

Interdependencies across Sovereign Bond Credit Default Swap Markets

April 2017

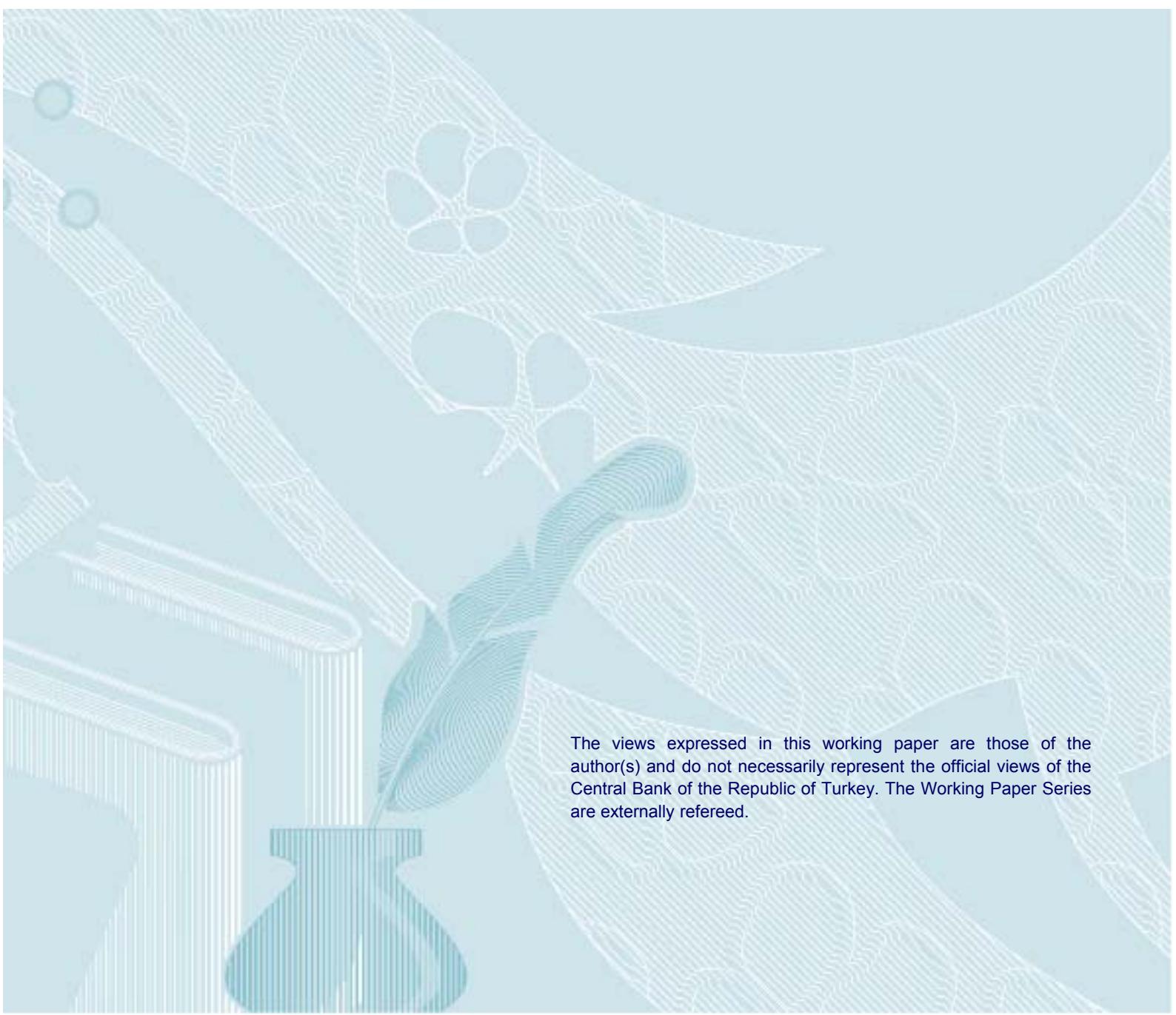
Derya Ezgi KAYALAR
İrem TALASLI
İbrahim ÜNALMIŞ

© Central Bank of the Republic of Turkey 2017

Address:
Central Bank of the Republic of Turkey
Head Office
Structural Economic Research Department
İstiklal Caddesi No: 10
Ulus, 06050 Ankara, Turkey

Phone:
+90 312 507 80 04

Facsimile:
+90 312 507 57 33



The views expressed in this working paper are those of the author(s) and do not necessarily represent the official views of the Central Bank of the Republic of Turkey. The Working Paper Series are externally refereed.

Interdependencies across Sovereign Bond Credit Default Swap Markets

Derya Ezgi Kayalar

İrem Talaslı

İbrahim Ünalı

Central Bank of the Republic of Turkey

Abstract

This paper investigates the dependence structures between sovereign credit default swap (CDS) spreads of fifteen countries for the period of January 2005-July 2015. We employ copula approach to conduct this analysis as it enables us to analyze dependence structure separately from univariate characteristics of the series and to model a richer dependence structure by utilizing a broad range of distribution functions. Our results demonstrate that dependence structures are similar among majority of the pairs and in most of the countries lower and upper tail dependencies show similar behavior. This result contradicts with the findings that asset prices tend to move together more during times of negative shocks. The second finding of the paper is that sovereign CDS spreads, adjusted for global risk aversion, show positive dependence for all country pairs yet with varying degrees. There are country groups showing high average and tail dependence. Dependence between most of the emerging markets is found to be high on average yet it is low between emerging market and advance economies. We argue that similarities in credit quality gauged by credit ratings and carry trade returns of international investors may lead to the observed interdependence structures of CDS spreads.

Keywords: Sovereign CDS market, copula approach, dependence structure

JEL Classification: G10, G15, G11.

1. Introduction

Credit default swap (CDS) contracts provide a hedge for credit risk in case of a default. Though sovereign CDS contracts are relatively new financial instruments their market size has expanded considerably, especially in the aftermath of the 2008 global financial crisis. According to Bank for International Settlements' (BIS) over the counter derivatives market statistics notational outstanding sovereign CDS contracts in the second half of 2007 was amounting to 1 trillion US dollar yet increased to 3 trillion US dollar in the second half of 2011 and declined to 2 trillion US dollar in the second half of 2015. Since CDS contracts transfer credit risk from buyer of the contract to the seller of the contract in exchange for the payment of a fee, CDS spreads are basically used as a proxy for default probability of the borrower.

In case of sovereign CDS contracts, interdependence between the country spreads or default probabilities indicates spillover of regional or country specific shocks to other countries. For example, during taper tantrum in May 2013, many countries' sovereign CDS spreads had increased with varying degrees. In 2014, due to a conflict between Russia and Ukraine, sovereign spreads of some emerging countries had increased altogether. Therefore, having knowledge about how rising risks in a country could affect the risk perception towards other countries would have implications for policy makers and financial market participants. Common movements of sovereign CDS spreads are investigated in a number of studies. Longstaff et al. (2011) examines the nature of commonality in sovereign external debt CDS spreads of 26 developed and less developed countries. Employing principle component and multivariate cluster analysis they conclude that sovereign credit spreads are driven primarily by common external factors and portfolios in the sovereign debt market might be less diversified than generally believed. Gündüz and Kaya (2014) present potential spillover effects in the CDS spreads of 10 Eurozone countries utilizing dynamic conditional correlation approach. They highlight the existence of a co-movement of CDS spread changes for all of the examined countries. Boyrie and Pavlova (2015) examine the interactions of BRICS (Brazil, Russia, India, China and South Africa) and MIST (Mexico, Indonesia, South Korea and Turkey) countries' sovereign CDS spreads. They use generalized vector autoregressive framework and principle component analysis and find significant spillover effects between countries.

Not only degree of dependence but also structure of dependence may also matter for policy makers and investors. This is due to the fact that dependence in the tail events or symmetric or asymmetric tail dependence may have different implications than average dependence in CDS spreads. For example, country pairs could show low dependence on average yet their dependence could increase significantly during turbulent times. From the point of view of a portfolio manager this is an important piece of information because risk of a portfolio or probability of loss during turbulent times increases. On the political front, as stated earlier by Fischer (1998) and Dornbusch et al (2000), later on Blanchard et al. (2014) and Gelos and Surti (2016), identifying international spillovers and implementing relevant reforms to reduce interdependence across international financial markets should be one of the key priorities of reforming international financial architecture agenda to reduce the catastrophic effects of a financial crisis in a systemically important country on other countries.

There are a limited number of papers, revealing the importance of dependence structure of CDS spreads and conduct analyses on it. As an example, Chen et al. (2011) examine dependence between selected Latin American sovereign CDS spreads through the Argentinean default in 2001 using copula approach. Their study reveals increased dependence among four major Latin American countries during the crisis period. They also show that degree of credit contagion was related to the creditworthiness of the country. Caporin et al (2013) investigate the dependence of CDS returns of major Eurozone countries for the period of 2008 and 2011 using quantile regression. They find that dependence between the movements of CDS returns is not a function of size and sign of the movement implying the linkage among countries are the same during normal and turbulent times.

