Systemic Sovereign Credit Risk: Lessons from the U.S. and Europe

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Overview

- Sovereign credit risk.
  - The ongoing European debt crisis.
  - Recent U.S. Treasury downgrade.
  - Increasing concerns about the solvency of U.S. states.

- The ever widening ripples from these shocks have affected many other financial markets and have raised fears that sovereign credit risk may be far more systemic that previously anticipated.
  - How much of sovereign credit risk is systemic?
  - What drives systemic sovereign credit risk?

Overview

- This paper provides a new perspective on systemic credit risk by studying and contrasting the credit risk of sovereigns within two important currency unions:
  - The Eurozone.
  - The U.S.
- The study makes use of a novel set of sovereign CDS spread data for the U.S. and individual states that has just become available.
- U.S. states are sovereign borrowers since under the U.S. Constitution, they may repudiate their debts without borrowers being able to claim assets in a bankruptcy process.
  - Differs from Municipalities which are subject to Chapter 9.

Overview

- Given that states have tighter fiscal, political, and economic linkages that is the case within the Eurozone, we would expect that there is greater systemic risk among U.S. sovereigns.
- We find that the opposite is true:
  - Only 12% of U.S. sovereign credit risk is systemic.
  - In contrast, 31% of Eurozone credit risk is systemic.
  - Correlations of CDS spreads are higher in Europe.
- Results provide evidence against the hypothesis that tighter macroeconomic linkages lead to higher levels of systemic risk.
  - We must look elsewhere to understand the source of systemic sovereign credit risk.

Overview

- We find that the systemic credit risk of both the U.S. and the Eurozone is strongly related to financial market factors:
  - Systemic risk declines as stock markets rally.
  - Systemic risk declines as corporate bond markets rally.
  - Systemic risk in the U.S. increases as financial firms funding costs increase.
  - Systemic risk in both Europe and the U.S. is tightly linked to China.
  - Increases in market volatility reduces U.S. systemic risk—flight to quality benefits?
- These results suggest that systemic sovereign risk has its roots in financial markets rather than in macroeconomic fundamentals.

Nominal GDP 2009 (millions USD)

United States	14,119,000	Germany	3,330,032
California	1,884,452	France	2,649,390
Texas	1,141,287	Italy	2,112,780
New York	1,085,131	Spain	1,460,250
Florida	729,485	Netherlands	792,128
Illinois	621,101	Belgium	468,522
New Jersey	478,391	Austria	384,908
Ohio	466,021	Greece	329,924
Massachusetts	362,413	Finland	237,512
Michigan	361,126	Portugal	227,676
Nevada	125,115	Ireland	227,193

Sovereign Default

- Little, if no, creditor protection. Countries cannot credibly commit to handing over domestic assets in the event of default.
- Sovereign immunity [has become weaker, esp since FSIA 1976]

  U.S. states have sovereign immunity. Under the 11th amendment to the U.S. constitution, no individual, domestic or foreign, can bring suit against a state [except with that state's consent].
- No formal bankruptcy mechanism

  Ch 9 of the bankruptcy code covers local municipality bankruptcy, but practice differs across states (29 states do not permit Ch 9 filings). No process exists for state bankruptcy.

Sovereign Default

- Previous state defaults:
  - 1830s and 1840s: Arkansas, Florida Territory, Illinois, Indiana, Louisiana, Maryland, Michigan Mississippi, Pennsylvania
  - 1870s and 1880s: Alabama, Arkansas, Florida, Georgia, Louisiana, Minnesota, North Carolina, South Carolina, Tennessee, Virginia
  - 1933: Arkansas
- Previous EMU country defaults:
  - Greece 1932
  - Spain 1936
  - Austria 1945
  - Germany 1948

Data

- CDS data

  CDS are direct measure of credit risk. Sovereign debt spreads are also affected by credit risk, but also interest rates, changes in supply, liquidity effects, etc

