	0.113
	(-0.64)	(-0.63)	(0.66)	(0.43)	(-1.32)	(0.10)	(1.18)	(1.81)
ΔCDS fee spread$_t$	0.410	0.775	0.437	0.740	0.049	0.184	0.101	0.280
	(4.71*)	(13.26*)	(11.82*)	(19.36*)	(5.71*)	(5.21*)	(2.06$^+$)	(3.39*)
R-Squared	0.050	0.297	0.255	0.475	0.072	0.065	0.014	0.034
Durbin-Watson	2.317	2.224	2.155	2.355	2.181	1.788	2.122	2.547
	Belgium		Austria		Finland		Portugal	
Sample	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12	9/16/08 6/30/10	7/1/10 3/31/12
Constant	-0.0002	0.001	0.0001	0.001	-0.001	0.0004	0.002	-0.0004
	(-0.12)	(0.35)	(0.08)	(0.42)	(-0.35)	(0.26)	(0.36)	(-0.04)
ΔBaa–Aaa spread	-0.029	0.069	-0.004	-0.111	0.032	0.091	0.017	0.288
	(-0.62)	(0.44)	(-0.08)	(-0.96)	(0.37)	(1.32)	(0.13)	(0.65)
ΔCDS fee spread$_t$	0.236	0.846	0.116	0.841	-0.042	0.029	0.802	0.566
	(5.83*)	(18.50*)	(4.30*)	(11.26*)	(-0.21)	(0.33)	(18.63*)	(13.72*)
R-Squared	0.075	0.456	0.042	0.233	0.0004	0.004	0.452	0.314
Durbin-Watson	2.201	2.426	1.990	2.02	2.535	2.546	2.766	3.376

*Indicates significance at .01, $^+$ at .05. Observations: 454 in the first interval, 451 in the second.

.05 level except for Finland, and regression R^2s increase for the late debt crisis period, substantially in several cases. Thus, modeled in first differences, the impact of global risk reflected in Baa-Aaa spreads appears is to be absorbed in CDS fee spreads. Also, default risks appear to explain a greater percentage of the variation in yield spreads after mid-2010.

The stronger relationship between yield and CDS fee spreads in the late debt crisis period motivates an investigation into the market dynamics of yield and CDS fee spreads. Perhaps the simplest test for this purpose is Granger causality. In the interest of space and because the results are straightforward, a summary is offered without a detailed table. First, for September 16, 2008 to June 30, 2010, CDS fee spreads “cause” yield spreads in only three of the eight countries, the Netherlands, Austria and Portugal; however, for July 1, 2010 to March 31, 2012 CDS fee spreads “cause” yield spreads in seven of the eight countries, the Netherlands being the only exception. In contrast, yield spreads “cause” CDS fee spreads in six countries in the first period, Finland and the Netherlands being the exceptions, but only five countries in the second period, the exceptions being Austria, Finland and Portugal. Thus, investors in sovereign bonds responded much more to CDS fees after mid-2010.

A more explicit method for unraveling the dynamics between yield and CDS fee spreads is cointegration and error correction modeling. For these tests, a 100 trading-day window is used, moving day-by-day, the first 100-day interval being September 15, 2008 to February 6, 2009 and the last being November 14, 2011 to March 31, 2012, a total of 821 cointegration regressions and two-equation ECMs. The cointegration regression YLD_SPRD = β_0 + β_1CDSfee_SPRD + e_t is estimated for each country and the CRDW is assigned to the end date of the estimation interval. The ECM is then estimated and the *t*-statistics for the z_{t-1} terms in the yield and CDS fee spread equations are assigned to the end date of the interval, $z_t = e_t$ from the cointegration regression.