Considering the above mentioned importance of dependence structure in sovereign CDS markets, this paper contributes to the literature by investigating the dependence structure of sovereign CDS spreads of fifteen countries. Specifically, we analyze tail comovement structure as well as average dependencies for each country pairs. Having these results, we discuss whether there are country groups showing similar dependence structure with similar sovereign country rating.

Countries, included in our data set comprising 70 percent of the outstanding volume of the CDS contracts in the global financial markets. CDS spreads are filtered using VIX and VSTOXX to remove the effect of global risk aversion on comovement of pairs. Our findings in

Table 3.2 show that dependence structures are similar among majority of the pairs. For most of the series, significant tail dependence is verified as Gaussian models rarely chosen. Although there are pairs showing asymmetric tail dependence most pairs are found to conform to symmetric tail dependence. For example, most of the EME sovereign CDS spreads show tail dependence, both in the upper and lower part, meaning that EME sovereign CDS spreads are highly correlated against positive and negative shocks and with similar magnitudes. This result contradicts with the findings on stock markets showing that markets move together more during times of negative shocks¹. Our findings also imply that analysis based on simple correlations between sovereign CDS spreads may be misleading since this method ignores tail correlation². Additionally, by using the copula approach rather than conditional correlations we avoid the multivariate normality assumption for the joint return distributions. After modeling marginal distributions we test a wide range of possible dependence structures by using different copulas.

Besides the findings related to dependence structures we find that sovereign CDS spreads, adjusted for global risk aversion, show positive dependence for all country pairs yet with varying degrees. Our analysis reveals that there are country groups showing high average and tail dependence. We identify four groups of countries. Pairs in these groups have high average and tail dependence. We investigate the possible factors that may lead to this grouping. We argue that rather than bilateral linkages, similarities in credit quality (macroeconomic fundamentals and economic soundness) gauged by credit ratings and carry trade returns of international investors may lead to the observed interdependence structures of CDS spreads.

The rest of the paper is organized as follows. Section two describes the data and methodology. Section three outlines the results and section four concludes.

2. Data and Methodology

Our sample includes 15 countries that have the highest outstanding CDS contracts constituting approximately 70 percent of the sovereign CDS market both in gross notional

¹ For a detailed discussion on asymmetric comovement of stock prices see Li (2014) and Hu (2006).

² For detailed discussion of pitfalls of linear correlation Embrechts et al. (2002) and Segoviano and Goodhart (2009). For possible drawbacks of conditional correlation Forbes and Rigobon (2002).

and net notional amounts outstanding³. The sample includes both advanced and emerging market economies namely; Brazil (BR), China (CH), France (FR), Germany (GE), Hungary (HU), Indonesia (IN), Italy (IT), Japan (JA), Republic of Korea (KO), Mexico (ME), Portuguese (PO), Russia (RU), South Africa (SA), Spain (SP) and Turkey (TU). To ensure the consistency in price discovery, instead of daily closing values, equally weighted weekly averages are used. 5-year US dollar CDS spread data collected for the time interval January 2005 – July 2015 (i.e. 548 observations for each series). Additionally, VIX, implied volatility index of S&P 500 Index options and VSTOXX, implied volatility index of EURO STOXX 50 Index are used in the modeling of country spreads' marginal distributions.

Returns are calculated as the logarithmic differences between the week t and t-1. Summary statistics of CDS returns of 15 countries and returns of VIX and VIXSTOXX series are given in Table 2.1. As seen in Table 2.1 all of the series show positive skewness and kurtosis, indicating the probability distribution of each series is asymmetric, and fat-tailed. The Jarque-Bera statistics shown in the last column reject the normality hypothesis for all of the series at 1% significance level.

Table 2.1. Descriptive statistics of CDS returns

	Mean	Std Dev	Skewness	Kurtosis	p (JB)x10 ³
Brazil	-0,0004	0,0781	0,9194	8,2747	0,712
China	0,0025	0,0813	1,3421	14,7067	3,294
France	0,0043	0,1090	1,5577	25,3296	1,161
German	0,0024	0,1141	0,8619	26,1205	1,227
Hungary	0,0040	0,0789	0,6865	8,2444	0,671
Japan	0,0036	0,0859	1,0390	9,5524	1,079
Indonesia	-0,0013	0,0751	0,2298	11,3154	1,583
Italy	0,0053	0,0828	0,4219	4,9513	0,103
Korea	0,0010	0,0828	0,2285	11,6309	1,706
Mexico	0,0008	0,0811	0,9817	9,2040	0,967
Portugal	0,0068	0,0887	0,1497	7,0863	0,383
Russia	0,0016	0,0885	0,5606	10,7885	1,414
South Africa	0,0024	0,0732	0,8540	7,3841	0,505
Spain	0,0064	0,0784	0,2284	4,7942	0,078
Turkey	-0,0001	0,0691	0,0621	8,1345	0,602
VIX	0,0005	0,0990	0,4339	4,7782	0,089
VIXSTOXX	0,0014	0,0944	0,5484	4,5759	0,084

³ Outstanding amounts data is taken from Depository Trust and Clearing Corporation (DTCC) and sample countries are the chosen among the ones with highest outstanding gross notentials according to end year values of years 2011- 2014 and end of the first half of 2015 value.

2.1. Copula Function and Measure of Dependence

A copula function links univariate marginal distributions to form a multivariate distribution function. Sklar (1959) shows that any multivariate distribution can be reformed as marginal distributions of each series and a copula function that captures the dependence between these marginal distributions. We only discuss the bivariate case in the context of our paper.

Sklar's Theorem. Let F_{XY} be a joint distribution function with marginals F_X and F_Y . Then there exists a copula C such that for all x, y in \mathbb{R}

$$F_{XY}(x, y) = C(F_X(x), F_Y(y)) \quad (1)$$

As long as the marginal distributions are continuous the copula function C is unique. Since copula can link any marginal distributions without functional form limitations, it provides a great flexibility in the modeling of individual series' distributions. Copulas also characterize the dependence between the tails of the marginal distributions. Intuitively, upper (lower) tail dependence refers to the relative amount of mass in the upper (lower) quantile of the distribution (Ning, 2010). Upper and lower tail index values provide information about the likelihood of joint occurrence of extreme events in the individual series. The left (lower) and right (upper) tail dependence coefficients are defined as

$$\lambda_L = \lim_{u \rightarrow 0} P[F_Y(y) \leq u | F_X(x) \leq u] = \lim_{u \rightarrow 0} \frac{C(u, u)}{u} \quad (2)$$

$$\lambda_U = \lim_{u \rightarrow 1} P[F_Y(y) \geq u | F_X(x) \geq u] = \lim_{u \rightarrow 1} \frac{1 - 2u + C(u, u)}{1-u} \quad (3)$$

where λ_L and $\lambda_U \in [0, 1]$. X and Y are upper (lower) tail dependent if and only if $\lambda_U > 0$ ($\lambda_L > 0$). If $\lambda_U = 0$ ($\lambda_L = 0$) variables are tail independent.

2.2 Marginal Models

Since copula framework enables a high degree of flexibility, parametric copula estimation can be done with two-stage maximum likelihood estimation as it is suggested in Patton (2006). Firstly, we select and estimate the models that provide the best fit for the individual variables. The statistics given in Table 2.1 indicate high levels of kurtosis auto correlation and fat tails in the return series and serially correlated return volatilities. In

order to solve these issues ARMA(1,1) and t-GARCH(1,1) specifications are used in the modeling of marginal distributions. It is confirmed that the specified model sufficiently captures the listed characteristics of the return series and produces independent and identically distributed (i.i.d.) residuals necessary for the copula function estimation. In order to be sure that the copula function reveals only the country specific dependence structure and is not derived by other common factors like the changes in global risk perception, we added the returns of VIX and VSTOXX as external variables into the mean equations. While VIX is the most commonly used global risk indicator, since our sample also includes European and associated countries like Turkey, VSTOXX is found to have relatively higher explanatory power for some of the countries. The mean and variance equations for CDS spread returns $r_{i,t}$ for $i \in C(BR, CH, FR, GE, HU, IN, IT, JA, KO, ME, PO, RU, SA, SP, TU)$ and $t=1, \dots, 548$ are;

$$r_{i,t} = \phi_0 + \phi_1 r_{i,t-1} + \epsilon_{i,t} + \phi_2 \epsilon_{i,t-1} + \phi_3 r_{vix,t} + \phi_4 r_{v2x,t} \quad (4)$$

where $r_{vix,t}$ and $r_{v2x,t}$ are the logarithmic changes in VIX and VSTOXX in the t^{th} week and it is assumed that the white noise process $\epsilon_{i,t}$ follows a Student-t distribution with degrees of freedom v_i for every $i \in C$;

$$\sqrt{\frac{v}{\sigma_{i,t}^2(v-2)}} \epsilon_{i,t} \sim i.i.d. t_{v_i} \quad (5)$$

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_1 \sigma_{i,t-1}^2 + \alpha_2 \epsilon_{i,t-1}^2. \quad (6)$$