  - Weekly frequency
  - 1, 2, 3, 4, 5-year contracts
  - May 14, 2008 to January 5, 2011

- Zero-coupon bonds bootstrapped from LIBOR rates and swap rates

Table 2

Summary Statistics for U.S. and Eurozone Sovereign CDS Spreads. This table reports summary statistics for the five-year CDS spreads for the indicated sovereigns. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

	Mean	Std. Dev.	Min.	Med.	Max.	Serial Corr.	N
California	243.57	81.98	63.00	268.00	402.00	0.962	133
Florida	137.10	50.47	39.00	135.00	240.00	0.960	133
Illinois	187.61	87.32	25.00	191.00	369.00	0.982	130
Massachusetts	120.93	54.67	21.00	124.00	243.00	0.978	134
Michigan	207.45	87.76	45.00	218.00	394.00	0.976	131
Nevada	171.76	73.03	42.00	183.00	329.00	0.967	138
New Jersey	179.06	76.31	33.00	196.00	337.00	0.973	135
New York	176.95	77.19	32.00	196.00	318.00	0.976	131
Ohio	122.04	52.04	35.00	125.00	251.00	0.972	134
Texas	86.82	42.01	20.00	79.00	180.00	0.976	134
USA	38.52	18.06	7.10	37.98	99.26	0.964	139
Austria	82.78	47.29	6.80	77.82	260.90	0.952	136
Belgium	75.63	48.76	10.00	62.01	227.68	0.977	139
Finland	31.04	16.59	5.30	28.98	88.33	0.970	139
France	47.49	26.95	6.75	43.78	108.84	0.975	139
Germany	33.56	17.16	4.40	33.75	90.61	0.959	139
Greece	353.34	316.99	32.19	230.25	1055.41	0.986	139
Ireland	205.94	143.40	17.30	162.48	613.43	0.982	139
Italy	121.86	58.34	24.75	113.68	241.03	0.963	139
Netherlands	44.58	26.38	6.30	41.27	123.33	0.970	139
Portugal	155.43	133.54	21.33	93.84	500.02	0.978	139
Spain	126.61	80.54	24.25	98.83	349.90	0.977	139

Table 3

Correlation Matrix of Weekly Changes in CDS Spreads. The top panel of this table reports the correlation matrix of weekly five-year CDS spread changes for the U.S. sovereigns. The bottom panel reports the correlation matrix of weekly five-year CDS spread changes for the Eurozone sovereigns. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

U.S.	CA	FL	IL	MA	MI	NV	NJ	NY	OH	TX	USA
CA	1.000										
FL	0.425	1.000									
IL	0.657	0.529	1.000								
MA	0.595	0.410	0.653	1.000							
MI	0.678	0.323	0.691	0.773	1.000						
NV	0.610	0.305	0.514	0.647	0.617	1.000					
NJ	0.726	0.352	0.615	0.665	0.683	0.630	1.000				
NY	0.721	0.428	0.648	0.664	0.716	0.668	0.842	1.000			
OH	0.633	0.432	0.722	0.827	0.844	0.637	0.696	0.700	1.000		
TX	0.614	0.351	0.590	0.771	0.748	0.577	0.647	0.572	0.777	1.000	
USA	0.320	0.158	0.197	0.259	0.278	0.283	0.280	0.262	0.270	0.364	1.000
EUROZONE	AUS	BEL	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA
AUS	1.000										
BEL	0.589	1.000									
FIN	0.816	0.649	1.000								
FRA	0.691	0.727	0.664	1.000							
GER	0.745	0.713	0.720	0.820	1.000						
GRE	0.319	0.330	0.327	0.411	0.392	1.000					
IRE	0.650	0.529	0.542	0.544	0.533	0.559	1.000				
ITA	0.573	0.580	0.584	0.597	0.536	0.553	0.675	1.000			
NET	0.716	0.668	0.785	0.587	0.665	0.325	0.548	0.554	1.000		
POR	0.343	0.420	0.358	0.469	0.395	0.771	0.755	0.691	0.398	1.000	
SPA	0.503	0.567	0.493	0.563	0.485	0.727	0.738	0.808	0.560	0.845	1.000

Table 4

Principal Components Analysis Results. This table reports summary statistics for the principal components analysis of the correlation matrix of weekly changes in five-year CDS spreads for the U.S. and Eurozone sovereigns. The correlation matrix is computed using all available overlapping observations for each pairwise correlation.