An ECM is a vector autoregression in differences with z_{t-1} added to each equation. The *t*-statistics for the z_{t-1} terms indicate the error correction process. With the cointegration regression above, a positive e_t (and therefore z_{t-1}), the expected sign for the z_{t-1} term in the ΔYLD_SPRD equation is negative (the yield spread declines if the yield spread exceeds its equilibrium with the CDS fee spread in the previous period). The expected sign for z_{t-1} in the ΔCDSfee_SPRD equation is positive. If the *t*-statistic for z_{t-1} in the ΔYLD-SPRD equation is negative and significant and the coefficient on z_{t-1} in the ΔCDSfee_SPRD equation is insignificant, then yield spreads adjust to CDS fee spreads and CDS fee spreads are said to “drive” yield spreads. The opposite one-way dynamic is also possible, as is a two-way error correction process.

Given that 821 cointegration/error correction models are estimated for each country, the results are presented graphically. Figure 3a shows the results for France. The CRDWs indicate consecutive 100-day cointegration periods ending July 23, 2010 and continuing until September 9, 2011; a total of 293 consecutive 100 trading days of cointegration between yield spreads and CDS fee spreads. Including the first 100 days, the span begins February 1, 2010, for a total of 19 months. Over almost the entire period, yield spreads adjust to CDS fee spreads (thus, CDS fee spreads drive yield spreads), with only short periods in late 2010 and mid-2011 when the error correction process is reversed. For the Netherlands (Figure 3b), the end dates begin May 14, 2010 and end March 24, 2011 (223 consecutive trading days and 15 months including the first 100 trading days), with CDS fee spreads almost exclusively driving yield spreads.

Figure 3
CRDWs and ECM z_{t-1} t-statistics

Figure 3a (France)

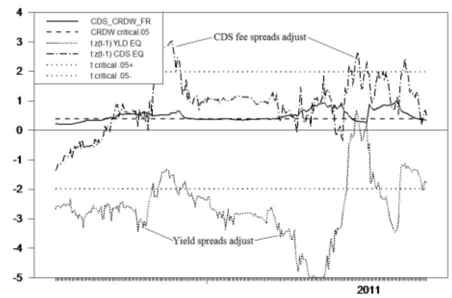


Figure 3b (Netherlands)

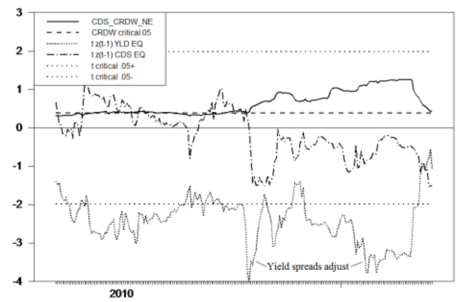


Figure 3c (Austria)

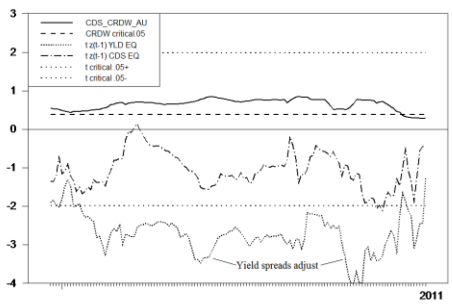
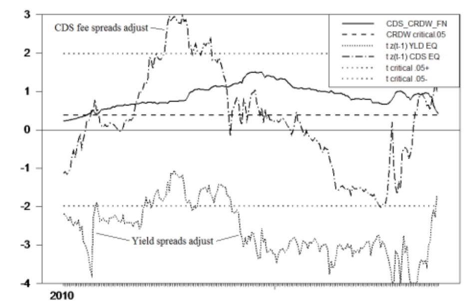


Figure 3d (Finland)



The time interval shown for Austria (Figure 3c) is January 3, 2011 through July 6, 2011 (131 trading days, 11 months including the first 100 days), with CDS fee spreads again driving yield spreads. Figure 3d shows the results for Finland, the time interval being July 12, 2010 to May 10, 2011 (228 trading days, 15 months with the first 100 days). Again, CDS fee spreads drive yield spreads except for a short period in late 2010, when the error correction process is reversed. For Portugal (not shown), the interval of consecutive 100-day cointegrated periods begins April 26, 2010 and ends 55 trading days later on July 12, 2010 (eight months with the first 100 trading days), again with CDS fee spreads exclusively driving yield spreads.