2.3 Copula Models of Conditional Dependence Structure

The specification of the copula function determines the structure of the dependence between the variables. Among the various types we concentrate on five copula functions which allow us to investigate tail dependence or independence and symmetry or asymmetry in the joint distribution of the variables. The Gaussian copula is a natural starting point with its symmetric distribution and zero tail dependence. The bivariate Gaussian copula is defined as

$$C_G(u, v; \rho) = \phi_\rho(\phi^{-1}(u), \phi^{-1}(v)) \quad (7)$$

where ϕ_ρ is the bivariate standard normal cumulative distribution function (cdf) with the correlation coefficient ρ between the variables and ϕ^{-1} is the inverse of the standard

normal cdf. The dependence parameter $\rho \in (-1,1)$ indicates independence of the variables for the values around zero. The Gaussian copula has zero tail dependence i.e. $\lambda_U = \lambda_L = 0$. The second alternative, Student-t copula is defined as

$$C_T(u, v; \rho, \nu) = t_{\rho, \nu}(t_\nu^{-1}(u), t_\nu^{-1}(v)) \quad (8)$$

with bivariate Student-t cdf $t_{\rho, \nu}$ where ρ is the correlation parameter similar to the Gaussian copula, ν is the degrees of freedom parameter and t_ν^{-1} is the inverse Student-t distribution. Student-t copula allows for symmetric tail dependence, that is occurrence of joint extreme positive or negative realizations have the same probability; $\lambda_U = \lambda_L = 2t_{\nu+1}(-\sqrt{\nu+1}\sqrt{1-\rho}/\sqrt{1+\rho}) > 0$. The third dependence specification used is the Clayton copula,

$$C_{CL}(u, v; \theta) = \max\left((u^{-\theta} + v^{-\theta} - 1)^{-\frac{1}{\theta}}, 0\right) \quad (9)$$

has asymptotic lower tail dependence as the major characteristics. For tail parameter $\theta \in [-1, \infty) \setminus \{0\}$, $\lambda_L = 2^{-1/\theta}$ and $\lambda_U = 0$. While the mass in the Clayton copula's left tail significantly higher than the mass in its right tail, the Gumbel copula has greater dependence in the upper tail than the lower tail. The Gumbel copula is given by

$$C_G(u, v; \beta) = \exp\left(-((-log u)^\beta + (-log v)^\beta)^{-\frac{1}{\beta}}\right) \quad (10)$$

The tail parameter, $\beta \in [1, \infty)$ is equal to 1 when the variables are independent. The tail indexes are $\lambda_U = 2 - 2^{-\frac{1}{\beta}}$ and $\lambda_L = 0$. Lastly, the symmetrized Joe-Clayton (SJC) copula is used to capture possible significant and different lower and upper tail dependencies (Patton, 2006) and symmetric tail dependence is contained as a nested case. The SJC copula is defined as

$$C_{SJC}(u, v; \lambda_U, \lambda_L) = 0.5(C_{JC}(u, v; \lambda_U, \lambda_L) + C_{JC}(1-u, 1-v; \lambda_U, \lambda_L) + u + v - 1) \quad (11)$$

The Joe-Clayton copula (JC) is defined as

$$C_{JC}(u, v; \lambda_U, \lambda_L) = 1 - \left(1 - \{[1 - (1-u)^\kappa]^{-\gamma} + [1 - (1-v)^\kappa]^{-\gamma} - 1\}^{-\frac{1}{\gamma}}\right)^\kappa \quad (12)$$

where $\kappa = 1/\log_2(2 - \lambda_U)$, $\gamma = -1/\log_2(\lambda_L)$ and $\lambda_L \in (0,1)$, $\lambda_U \in (0,1)$.

3. Empirical Results

3.1 Results of Marginal Models

The estimation results for the individual CDS return series modeled as in the Eq. (4) – (6) are given in the Table 3.1. Although our base model is ARMAX(1,1, [r_{VIX}, r_{V2X}])-GARCH(1,1), insignificant autoregressive or moving average lags are dropped from the marginal country models. However, to ensure the consistency interpretation, independent from their significance levels both of the exogenous volatility measures are kept in equations.

Table 3.1. Estimation results of marginal Models

	Const.	AR(1)	MA(1)	r _{VIX}	r _{V2X}	GARCH	Lagged	Lagged	Deg.
	ϕ_0	ϕ_1	ϕ_2	ϕ_3	ϕ_4	α_0	α_1	α_2	of Freedom
Brazil	-0.003	-0.326**	0.567*	0.183*	0.187*	0.000	0.194*	0.675*	7.72*
China	-0.002	-0.271***	0.465*	0.034	0.162*	0.000	0.118**	0.883*	2.76*
France	-0.003	0.068***		-0.006	0.170*	0.000	0.320*	0.656*	3.45*
German	-0.002	0.088**		-0.048	0.188*	0.001	0.435	0.736*	2.46*
Hungary	-0.001		0.378*	-0.026	0.230*	0.000	0.251*	0.679*	4.72*
Indonesia	-0.005		0.110*	0.036	0.182*	0.000	0.290**	0.650*	2.95*
Italy	-0.001		0.233*	-0.043	0.261*	0.000	0.185*	0.797*	4.08*
Japan	-0.006	0.213*		0.051***	0.090*	0.000	0.363*	0.740*	2.88*
Korea	-0.004	-0.289**	0.566*	0.019	0.181*	0.000	0.335*	0.710*	2.98*
Mexico	-0.004	-0.310**	0.546*	0.181*	0.164*	0.001	0.182*	0.708*	4.75*
Portugal	0.000		0.264*	-0.038	0.169*	0.001	0.342*	0.587*	3.94*
Russia	-0.003		0.253*	0.105**	0.285*	0.000	0.221*	0.590*	7.39*
S. Africa	-0.003	-0.300**	0.556*	0.089*	0.180*	0.000	0.185*	0.753*	6.44*
Spain	-0.001	-0.340***	0.521*	0.008	0.084*	0.000	0.175*	0.864*	4.86*
Turkey	-0.002	-0.412**	0.586*	0.112*	0.240*	0.000	0.234*	0.454*	14.57***

* , ** and *** indicates 1%, 5% and 10% significance respectively.

According to the Table 3.1 for seven of the fifteen return series both AR and MA coefficients are significant. For all of the CDS return series VSTOXX has highly significant explanatory power while VIX is significant only for Brazil, Mexico, Russia, South Africa, Turkey and Japan. In the variance equations, first lag of squared residuals and variance terms are significant for all of the countries and ARCH test applied to the residuals states that GARCH (1, 1) is enough to capture the conditional heteroscedasticity in the series. Significant Student-t distribution degrees of freedom values indicate heavy tails for the series.

As it is discussed the copula model is a function of the marginal distributions. Therefore its explanatory and indicative power depends on the correct specification and validity of the marginal models. If the marginal distributions are not correct, their probability transforms, u_i for $i \in C$ will not be i.i.d. uniform (0,1) (Ning, 2010). Similar to Patton (2006) we applied Lagrange Multiplier and Kolmogorov-Smirnov tests and confirm that the probability transform of the standardized residuals are serially independent and distributed uniformly. Moreover, following Diebold et al. (1998), we examine the correlograms of $(u_i - \bar{u}_i)^k$ for $k = 1, 2, 3, 4$ where \bar{u}_i is the mean of the probability transform of the i^{th} series. Both the visual examination and Ljung-Box Q-statistics confirm that there is no autocorrelation up to 10 lags in the defined series⁴. These results are sufficient enough to conclude that our marginal models are not misspecified and we can continue with copula modeling.

3.2 Results of Copula Models

Six copula models, namely Gaussian, Student-t, Clayton, Gumbel, Symmetrized Joe Clayton (SJC) and nested Symmetrized Joe Clayton (SJCc) (where upper and lower tail dependence parameters are set equal) are applied for each country pair. As 15 countries are used in the study, 105 pairs are analyzed. Firstly, parameter estimates from the copula models are given. Best fitting copulas and their implications for the structure of dependence are analyzed in the next part. Next, association of the country pairs is discussed.

Parameter estimates of six copulas are given in Appendix A. For all pairs, dependence parameters are positive in all copula models. Dependence parameters extracted from

⁴ Test results are available upon request.

Gaussian (Table A.1.) and Student-t (Table A.2.) copula models are close as expected since these models have both elliptical margins.

Looking at dependence parameters from the estimated copula models (Appendix A), one can see that there are country groups in which each member have high dependence parameter values with other countries in the group. More discussion on this grouping is given in 3.4.

For all of the pairs, the dependence parameters of Gaussian (Table A.1.), Student-t (Table A.2.), Clayton (Table A.3.), and Gumbel (Table A.4.) copulas are significant at 5% significance level⁵. For some pairs, the parameters of SJC (Table A.5) are insignificant. These pairs are mostly the pairs that are expected to have dependence on average but not on extreme cases. However, when the upper and lower tail dependence parameters are set equal in SJCC model (Table A.6.), the parameters mostly turn to significant. Given in Table A.2. degrees of freedom (DoF) parameters of the Student-t copula vary between 3 and 63; the lower values indicate extreme co-movements and tail dependence while higher values imply Gaussian structure.⁶ Pairs with high dependence parameters also have low DoF estimates, indicating a tail dependence structure. The pairs having high DoF are usually the ones consist of an EU and a non-European EME. France-Russia, France-Brazil, France- South Africa, Italy- China, Italy-Korea, Portugal-China, Portugal-Korea are some examples. This finding is also valid for the significance of DoF parameter. Generally, the pairs of EU countries with EMEs have insignificant DoF at 5% significance level.