Region	Principal Component	Percentage Explained	Cumulative Percentage Explained
USA	First	61.83	61.83
	Second	8.45	70.28
	Third	7.48	77.76
Eurozone	First	62.40	62.40
	Second	14.95	77.35
	Third	5.19	82.54

Systemic Risk

- There are many definitions of systemic risk in the literature.
- We use the Duffie and Singleton (2003) multivariate credit model. In this setting, default happens in one of two ways.
  - When a sovereign defaults for country-specific reasons.
  - When an economic shock occurs that could potentially affect all countries. After the shock, each sovereign now has some probability of defaulting, where the probability may differ across sovereigns. Thus, multiple defaults can occur in the wake of a shock. Furthermore, each sovereign's probability of default given a shock measures its degree of systemic risk.

Systemic and Non-Systemic Credit Risk

- Model default as arrival of Poisson processes (see Duffie and Singleton (1997, 1999))
- Non-systemic default intensity:

$$d\xi = (a - b\xi)dt + c\sqrt{\xi}dZ$$

  The coefficients (a, b, c) and Brownian motion Z are sovereign specific, but Z can be correlated across countries. That is, we have correlated idiosyncratic defaults.

- Systemic default intensity:

$$d\lambda = (\alpha - \beta\lambda)dt + \sigma\sqrt{\lambda}dZ_\lambda$$

- When a systemic shock occurs, each sovereign has some sovereign-specific probability γ of defaulting