Together, the evidence in this section shows that the Eurozone debt crisis began soon after September 15, 2008. In the early stages of the debt crisis, global risks measured by Baa-Aaa spreads appear to influence Eurozone yield spreads independently of CDS fee spreads, but by mid-2010 Baa-Aaa spreads had returned to 2007 levels and, whether modeled in levels or differences, CDS fee spreads became more strongly related to yield spreads. Examining the time-series dynamics between yield and CDS fee spreads, Granger causality tests indicate CDS fee spreads cause yield spreads in only three of eight countries before June 30, 2010, but seven of eight countries after mid-2010. More importantly, cointegration and error correction analysis shows that, when yield and CDS fee spreads are cointegrated (beginning in mid-2010 in four of five cases), CDS fee spreads almost exclusively drive yield spreads.

V. CONCLUSIONS AND FUTURE RESEARCH

A detailed examination of the Eurozone financial crisis and the debt crisis that followed reveals some interesting and important results. First, the financial crisis occurred in three stages, with financial shocks occurring on July 25, 2007, February 18, 2008 and September 15, 2008, the second breakpoint having not been identified in previous research. Sovereign yields for Germany, France, the Netherlands, and Finland were cointegrated in each of the three stages, with Germany and the Netherlands having the most consistent influence on the other cointegrated yields. Modeling yield spreads over the three cointegrated time periods shows that five Eurozone countries' yields spreads responded to global risks represented by Baa-Aaa spreads, but those for France, the Netherlands, and Finland did not, demonstrating that the four cointegrated rates must be modeled and analyzed separately. Future research into the political/economic attributes of these four countries should reveal some of the key factors required for financial integration.

Examination of the debt crisis indicates CDS fee spreads drive yield spreads. Modeling sovereign yield spreads in both levels and differences shows that the relationship between yield spreads and default risks reflected in CDS fee spreads became stronger after mid-2010. The time-series dynamics between yield and CDS fee spreads are perhaps the most important finding, as these results show that CDS fee spreads drive yield spreads. The strongest evidence is from cointegration and error correction modeling, which shows that when yield and CDS fee spreads are cointegrated, CDS fee spreads almost exclusively drive yield spreads, with little evidence of the reverse. Since CDS fees reflect primarily fiscal fundamentals after mid-2010, it is unlikely that a high degree of financial integration can be achieved without *first* achieving a high degree of fiscal integration in some form, as validated by the CDS market.

ENDNOTES

1. The use of Baa-Aaa spreads as a measure of global risk follows Favero and Missale (2012). Daily Baa and Aaa bond rates are taken from the St. Louis Federal Reserve's FRED database. A CDS is a financial instrument used to insure against the risk of a government default. The buyer of the CDS makes a series of payments (the CDS "spread" or "fee") to the seller and receives a payoff if the loan defaults. Given the many references to spreads in this paper, the CDS payment is referred to here as the CDS fee and the CDS fee spread is the difference between the CDS fee for one country versus that for Germany. CDS fees are obtained from Bloomberg.
2. August 9 is also listed on a St. Louis Federal Reserve Bank website chronicling the financial and debt crises. The website is http://timeline.stlouisfed.org/pdf/CrisisTimeline.pdf. The ECB website http://www.ecb.int/ecb/html/crisis.en.html also chronicles events of the Eurozone crises.
3. Daily 10-year government bond rates are from Thomson Reuters, obtained on the *Financial Times* website http://markets.ft.com/research/Markets/Data-Archive, last accessed July 30, 2012. Data for Luxembourg are not included in the dataset.
4. Like Gonzalo and Granger (1995), critical values are taken from Table 1.1* in Osterwald-Lenum (1992). As Banerjee, Dolado, Galbraith and Hendry (1992, pp.