The calculated tail dependence parameters are given in the Appendix B⁷. Upper (lower) tail dependence parameter measures the dependence between CDS spread returns of the two countries when both of them are extremely large (small). Therefore, the high upper (lower) tail dependence parameter implies association of CDS spreads when returns are high (low), thus when the risks are increasing (decreasing). Pairs with high overall dependence parameter have also high tail dependence whereas less (overall) dependent series have low tail dependence or do not have tail dependence at all. Also, series with low

⁵ T-statistics are not given to save space but available upon requested.

⁶ Computing Student-t parameters, the maximum value of DoF parameter is set as 100; the pairs with values higher than 100 are modeled with Gaussian copula. Accordingly, France-Turkey, France- Mexico, France-China and, France-Indonesia pairs are modeled with Gaussian copula since their DoF estimates are greater than 100.

⁷ Dependence parameters extracted directly from SJC and SJCC models are the tail dependence parameters.

tail dependence are the ones with high or insignificant DoF parameter of Student-t copula (Table B.1 and Table A.2).

3.3 Goodness of Fit Tests

Copula models produce dependence parameters according to their functional forms. Thus, it is important to find the best fitting model to the data. For this purpose, we use several copula models differing in their dependence assumptions. Being both elliptic models, Gaussian copula assumes no tail dependence while Student-t copula accounts for symmetric tail dependence. Among Archimedean copulas, we include Clayton copula which accounts for only lower tail dependence, Gumbel copula that assumes only upper tail dependence, Symmetrized Joe-Clayton model for asymmetric tail dependence and nested Symmetrized Joe-Clayton model for symmetric tail dependence. Thus, we try to cover all possible dependence structures among pairs. Once we select the best fitting model, than we can identify the dependence structure and association degree of the related pair.

AIC and BIC values shown in Appendix C, Table C.1 and C.2 give inconclusive results to pick the best model, thus following Hu (2003) further research is conducted by constructing contingency tables using observed and predicted frequencies. This method is referred as the empirical copula test for the rest of the paper. For constructing observed frequency tables probability transforms of the series are used. The probability range $[0,1]$ is divided into k even parts, $k = 10$ in this study. For each bivariate probability transformed series $(u(t), v(t)) t \in [0, T]$, a $k \times k$ matrix is constructed. Then all elements of the bivariate time series is distributed such that each cell of the matrix gives the number of observed pairs in the respective range.

This matrix reflects empirical dependence structure. If two series are positively correlated, then majority of the observations lie on the diagonal. If they are independent, then numbers of observations in each cell are about the same, if they are negatively correlated, then most observations lie on the diagonal connecting the upper-right and lower-left corner (Hu, 2003). Also, if there is positive lower tail dependence, more observations lie in cell (1,1); if there is positive upper tail dependence, more observations lie in cell (10,10).

Pearson chi-square test is used to measure the goodness of fit between the joint empirical distribution of the series pairs and corresponding fitted copula distributions.

When $A_{i,j}$ and $B_{i,j}$ denote the number of observed and predicted frequencies in cell (i,j) respectively, the Pearson χ^2 statistics is calculated as:

$$D = \sum_i^k \sum_i^k \frac{(A_{i,j} - B_{i,j})^2}{B_{i,j}} \quad (13)$$

where D follows χ^2 distribution with $(k - 1)^2$ degrees of freedom.

The results of the χ^2 test are given in Table C.3. Generally, statistics calculated for Student-t, SJC and SJCc models is below the χ^2 test statistics of 5% confidence level which is equal to 101.89. However, Gaussian, Gumbel and Clayton models for most of the pairs perform poorly. The model with the lowest χ^2 statistic is chosen as the best fitting model.

Table 3.2 summarizes our findings. Lower diagonal part shows the best model based on empirical copula test while upper diagonal part gives the related dependence parameters. First, second and third row gives the dependence parameter, upper tail and lower tail dependence parameters respectively. As seen from the Table 3.2, significant tail dependence is verified since models assuming tail dependence is chosen as the best fitting model for most of the series and Gaussian model is rarely chosen. It may be expected that most pairs would show asymmetric tail dependence with a higher upper tail dependence parameter, since there exists a remarkably large literature stating that asset prices move together after a negative shock but their responses could differ in case of a positive one in stock markets (Hu (2003), Li (2014)). According to Table 3.2. 33 pairs out of 105 show asymmetric tail dependence. CDS spreads, as a measure of risk does not have the same asymmetry of asset price co-movements⁸. This result implies that positive and negative shocks affect spreads of countries in a similar magnitude in most cases. Symmetric tail behavior is also found by Caporin et al. (2013) for CDS market.

3.3 What may explain the country groups?

We find that sovereign CDS spreads, adjusted for global risk aversion, show positive dependence for all country pairs yet with varying degrees. Our analysis reveals that there are country groups in which each member have high dependence parameter values with other countries in the group. Four groups of countries can be identified. First one is “Emerging Asia” group, consisting of China, Korea and Indonesia. Second one is “Other EMEs” group

⁸ Besides the results for filtered series with VIX and VSTOXX given, models are applied to non-filtered series and similar results are found. However, dependence parameters are usually higher.

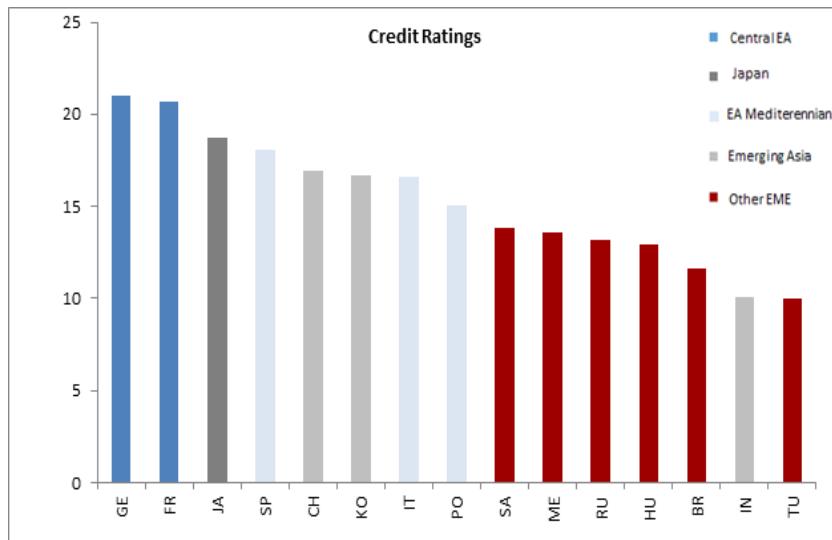
that includes Turkey, Russia, Brazil, Mexico, South Africa, and Hungary. Third group consists of Italy, Spain, and Portugal. The last group is the "Central European countries" consisting of Germany and France. Pairs in these groups not only have high average dependence but also have high tail dependence. Another finding is average dependence between AEs and EMEs is generally low. Also, tail dependencies between EMEs and AE pairs are generally very low and insignificant. Correlation coefficients between the other countries and Japan are quite close and low. Hence, it is hard to associate Japan with any of these country groups.

In this part, we investigate the possible underlying factors of comovements in the CDS spreads. Similarities in economic fundamentals, trade or portfolio investment links, and investments of international investors may govern the correlations. Accordingly, we first check if credit ratings as composite indicator of economic fundamentals and soundness may provide an explanation. Further analysis is done based on bilateral trade and financial exposures of the countries as well as bilateral portfolio investment interdependencies. Finally we check carry trade activities.

To assess the relation with credit ratings, we convert long term foreign currency sovereign ratings of three credit rating agencies (Moody's, S&P and Fitch) to numerical values. Ratings from "C" to "AAA" are matched with numbers from 1 to 21. Average credit rating is calculated for each country for the period of January 2005 – July 2015. Figure 3.1 shows sorting of credit ratings along with CDS spread correlations (Kendall's rank correlation). Assuming country ratings represent all related information on macroeconomic fundamentals and soundness, we argue that similarities in macroeconomic fundamentals and soundness may have a role in explaining the comovements in CDS spreads.

Figure 3.1. Credit Ratings vs Dependence Levels

a. Credit Ratings



Source: Bloomberg

b. Kendall's Rank Correlations*

	BR	CH	FR	GE	HU	IN	IT	JA	KO	ME	PO	RU	SA	SP	TU
BR		0.49	0.26	0.23	0.47	0.48	0.25	0.17	0.47	0.83	0.20	0.64	0.65	0.22	0.68
CH			0.32	0.27	0.41	0.58	0.33	0.35	0.78	0.53	0.30	0.52	0.55	0.32	0.53
FR				0.60	0.34	0.19	0.50	0.27	0.27	0.28	0.46	0.30	0.34	0.54	0.33
GE					0.29	0.21	0.37	0.18	0.27	0.21	0.34	0.27	0.30	0.38	0.29
HU						0.39	0.42	0.19	0.40	0.48	0.33	0.52	0.58	0.39	0.51
IN							0.21	0.27	0.59	0.49	0.22	0.48	0.54	0.18	0.54
IT								0.20	0.30	0.23	0.64	0.27	0.33	0.70	0.29
JA									0.32	0.23	0.16	0.21	0.24	0.19	0.21
KO										0.50	0.29	0.49	0.50	0.31	0.49
ME											0.20	0.65	0.64	0.21	0.63
PO											0.23	0.27	0.67	0.26	
RU												0.69	0.26	0.74	
SA													0.31	0.74	
SP														0.23	
TU															

*Table is formatted to emphasize higher correlations.