Systemic and Non-Systemic Credit Risk

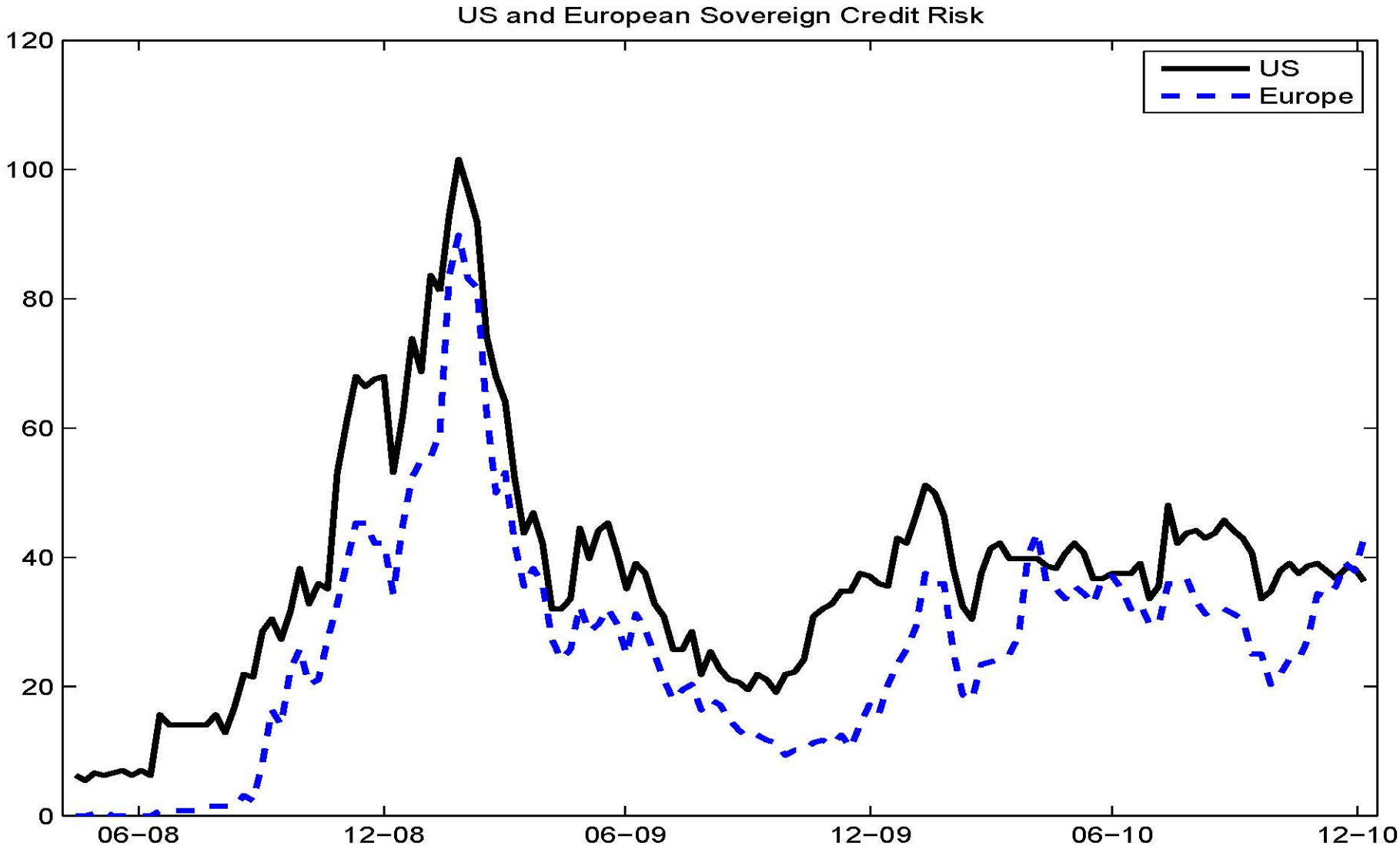
- Default occurs the first time there is an arrival of the sovereign-specific process (with intensity ξ)
- Default occurs with probability γ the first time there is an arrival of the systemic process (with intensity λ), if no previous idiosyncratic default
- Default occurs with probability $(1-\gamma)\gamma$ the second time there is an arrival of the systemic process, if no previous idiosyncratic default
- Default occurs with probability $(1-\gamma)^2\gamma$ the third time there is an arrival of the systemic process, if no previous idiosyncratic default, etc...

Systemic and Non-Systemic Credit Risk

- Probability that no default occurs by time t is:

$$
\begin{aligned}
&= \exp\left(-\int_0^t \xi_s \, ds\right) \left[\sum_{i=0}^{\infty} \frac{1}{i!} \exp\left(-\int_0^t \lambda_s \, ds\right) \left((1-\gamma)\int_0^t \lambda_s \, ds\right.\right. \\
&= \exp\left(-\int_0^t \xi_s \, ds\right) \exp\left(-\int_0^t \lambda_s \, ds\right) \exp\left(\int_0^t (1-\gamma)\lambda_s \, ds\right) \\
&= \exp\left(-\int_0^t \gamma \, \lambda_s + \xi_s \, ds\right)
\end{aligned}
$$

- Thus, the instantaneous default intensity is $\gamma\lambda + \xi$
- Valuation of CDS follows from Longstaff, Mithal and Neis (2005)
- Assume bondholder recovers a fraction $1 - w$, $w = 0.5$ of the par value of the bond in the event of default


US and European Sovereign Credit Risk
120
100
80
60
40
20
0
06–08
12–08
06–09
12–09
06–10
12–10
US
Europe

Systemic Sensitivity γ

- Normalize the value of γ to one for the U.S., so the estimated values for states represent the ratio of the conditional probability of default for the sovereign to the U.S.
- Similar for Germany and EMU countries
- Thus, γ is an index of relative systemic default risk