271-275) point out, these critical values apply to models where the intercept enters only the error correction model, which is appropriate for models of interest rates.

5. For these five countries plus Italy and for each of the time intervals in Table 1, ADF tests indicate that each interest-rate series is I(1) at the .05 level. Also, each of the series is a first-order autoregressive process. Thus, Engle and Granger's (1987) Table II critical values are used.
6. The λ_{max} test is the focus here rather than the trace test, given Johansen and Juselius' (1989, p. 19) conclusion that, "One would, however, expect the power of this procedure [the trace test] to be low, since it does not use the information that the last three eigenvalues have been found not to differ significantly from zero. Thus one would expect the maximal-eigenvalue test to produce clearer cut results." Enders (1995, p. 393) makes a similar conclusion.

REFERENCES

Banerjee, A., J. Dolado, J.W. Galbraith, and F.H. David, 1992, *Co-integration, Error Correction, and the Econometric Analysis of Non-stationary Data,* New York: Oxford University Press.

Beirne, J., 2012, "The EONIA Spread Before and During the Crisis of 2007-2009: The Role of Liquidity and Credit Risk," *Journal of International Money and Finance*, 31, 534-551.

Bernoth, K., and E. Burcu, 2012, "Sovereign Bond Yield Spreads: A Time-Varying Coefficient Approach," *Journal of International Money and Finance*, 31, 639-656.

Dickey, D.A., and A.F. Wayne, 1979, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, 74, 423-431.

Dickey, D.A., and A.F. Wayne, 1981, "Likelihood Ratio Statistics for Auto-regressive Time Series with a Unit Root," *Econometrica*, 49, 1057-1072.

Enders, W., 1995, *Applied Econometric Time Series*. New York: John Wiley & Sons.

Engle, R.F., and C.W.J. Granger, 1987, "Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica,* 55, 251-76.

Eichler, S., and H. Kai, 2012, "Does the ECB Act as a Lender of Last Resort During the Subprime Lending Crisis? Evidence from Monetary Policy Reaction Models," *Journal of International Money and Finance*, 2012, 31, 552-568.

Favero, C., and M. Alessandro, 2012, "Sovereign Spreads in the Eurozone: Which Prospects for a Eurobond," *Economic Policy*, 27, 231-273.

Gonzalo, J., and G. Clive, 1995, "Estimation of Common Long-Memory Components in Cointegrated Systems," *Journal of Business and Economic Statistics*, 13, 27-35.

Jappelli, T., and P. Marco, 2010, "Financial Market Integration Under EMU," in *The Euro - The First Decade*, edited by Marco Buti, Servaas Deroose, Vitor Gaspar, and Joao Nogueira Martins. New York: Cambridge University Press, 315-353.

Johansen, S., 1988, "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics and Control*, 12, 231-54.

Johansen, S., and J. Katrina, 1989, *The Full Information Maximum Likelihood Procedure for Inference on Cointegration with Applications*. Institute of Mathematical Statistics Reprint No. 4, University of Copenhagen.

Johansen, S., and J. Katrina, 1990, "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Maltritz, D., 2012, "Determinants of Sovereign Yield Spreads in the Eurozone: A Bayesian Approach," *Journal of International Money and Finance*, 31, 657-662.

Osterwald-Lenum, M., 1992, "A Note with Quintiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics," *Oxford Bulletin of Economics and Statistics*, 54, 461-480.

Patel, A., and S. Gary, 2004, "Term Structure Linkages Surrounding the Plaza and Louvre Accords: Evidence from Euro-Rates and Long-Memory Components," *Journal of Banking and Finance*, 28, 2051-2075.

Pozzi, L., and W. Guido, 2012, "The Time-Varying Integration of Euro Area Government Bond Markets," *European Economic Review*, 56, 36-53.

Reuters, "Brown Fights Backlash Over Northern Rock," February 18, 2008.