As a possible underlying factor of comovements in the CDS spreads, bilateral trade and financial exposures of the countries are examined. Table 3.2 presents the average share of the countries given in rows in total foreign trade (merchandise exports+imports) of the countries shown in columns over 2005-2015. For instance Brazil's exports to China and imports from China constitute 13% of its total foreign trade. While for China, Brazil's share in total foreign trade is 1.8%. The table indicates relative dominance of China and Germany in general and higher intra-region linkages in Euro Area and East Asia. Bilateral foreign trade exposures cannot identify the Other EMEs group extracted from the CDS analysis.

Table 3.2. Bilateral Foreign Trade Shares (%)^{*}

	BR	CH	FR	GE	HU	IN	IT	JA	KO	ME	PO	RU	SA	SP	TU
BR		1.8	0.8	1.0	0.2	0.9	1.0	0.9	1.2	1.3	1.6	0.8	1.3	1.1	0.6
CH	13.1		5.3	6.4	3.5	11.9	4.3	19.4	20.5	7.4	2.0	9.0	10.9	4.5	6.0
FR	2.2	1.4		8.7	4.5	0.9	10.0	1.3	1.0	0.7	9.5	2.6	2.2	14.2	4.5
GE	5.1	4.4	16.3		26.2	2.1	14.3	2.9	2.9	2.5	12.7	8.0	8.9	12.0	10.0
HU	0.1	0.2	0.7	1.9		0.1	1.0	0.2	0.2	0.1	0.4	1.3	0.3	0.6	0.6
IN	0.7	1.4	0.3	0.3	0.1		0.4	2.8	2.3	0.2	0.1	0.3	0.7	0.5	0.5
IT	2.5	1.3	8.0	5.7	4.8	1.1		0.9	0.9	0.9	4.7	5.8	2.2	7.5	5.7
JA	3.3	9.6	1.8	2.0	1.3	14.2	1.2		10.2	2.9	0.6	3.6	6.5	1.3	1.2
KO	2.6	7.1	0.8	1.1	1.1	6.5	0.8	6.1		2.1	0.3	2.7	1.9	0.7	1.7
ME	2.1	0.8	0.4	0.6	0.3	0.3	0.5	0.9	1.2		0.4	0.2	0.4	1.5	0.2
PO	0.6	0.1	1.0	0.7	0.3	0.1	0.7	0.1	0.1	0.1		0.2	0.2	5.6	0.3
RU	1.6	2.0	1.9	3.4	5.2	0.6	3.0	1.7	1.9	0.2	0.7		0.3	1.9	8.7
SA	0.6	1.0	0.3	0.7	0.2	0.4	0.5	0.7	0.4	0.1	0.3	0.1		0.4	0.7
SP	1.7	0.8	7.2	3.3	2.2	0.8	5.1	0.5	0.5	1.3	28.8	1.2	1.6		2.9
TU	0.4	0.5	1.3	1.5	1.1	0.6	1.9	0.2	0.6	0.1	0.7	3.3	0.6	1.6	

Source: International Trade Center

*Table is formatted to emphasize the higher shares.

In a similar way bilateral portfolio investment interdependencies of the countries are explored in Table 3.3. It shows the average share of each country in the total portfolio asset and liability stock of the countries identified in the columns for the 2005- 2015 period. While France and Germany have the highest shares in each other's total portfolio investments, they are also the dominant actors for other European countries. However, for the emerging economies, country groupings according to CDS dependencies are not confirmed by the international portfolio exposures. Moreover, the last two rows of the table indicate for most of the countries US and UK have higher shares than the others.

Table 3.3. Bilateral Foreign Trade Shares (%)^{*}

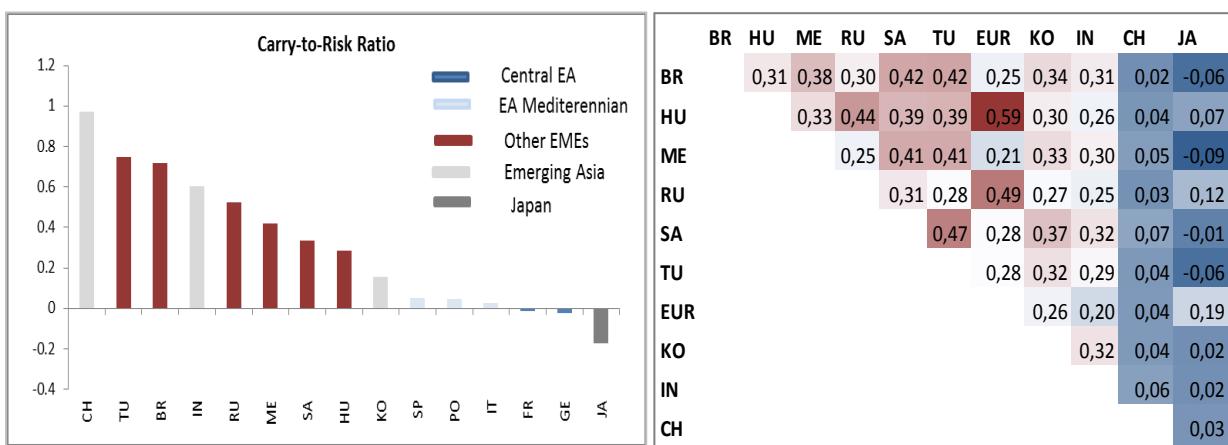
	BR	CH	FR	GE	HU	IN	IT	JA	KO	ME	PO	RU	SA	SP	TU
BR		0.1	0.1	0.1	0.0	0.0	0.1	0.4	1.1	0.3	0.8	0.0	0.2	0.4	0.0
CH	0.3		0.3	0.2	0.3	2.0	0.1	0.5	2.6	0.3	0.2		0.3		0.6
FR	1.6	1.4		10.8	4.4	0.9	16.9	6.4	3.2	1.4	15.6	2.7	0.9	18.1	2.1
GE	1.8	1.0	11.2		15.3	1.8	12.0	4.7	1.6	2.5	11.5	2.9	2.0	14.5	4.3
HU	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
IN	0.0	0.3	0.0	0.0			0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
IT	0.8	0.1	8.2	5.7	1.2	0.5		1.6	0.4	0.8	7.8	0.6	0.3	7.3	1.2
JA	3.8	2.6	5.4	3.8	1.4	4.0	2.8		4.7	4.2	1.4	1.3	1.7	2.0	2.9
KO	1.3	1.6	0.3	0.2	0.2	0.5	0.1	0.5		0.3	0.0	0.7	0.2	0.1	0.2
ME	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.3	0.1		0.0	0.0	0.1	0.1	0.0
PO	0.7	0.0	1.1	0.8	0.1	0.0	0.9	0.1	0.0	0.0		0.0	0.1	2.1	0.1
RU	0.0		0.1	0.1	0.4	0.0	0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.1
SA	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1		0.0	0.0	0.0
SP	2.3		5.7	4.5	0.8	0.0	4.6	0.7	0.2	1.0	10.5	0.1	0.0		0.2
TU	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	
UK	12.3	5.7	8.5	7.5	10.2	7.8	7.2	8.3	10.1	7.2	5.9	13.5	32.5	7.5	16.3
US	42.8	21.3	11.7	10.1	16.8	31.1	7.5	35.7	37.6	57.9	5.0	28.9	32.8	9.0	26.8

Source: IMF CIPS, Haver

*Table is formatted to emphasize higher shares.

Considering the possibility of common international investors, carry trade activities can also lead to the observed comovements in the case of relatively high yielding currencies. According to Pavlova and Boyrie (2015), for the Asian markets carry trade returns and changes in sovereign CDS index are negatively correlated and there exists bidirectional causality between them. In this context, we explore whether a relatively high degree of comovement in countries' CDS spreads corresponds to similar carry trade indicators. In order to determine the attractiveness of the carry trade we use carry-to-risk ratios⁹ which measures the ex-ante risk adjusted profitability of a carry trade position (Curcuru et. al., 2010). As it is shown on the left panel of Figure 3.4, all emerging market economies have carry-to-risk ratios higher than the advanced economies¹⁰. While the indicator diverges for emerging Asia countries, it takes values between 0.29-0.75 for the other emerging economies. Being a funding currency rather than a carry trade currency Japanese yen has the lowest ratio. On the right panel Kendall's tau correlations of the carry trade returns are represented. These values are comovement degrees of the carry trade index returns after global risk indicators, autoregressive structure and volatility clustering in the series are taken into consideration¹¹. Although, carry return dependencies are not as high as the CDS returns, countries, grouped under the Other EMEs category, show relatively higher correlations. Therefore, common third party investors might lead to the observed interdependence structures in case of the emerging market countries.