Table 5

Estimation Results for the CDS Valuation Model Using Federal, State, and Eurozone CDS Spreads. This table reports the parameter estimates and their standard errors obtained by fitting the CDS valuation model to the term structure of CDS spreads for the indicated Federal, State, and Eurozone CDS contracts. For the systemic processes, the parameters reported are α, β, and σ. The RMSEs are measured in basis points. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

	Parameter			Standard Error			
	a	b	c	a	b	c	RMSE
California	0.00250	−0.1768	0.1064	0.00013	0.0114	0.0254	11.790
Florida	0.00306	0.1912	0.0268	0.00015	0.0187	0.2914	9.384
Illinois	−0.00010	−0.0566	0.0096	0.00019	0.0094	0.2592	15.758
Massachusetts	0.00140	0.0813	0.0174	0.00005	0.0068	0.1290	4.115
Michigan	0.00214	0.0549	0.0440	0.00018	0.0151	0.1074	13.448
Nevada	0.00171	−0.0508	0.1724	0.00012	0.0153	0.0246	10.218
New Jersey	0.00092	−0.0332	0.0253	0.00011	0.0135	0.1466	9.505
New York	0.00206	−0.1980	0.0607	0.00009	0.0064	0.0252	7.549
Ohio	0.00108	−0.0796	0.2172	0.00004	0.0043	0.0049	3.595
Texas	0.00091	0.0914	0.0389	0.00007	0.0135	0.1213	5.419
US Systemic	0.00009	−0.4720	0.2868	0.00001	0.0041	0.0020	1.179
Austria	0.00006	−0.0976	0.0506	0.00005	0.0176	0.0901	5.592
Belgium	−0.00019	−0.4646	0.2319	0.00002	0.0091	0.0070	4.181
Finland	0.00033	−0.1356	0.0228	0.00002	0.0188	0.1950	2.253
France	−0.00026	−0.4346	0.2013	0.00001	0.0065	0.0056	1.632
Greece	0.00081	−0.9786	0.5692	0.00022	0.0194	0.0083	51.694
Ireland	0.00115	−0.2562	0.3291	0.00010	0.0083	0.0076	12.742
Italy	0.00136	−0.1176	0.1623	0.00008	0.0166	0.0288	8.904
Netherlands	0.00041	0.0136	0.0954	0.00002	0.0175	0.0571	2.548
Portugal	0.00063	−0.1926	0.2969	0.00012	0.0115	0.0126	16.556
Spain	0.00129	−0.0792	0.2232	0.00009	0.0118	0.0182	10.153
Eurozone Systemic	0.00042	−0.4332	0.2672	0.00002	0.0161	0.0056	2.528

Table 6

Systemic Default Indexes This table reports the estimated value of the systemic default index parameter γ and its standard error for the indicated sovereigns. The value of γ is constrained to be 1.000 for the USA and Germany. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

	Systemic Index	Standard Error
California	2.647	0.045
Florida	0.909	0.035
Illinois	0.000	0.031
Massachusetts	0.468	0.014
Michigan	0.731	0.054
Nevada	0.854	0.043
New Jersey	0.982	0.041
New York	0.000	0.022
Ohio	0.066	0.011
Texas	0.536	0.018
USA	1.000	–
Austria	1.173	0.028
Belgium	1.662	0.014
Finland	0.356	0.007
France	0.933	0.005
Germany	1.000	–
Greece	4.688	0.238
Ireland	1.604	0.049
Italy	1.710	0.037
Netherlands	0.668	0.011
Portugal	1.674	0.057
Spain	1.506	0.036

Table 7

Summary Statistics for the Percentage Systemic Component of U.S. and Eurozone Sovereign Default Risk. This table reports summary statistics for the percentage that the systemic component represents of the total credit risk of the indicated sovereigns. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