Figure 3.4. Carry -to-Risk Ratios and Carry Return Rank Correlations



Source: Bloomberg

⁹ The ratio is defined as the 3 month interest rate differential between the currency and US dollar divided by the implied volatility of 3 month at-the-money exchange rate option. In order to make a distinction between the euro area countries the difference between 3 month government bond yield differential is used.

¹⁰ Indicator does not accurate for China, since the managed floating regime applied by the country supresses the implied volatility to very low levels and there are regulatory obstacles to the free trade of the yuan.

¹¹ Carry returns are the percentage change in Bloomberg carry return indices against US dollar. In order to uniformity of the series Euro area is represented by the single return of euro.

The indicators above imply that bilateral linkages cannot be the sole determinant of the observed interdependence structures in CDS spreads. Similarities in countries' macroeconomic fundamentals and soundness gauged by their credit ratings and carry trade returns of the respective currencies may play a role as the factors affecting third party investors' behaviour.

4. Conclusion

This paper aims to fill a gap in the literature by analyzing dependence structure of the sovereign CDS spreads of fifteen countries which cover almost 70 percent of the outstanding global CDS market. We use copula approach as it enables us to cover several possible dependence structures. Our results show that dependence structures are similar among majority of the pairs. Although there are pairs showing asymmetric tail dependence most pairs are found to conform to symmetric tail dependence. This result implies that positive and negative shocks tend to affect country spreads in similar magnitude. This result contradicts with the findings on stock markets arguing that stock markets tend to move together more during times of negative shocks. We also find that sovereign CDS spreads, adjusted for global risk aversion, show positive dependence for all country pairs with varying degrees. Four country groups are found to show high average and tail dependence. We argue that rather than bilateral linkages, similarities in credit quality (macroeconomic fundamentals and economic soundness) gauged by credit ratings and carry trade returns of international investors may lead to the observed interdependence structures of CDS spreads.

References

- Chen, C.Y., Wang,K. and Tu, A.H., 2011. Default correlation at the sovereign level: evidence from some Latin American markets. *Applied Economics*, Volume 43, Issue 11, 1399-1411.
- Curcuru, S., Vega, C. and Hoek, J. , 2010. Measuring carry trade activity. *IFC Bulletin*, No: 25, 436.
- De Boyrie, M.E.and Pavlova, I., 2016. Dynamic interdependence of sovereign credit default swaps in BRICS and MIST countries. *Applied Economics*, Volume 48, Issue 7, 563-575.
- Diebold, F.X., Gunther, T.A. and Tay, A.S., 1998. Evaluating density forecasts with application to financial risk management. *International Economic Review*, Volume 39, No. 4, 863-883.
- Embrechts, P., McNeil, A. J. and Straumann, D., 2002. Correlation and dependence in risk management: Properties and pitfalls. *Risk Management: Value at Risk and Beyond* Cambridge University Press, 176–223.
- Forbes K. andRigobon, R., 2002. No contagion, only interdependence: Measuring stock market comovements. *Journal of Finance*, Volume 57, Issue 5, 2223-2261.
- Gündüz, Y. and Kaya, O., 2014. Impacts of the financial crisis on Eurozone sovereign CDS spreads. *Journal of International Money and Finance*, Volume 49, Part B, 425-442.
- Hu, L., 2003. Dependence patterns across financial markets: A mixed copula approach. *Applied Financial Economics*, Volume 16, Issue 10, 717-729.
- IMF, 2013. Global Financial Stability Report: Old Risks, New Challenges. International Monetary Fund, 57-92.
- Li, F., 2014. Identfyng Asymmetric comevement of international stock markets. Volume 12, No. 3, 507-543.
- Longstaff, F.A., Pan, J., Pedersen, L.H. and Singleton, K.J., 2011. How sovereign is sovereign Credit Risk? *American Economic Journal: Macroeconomics*, Volume 3, No. 2, 75–103.
- Ning, C.,2010. Dependence structure between the equity market and the foreign exchange market - A copula approach. *Journal of International Money and Finance*, Volume 29, 743–759.
- Patton, A.J., 2006. Modelling asymmetric exchange rate dependence. *International Economic Review*, Volume 47, No. 2, 527-556.
- Pavlova, I. and de Boyrie, M. E., 2015. Carry Trades and Sovereign CDS Spreads: Evidence from Asia-Pacific Markets. *Journal of Futures Markets*, Volume 35, Issue 11, 1067-1087.

Segoviano, M.A. and Goodhart, C. 2009. Banking Stability Measures. IMF Working Paper No 09/04. International Monetary Fund.

Sklar, A., 1959. Fonctions de répartition à n dimensions et leurs marges. Publications de l’Institut de Statistique de l’Université de Paris, 8, 229-231.

Table 3.2. Best Fitting Models and Parameter Estimation of the Related Models

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy		-	-	-	0.7317	0.5174	0.4230	-	0.3298	-	-	0.2145	-	-	0.2114
		0.0255	0.0621	0.0224	0.4590	0.2920	0.2641	0.0053	0.0006	0.1183	0.1194	0.0248	0.4127	0.2358	0.0252
		0.2308	0.1678	0.1695	0.4590	0.2920	0.2641	0.1714	0.0006	0.1183	0.1958	0.0248	0.5286	0.2358	0.0252
Turkey	SJC		0.7642	0.6879	0.2443	-	-	-	0.5360	0.5004	0.7497	0.2205	0.2678	-	0.5587
			0.4235	0.1577	0.0558	0.0947	0.1310	0.4508	0.0933	0.2001	0.1817	0.0801	0.0194	0.3191	0.1154
			0.4235	0.1577	0.0558	0.1777	0.1310	0.4175	0.0933	0.2001	0.1817	0.0801	0.0194	0.3191	0.1154
Russia	SJC	t	0.6520	-	0.3040	-	-	-	0.5247	-	0.7049	0.2113	0.2372	0.5466	0.4941
			0.3185	0.1022	-	0.0657	0.5149	0.1725	0.1725	0.3802	0.3032	0.0805	0.0223	0.0986	0.1290
			0.3185	0.1022	-	0.1484	0.4013	0.1725	0.1725	0.2696	0.3032	0.0805	0.0223	0.0986	0.1290
Brazil	SJC	t	t	0.2289	0.2615	0.2335	0.8397	0.5030	14.577	0.6461	0.1798	0.2010	0.4703	0.5082	
				0.0494	-	0.0051	0.5491	0.0870	0.3912	-	0.0051	0.0310	-	0.1291	
				0.0494	-	0.0051	0.5491	0.0870	-	-	0.0051	0.0310	-	0.1291	
Spain	t	t	SJCc	t		0.5602	0.3964	-	0.3285	0.3194	0.3208	0.2132	0.6919	0.3970	-
						0.2157	0.0848	0.0449	0.0315	0.0073	0.0540	0.0161	0.4052	0.0458	0.0588
						0.2157	0.0848	0.0905	0.0315	0.0073	0.0540	0.0161	0.4052	0.0458	0.0332
France	t	SJC	Gaussian	Gaussian	t		0.6639	0.2803	-	0.2727	-	0.2712	0.4917	-	0.1887
							0.4515	-	0.0982	-	0.1627	-	0.2467	0.1272	-
							0.4515	-	0.1665	-	0.1627	-	0.2467	0.2106	-
German	t	SJCc	SJC	t	t	t		-	-	-	-	0.1993	-	-	-
								0.0650	0.0872	0.1115	0.1016	0.0623	0.2605	0.0739	0.0641
								0.0650	0.1504	0.1115	0.1800	0.0623	0.1147	0.1876	0.0606
Mex	SJC	SJC	SJC	t	SJC	Gaussian	SJCc		-	-	-	-	0.2007	0.4758	0.5076
									0.3834	0.3775	0.3982	0.1307	0.0651	-	0.1540
									0.3108	0.2546	0.4917	0.0504	0.0651	-	0.1540

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
China	t	t	t	t	t	SJC	SJC	SJC		0.7964	-	0.3631	-	-	0.6147
										0.4981	0.3988	0.1776	0.0563	0.2608	0.3194
										0.4981	0.3172	0.1776	0.1872	0.1868	0.3194
Korea	SJCc	t	SJC	Gumbel	t	Gaussian	SJCc	SJC		-	0.3204	0.2919	1.3442	-	-
										0.3622	0.1202	-	0.3253	0.4445	-
										0.2782	0.1202	-	-	-	0.3596
Soaf	SJC	t	t	Gaussian	t	SJCc	SJC	SJC		0.2388	0.2638	0.5940	0.5534	-	-
										0.0943	0.0257	0.1762	0.1741	-	-
										0.0943	0.0257	0.1762	0.1741	-	-
Jgb	t	t	t	t	t	Gaussian	t	SJC		-	0.1712	0.2040	0.2829	-	-
										t	0.0174	0.0499	0.1347	-	-
										t	0.0174	0.0499	0.1347	-	-
Portug	SJC	t	t	t	t	t	SJC	t		-	0.0518	0.0216	-	-	-
										SJC	-	0.2473	0.1330	-	-
										Gaussian	t	t	t	-	-
Hungary	SJCc	SJCc	t	Gaussian	t	SJC	SJC	Gaussian		-	SJC	-	-	-	-
										SJC	-	-	-	-	-
										Gumbel	t	t	t	-	-
Indon	t	t	t	t	SJC	Gaussian	SJC	t		SJC	t	t	SJC	t	-
										-	-	-	-	-	-
										-	-	-	-	-	-

Lower diagonal part shows the best model based on empirical copula test while upper diagonal part gives the related dependence parameters. First, second and third row gives the dependence parameter, upper tail and lower tail dependence parameters respectively.

APPENDIX A

Table A.1.Gaussian Copula Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.2935														
Russia	0.2685	0.7388													
Brazil	0.2489	0.6781	0.6365												
Spain	0.7016	0.2346	0.2578	0.2247											
France	0.4975	0.3252	0.3040	0.2615	0.5420										
German	0.3748	0.2929	0.2683	0.2254	0.3761	0.6023									
Mex	0.2304	0.6322	0.6533	0.8305	0.2068	0.2803	0.2113								
China	0.3270	0.5294	0.5168	0.4930	0.3196	0.3154	0.2747	0.5281							
Korea	0.2952	0.4897	0.4944	0.4675	0.3124	0.2727	0.2653	0.4970	0.7750						
Soaf	0.3313	0.7423	0.6893	0.6461	0.3134	0.3449	0.2985	0.6426	0.5497	0.5030					
Jgb	0.1979	0.2115	0.2089	0.1745	0.1907	0.2712	0.1821	0.2269	0.3482	0.3234	0.2359				
Portug	0.6446	0.2643	0.2305	0.1956	0.6654	0.4592	0.3447	0.1953	0.2987	0.2919	0.2650	0.1578			
Hungary	0.4231	0.5081	0.5223	0.4703	0.3896	0.3355	0.2876	0.4758	0.4123	0.3968	0.5767	0.1876	0.3336		
Indon	0.2100	0.5405	0.4770	0.4828	0.1838	0.1887	0.2084	0.4871	0.5779	0.5924	0.5368	0.2749	0.2247	0.3923	

Table A.2. Student-t Copula Dependence and Degrees of Freedom Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy		9.00	7.61	9.25	3.32	3.62	3.15	9.68	28.20	63.24	11.01	9.77	4.06	11.69	9.62
Turkey	0.3000		4.68	11.28	7.23	100.00	10.68	9.66	10.18	5.22	12.92	5.93	11.61	7.02	9.50
Russia	0.2807	0.7642		4.82	10.92	24.58	13.08	7.65	6.40	4.48	6.13	5.77	10.44	10.11	7.46
Brazil	0.2518	0.6879	0.6520		7.53	33.02	15.91	3.90	9.89	6.74	12.82	14.41	8.80	15.79	7.78
Spain	0.7317	0.2443	0.2664	0.2289		5.79	7.95	9.54	11.00	17.00	8.54	11.07	3.74	10.74	13.59
France	0.5174	0.3306	0.3089	0.2657	0.5602		2.69	100.00	100.00	15.84	26.77	23.85	4.05	7.47	100.00
German	0.4230	0.3045	0.2766	0.2335	0.3964	0.6639		17.18	7.66	10.93	7.77	6.35	5.28	8.54	16.16
Mex	0.2297	0.6389	0.6574	0.8397	0.2028	0.2852	0.2151		6.05	5.80	10.42	6.66	6.18	15.99	6.82
China	0.3298	0.5360	0.5247	0.5030	0.3285	0.3206	0.2810	0.5328		3.89	8.05	4.26	37.34	18.01	4.12
Korea	0.3002	0.5004	0.5058	0.4848	0.3194	0.2774	0.2726	0.5043	0.7964		6.50	5.37	38.96	10.80	6.74
Soaf	0.3264	0.7497	0.7049	0.6539	0.3208	0.3504	0.3113	0.6460	0.5557	0.5135		5.41	10.41	7.64	6.96
Jgb	0.2145	0.2205	0.2113	0.1798	0.2132	0.2821	0.1993	0.2412	0.3631	0.3204	0.2388		10.05	7.05	4.69
Portug	0.6605	0.2678	0.2372	0.2010	0.6919	0.4917	0.3717	0.2007	0.3027	0.2967	0.2638	0.1712		17.87	12.73
Hungary	0.4300	0.5336	0.5466	0.4786	0.3970	0.3405	0.2979	0.4808	0.4188	0.4104	0.5940	0.2040	0.3413		7.60
Indon	0.2114	0.5587	0.4941	0.5082	0.1881	0.1921	0.2131	0.5076	0.6147	0.6076	0.5534	0.2829	0.2222	0.4171	

Lower part of the diagonal shows dependence parameters. upper part of the diagonal shows degrees of freedom parameters.

Table A.3. Clayton Copula Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.4319														
Russia	0.3708	1.5514													
Brazil	0.3451	1.1751	1.0217												
Spain	1.6270	0.3095	0.3347	0.2877											
France	0.7655	0.4025	0.3790	0.3009	0.8393										
German	0.4970	0.3850	0.3449	0.2729	0.5109	1.2452									
Mex	0.3291	1.0379	1.0693	2.0588	0.2554	0.3056	0.2425								
China	0.4018	0.7371	0.7515	0.6435	0.4020	0.3886	0.3576	0.7687							
Korea	0.3460	0.6631	0.7048	0.5994	0.3520	0.3119	0.3328	0.6832	1.8714						
Soaf	0.4314	1.5718	1.3297	1.1826	0.3944	0.4297	0.3988	1.1715	0.8021	0.7110					
Jgb	0.2409	0.2757	0.2654	0.1841	0.2479	0.3211	0.2293	0.2580	0.4552	0.4013	0.2867				
Portug	1.2902	0.3402	0.2955	0.2148	1.2912	0.6743	0.4193	0.2324	0.3881	0.3427	0.3135	0.2147			
Hungary	0.6108	0.7656	0.7778	0.7013	0.5144	0.4515	0.3878	0.7089	0.5151	0.4630	0.9476	0.2606	0.4696		
Indon	0.2520	0.8230	0.6951	0.6719	0.1931	0.2116	0.2330	0.6872	0.9003	0.9434	0.7942	0.3303	0.2874	0.5164	

Table A.4. Gumbel Copula Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	1.2035														
Russia	1.1956	2.1432													
Brazil	1.1638	1.8458	1.8089												
Spain	1.9694	1.1660	1.1798	1.1541											
France	1.5022	1.2222	1.2135	1.1741	1.5633										
German	1.3653	1.2173	1.1902	1.1506	1.3129	1.7514									
Mex	1.1436	1.7127	1.7941	2.7137	1.1349	1.1858	1.1427								
China	1.2292	1.5134	1.5051	1.4691	1.2363	1.2166	1.1983	1.5262							
Korea	1.2055	1.4883	1.4976	1.4577	1.2307	1.1939	1.1874	1.4886	2.3090						
Soaf	1.2368	2.0207	1.8920	1.7134	1.2346	1.2617	1.2233	1.7064	1.5543	1.4868					
Jgb	1.1375	1.1539	1.1498	1.1181	1.1259	1.1893	1.1323	1.1787	1.3051	1.2603	1.1754				
Portug	1.7768	1.1796	1.1521	1.1376	1.8768	1.4600	1.3071	1.1372	1.1937	1.1968	1.1837	1.0917			
Hungary	1.3398	1.5007	1.5206	1.3974	1.3153	1.2579	1.2056	1.3983	1.3451	1.3442	1.6016	1.1307	1.2316		
Indon	1.1395	1.5357	1.4371	1.4577	1.1238	1.1055	1.1374	1.4677	1.6860	1.6529	1.5470	1.2233	1.1371	1.3426	

Table A.5. Symmetrized Joe Clayton Copula Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy		0.0255	0.0621	0.0224	0.4389	0.3421	0.2956	0.0053	0.1275	0.1148	0.1194	0.0441	0.4127	0.1656	0.0533
Turkey	0.2308		0.5801	0.4897	0.0539	0.0947	0.0858	0.4508	0.3663	0.3765	0.4888	0.0629	0.0610	0.3091	0.3407
Russia	0.1678	0.5393		0.5369	0.0638	0.0963	0.0657	0.5149	0.3653	0.3802	0.4823	0.0563	0.0404	0.3194	0.2988
Brazil	0.1695	0.4541	0.3517		0.0556	0.0889	0.0522	0.7285	0.3736	0.3728	0.3734	0.0608	0.0711	0.2081	0.3310
Spain	0.6101	0.1319	0.1397	0.1123		0.3641	0.1798	0.0449	0.1283	0.1698	0.1353	0.0064	0.4839	0.1937	0.0588
France	0.3280	0.1777	0.1564	0.0998	0.3550		0.3959	0.1136	0.0982	0.1286	0.1493	0.0859	0.3386	0.1272	0.0163
German	0.1699	0.1729	0.1484	0.0978	0.2261	0.5154		0.0659	0.0872	0.0907	0.1016	0.0425	0.2605	0.0739	0.0641
Mex	0.1714	0.4175	0.4013	0.5944	0.0905	0.0887	0.0640		0.3834	0.3775	0.3982	0.1307	0.0540	0.2253	0.3413
China	0.1624	0.2963	0.3025	0.2151	0.1648	0.1665	0.1504	0.3108		0.6085	0.3988	0.2352	0.0563	0.2608	0.4873
Korea	0.1218	0.2467	0.2696	0.1816	0.0983	0.0934	0.1321	0.2546	0.6151		0.3622	0.1905	0.1099	0.2990	0.4445
Soaf	0.1958	0.5790	0.5149	0.5029	0.1585	0.1753	0.1800	0.4917	0.3172	0.2782		0.1005	0.1019	0.3439	0.3843
Jgb	0.0735	0.1005	0.0982	0.0264	0.1009	0.1102	0.0688	0.0504	0.1666	0.1489	0.0974		0.0000	0.0108	0.1647
Portug	0.5286	0.1455	0.1238	0.0503	0.5077	0.2641	0.1147	0.0821	0.1872	0.1248	0.1133	0.1010		0.0518	0.0216
Hungary	0.2950	0.3293	0.3235	0.3313	0.2207	0.2106	0.1876	0.3330	0.1868	0.1167	0.4151	0.1159	0.2473		0.2507
Indon	0.0857	0.3480	0.2887	0.2548	0.0332	0.0645	0.0606	0.2664	0.3110	0.3596	0.3143	0.1075	0.1330	0.1925	

Lower part of the diagonal shows lower tail dependence parameters. upper part of the diagonal shows upper tail dependence parameters.