	Mean	Std. Dev.	Min.	Med.	Max.	N
California	36.78	13.62	17.60	32.16	92.81	133
Florida	18.18	12.32	5.80	14.53	73.17	133
Illinois	0.00	0.00	0.00	0.00	0.00	130
Massachusetts	10.59	6.02	3.46	9.49	40.07	134
Michigan	8.83	4.33	3.35	7.71	26.76	131
Nevada	13.63	6.24	6.27	12.11	47.64	138
New Jersey	15.05	5.55	7.15	13.59	36.72	135
New York	0.00	0.00	0.00	0.00	0.00	131
Ohio	1.28	0.38	0.62	1.22	2.50	134
Texas	17.73	9.73	5.58	15.42	60.01	134
USA	100.00	0.00	100.00	100.00	100.00	139
Austria	34.31	16.16	0.00	30.76	100.00	136
Belgium	56.87	25.23	0.00	67.67	89.97	139
Finland	39.75	22.20	0.00	33.49	100.00	138
France	53.15	23.70	0.00	55.99	92.58	139
Germany	100.00	0.00	100.00	100.00	100.00	139
Greece	44.48	30.24	0.00	35.00	100.00	138
Ireland	16.77	9.82	0.00	15.30	45.71	139
Italy	31.84	15.36	0.00	31.32	71.60	139
Netherlands	39.79	21.10	0.00	34.27	100.00	138
Portugal	32.84	26.78	0.00	22.24	96.01	139
Spain	28.24	19.53	0.00	22.32	79.74	139

Table 8

Regression Results for Systemic Risk. This table reports the t-statistics and other summary statistics from the regression of weekly changes in the systemic credit process on the indicated variables. Mkt denotes the return on the S&P500 for the US, and the return on the DAX for Europe. VIX denotes the weekly change in the VIX volatility index. Corp denotes the weekly change in the CDX IG index for the US, and the weekly change in the ITraxx index for Europe. Japan, China, and EM denote the weekly changes in the CDS spreads for the respective sovereigns or sovereign indexes. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

Region	Intercept	Mkt	Swap	VIX	Corp	Japan	China	EM	R^2	N
US Systemic	0.55	-4.31^{**}	2.60^{**}	-2.83^{**}	1.80^{*}	1.64	1.80^{*}	-0.50	0.352	138
Eurozone Systemic	0.56	-1.97^{**}	-0.61	-1.60	1.86^{*}	1.44	2.67^{**}	1.02	0.431	138

Table V

Regression Results

This table reports the slope coefficient and associated Newey–West t-statistics from the regression of monthly changes in the estimated marginal tax rate on the indicated explanatory variables.

Explanatory Variable	Coefficient	t-Statistic
Intercept	−0.00257	−0.44
S&P 500 Return	0.70723	3.01
Treasury bond return	1.00414	1.85
Commodity index return	−0.20760	−2.03
Personal income growth	−0.02583	−1.64
Inflation rate	0.29538	0.37
Change in unemployment	0.04108	0.78
Industrial production growth	−0.24283	−0.29
R^2		0.1880
Number of observations		98

Table 9

Credit Clusters. This table reports the clusters formed on the basis of the correlation matrix of the weekly changes in the nonsystemic sovereign credit processes. The pairwise correlations in the correlation matrix are computed using all available overlapping observations for each pair.

Region	Cluster 1	Cluster 2	Cluster 3
USA	Illinois Massachusetts Michigan Ohio Texas	California Nevada New Jersey New York	Florida
Eurozone	Greece Ireland Italy Portugal Spain	Austria Finland Netherlands	Belgium France

What Drives Sovereign-Specific Credit Risk?

- Explanatory power of financial variables is generally lower for sovereign-specific risk
  - The average R^2 across U.S. states is 0.12, compared to 0.35 for systemic risk
  - The average R^2 for EMU non-German countries is 0.18, compared to 0.43 for systemic risk
- Corporate CDS is significantly positive for all but one of the European sovereigns, but this plays little role for U.S. states
- Stock market returns are significant for several states: Florida, New Jersey, New York, Ohio. They are significant only for Austria in Europe.

Table 10

Regression Results for the Sovereign-Specific Credit Processes. This table reports the t-statistics and other summary statistics from the regression of weekly changes in the sovereign-specific credit processes on the indicated variables. Mkt denotes the return on the S&P500 for the US, and the return on the DAX for the Eurozone. VIX denotes the weekly change in the VIX volatility index. Corp denotes the weekly change in the CDX IG index for the US, and the weekly change in the ITraxx index for Europe. Japan, China, and EM denote the weekly changes in the CDS spreads for the respective sovereigns or sovereign indexes. The sample consists of weekly observations for the May 14, 2008 to January 5, 2011 period.

Region	Intercept	Mkt	Swap	VIX	Corp	Japan	China	EM	R^2	N
California	0.48	−0.31	−2.51**	−0.31	0.13	−0.50	−0.08	−1.11	0.094	132
Florida	0.14	−1.77*	−2.11**	−0.82	−2.07**	0.55	−3.52**	−3.17**	0.136	132
Illinois	1.45	−1.64	−1.39	−0.07	−1.66*	−0.84	0.81	−1.54	0.135	129
Massachusetts	0.73	−1.50	−0.89	−1.50	−0.13	1.19	−0.40	−1.24	0.074	133
Michigan	0.51	−0.63	−1.84*	−1.44	0.08	0.66	−0.03	−1.57	0.113	130
Nevada	0.70	−0.93	−0.19	−0.56	0.68	−0.47	−0.33	−1.41	0.089	137
New Jersey	0.44	−2.56**	−1.62	−2.41**	−0.99	0.05	0.19	−1.58	0.132	134
New York	0.33	−1.95*	−1.13	−1.66*	−1.75*	0.36	0.71	−3.19**	0.217	130
Ohio	0.94	2.35**	−0.80	1.83*	2.63**	−0.58	2.81**	2.69**	0.144	133
Texas	0.31	−0.18	−1.10	−0.31	0.02	1.96**	−0.11	−0.89	0.082	133
Austria	0.04	−2.21**	−0.62	−2.49**	1.98**	1.36	0.76	0.12	0.336	135
Belgium	1.52	0.85	−0.97	−0.86	1.78*	−0.51	−0.91	−0.97	0.061	138
Finland	−0.21	−0.83	−0.58	−0.85	1.99**	0.37	0.96	0.67	0.281	137
France	1.37	0.47	−1.52	0.74	2.01**	−0.07	−2.83**	−1.41	0.147	138
Greece	1.42	1.34	−1.01	−1.69*	1.42	−0.72	−2.05**	−1.73*	0.086	137
Ireland	1.70*	−1.32	−2.20**	−2.13**	2.24**	0.06	0.41	0.71	0.184	138
Italy	0.78	−0.63	−2.34**	−0.74	2.71**	−0.82	−1.17	−0.13	0.232	138
Netherlands	0.15	−0.52	0.05	−1.32	1.85*	1.03	1.22	0.53	0.177	137
Portugal	0.94	0.96	−2.56**	−0.55	1.87*	−1.27	−1.03	0.65	0.161	138
Spain	1.33	−0.02	−1.84*	−1.36	2.26**	−0.98	−1.06	−0.59	0.146	138

Conclusions

- Examine the nature of systemic sovereign credit risk by examining CDS contracts on the U.S., states, and major EMU countries
- Systemic risk represents a much larger fraction of total credit risk for Europe than for the U.S.: this rejects the hypothesis that systemic risk is due to common macroeconomic fundamentals
- U.S. and European systemic credit risk are highly correlated and both are strongly related to financial market variables. This suggests that systemic risk may arise through financial channels.
- U.S. systemic risk is negatively related to aggregate volatility. This is consistent with the U.S. being a "reserve" asset.