Table A.6. Nested Symmetrized Joe Clayton Copula Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.1322														
Russia	0.1173	0.5603													
Brazil	0.0971	0.4722	0.4558												
Spain	0.5377	0.0934	0.1022	0.0833											
France	0.3352	0.1376	0.1269	0.0942	0.3597										
German	0.2362	0.1310	0.1082	0.0743	0.2035	0.4605									
Mex	0.0854	0.4346	0.4620	0.6711	0.0675	0.1008	0.0650								
China	0.1451	0.3329	0.3354	0.3013	0.1466	0.1331	0.1191	0.3485							
Korea	0.1183	0.3154	0.3281	0.2854	0.1353	0.1109	0.1115	0.3194	0.6118						
Soaf	0.1585	0.5374	0.4990	0.4440	0.1469	0.1627	0.1413	0.4477	0.3605	0.3223					
Jgb	0.1250	0.0818	0.0777	0.0426	0.0493	0.0983	0.0554	0.0890	0.2013	0.1695	0.0988				
Portug	0.4762	0.1044	0.0814	0.0604	0.4961	0.3027	0.1911	0.0680	0.1229	0.1171	0.1073	0.0334			
Hungary	0.2358	0.3191	0.3213	0.2734	0.2077	0.1715	0.1318	0.2814	0.2249	0.2156	0.3814	0.1250	0.1547		
Indon	0.0694	0.3444	0.2940	0.2958	0.1250	0.0390	0.1250	0.3060	0.4114	0.4056	0.3514	0.1356	0.0757	0.2223	

APPENDIX B

Table B.1. Student-t Copula Tail Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.0455														
Russia	0.0591	0.4235													
Brazil	0.0328	0.1577	0.3185												
Spain	0.4590	0.0558	0.0235	0.0494											
France	0.2920	0.0000	0.0011	0.0001	0.2157										
German	0.2641	0.0298	0.0135	0.0051	0.0848	0.4515									
Mex	0.0271	0.1563	0.2179	0.5491	0.0246	0.0000	0.0030								
China	0.0006	0.0933	0.1725	0.0870	0.0315	0.0000	0.0586	0.1862							
Korea	0.0000	0.2001	0.2375	0.1453	0.0073	0.0071	0.0242	0.1850	0.4981						
Soaf	0.0295	0.1817	0.3032	0.1128	0.0540	0.0011	0.0642	0.1454	0.1424	0.1645					
Jgb	0.0248	0.0801	0.0805	0.0051	0.0161	0.0010	0.0623	0.0672	0.1776	0.1202	0.0943				
Portug	0.3557	0.0194	0.0223	0.0310	0.4052	0.2467	0.1408	0.0651	0.0001	0.0000	0.0257	0.0174			
Hungary	0.0441	0.1570	0.0986	0.0270	0.0458	0.0755	0.0493	0.0267	0.0117	0.0483	0.1762	0.0499	0.0070		
Indon	0.0252	0.1154	0.1290	0.1291	0.0070	0.0000	0.0039	0.1540	0.3194	0.2117	0.1741	0.1347	0.0112	0.0967	

Table B.2.Clayton Copula Tail Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.2009														
Russia	0.1543	0.6397													
Brazil	0.1341	0.5544	0.5074												
Spain	0.6531	0.1065	0.1260	0.0899											
France	0.4043	0.1787	0.1606	0.0999	0.4379										
German	0.2479	0.1652	0.1341	0.0789	0.2575	0.5731									
Mex	0.1217	0.5128	0.5230	0.7141	0.0663	0.1035	0.0574								
China	0.1781	0.3905	0.3976	0.3406	0.1783	0.1680	0.1439	0.4059							
Korea	0.1349	0.3516	0.3740	0.3146	0.1396	0.1084	0.1246	0.3626	0.6905						
Soaf	0.2005	0.6434	0.5938	0.5565	0.1724	0.1992	0.1758	0.5534	0.4214	0.3772					
Jgb	0.0563	0.0809	0.0734	0.0232	0.0610	0.1154	0.0487	0.0681	0.2181	0.1778	0.0891				
Portug	0.5844	0.1303	0.0958	0.0397	0.5846	0.3577	0.1914	0.0507	0.1676	0.1323	0.1096	0.0396			
Hungary	0.3215	0.4044	0.4102	0.3722	0.2599	0.2154	0.1674	0.3762	0.2604	0.2238	0.4812	0.0700	0.2286		
Indon	0.0639	0.4308	0.3689	0.3564	0.0276	0.0378	0.0510	0.3647	0.4630	0.4796	0.4178	0.1226	0.0897	0.2613	

Table B.3. Gumbel Copula Tail Dependence Parameters Estimation Results

	Italy	Turkey	Russia	Brazil	Spain	France	German	Mex	China	Korea	Soaf	Jgb	Portug	Hungary	Indon
Italy															
Turkey	0.2212														
Russia	0.2145	0.6182													
Brazil	0.1859	0.5442	0.5330												
Spain	0.5782	0.1879	0.2005	0.1768											
France	0.4137	0.2368	0.2296	0.1954	0.4420										
German	0.3385	0.2328	0.2097	0.1735	0.3045	0.5145									
Mex	0.1667	0.5011	0.5284	0.7090	0.1582	0.2058	0.1659								
China	0.2425	0.4191	0.4151	0.3971	0.2481	0.2322	0.2167	0.4252							
Korea	0.2229	0.4068	0.4114	0.3912	0.2437	0.2129	0.2072	0.4070	0.6499						
Soaf	0.2486	0.5908	0.5575	0.5014	0.2469	0.2678	0.2377	0.4989	0.4380	0.4061					
Jgb	0.1608	0.1766	0.1727	0.1412	0.1492	0.2089	0.1556	0.1995	0.2992	0.2668	0.1965				
Portug	0.5229	0.2003	0.1749	0.1609	0.5533	0.3924	0.3006	0.1604	0.2128	0.2154	0.2040	0.1131			
Hungary	0.3224	0.4129	0.4225	0.3578	0.3062	0.2650	0.2230	0.3584	0.3259	0.3253	0.4584	0.1540	0.2444		
Indon	0.1627	0.4295	0.3802	0.3912	0.1470	0.1280	0.1607	0.3964	0.4915	0.4790	0.4347	0.2377	0.1603	0.3242	

APPENDIX C

Table C.1. Akaike Information Criteria Results

i	k	Country i	Country k	Gaussian	Student-t	Clayton	Gumbel	SJC	Nested SJC
1	2	Italy	Turkey	-47.27	-49.58	-56.52	-36.93	-55.13	-50.06
1	3	Italy	Russia	-38.94	-43.68	-42.40	-35.54	-44.56	-43.30
1	4	Italy	Brazil	-32.99	-35.61	-38.62	-25.40	-38.38	-35.55
1	5	Italy	Spain	-368.78	-421.23	-358.27	-358.22	-399.05	-390.52
1	6	Italy	France	-153.57	-183.48	-127.12	-162.40	-171.74	-171.71
1	7	Italy	German	-80.81	-116.64	-61.23	-102.02	-98.73	-96.99
1	8	Italy	Mex	-27.84	-29.97	-35.94	-20.06	-34.99	-30.90
1	9	Italy	China	-59.87	-58.45	-48.15	-51.54	-59.06	-58.92
1	10	Italy	Korea	-47.89	-46.00	-36.45	-40.24	-44.10	-44.09
1	11	Italy	Soaf	-61.58	-62.19	-56.78	-54.30	-65.73	-65.00
1	12	Italy	Jgb	-19.86	-23.53	-17.74	-18.39	-19.54	-19.43
1	13	Italy	Portug	-291.72	-326.84	-272.04	-283.54	-317.22	-313.93
1	14	Italy	Hungary	-105.91	-108.14	-96.36	-87.85	-106.90	-104.94
1	15	Italy	Indon	-22.66	-25.22	-20.31	-21.40	-24.98	-21.56
2	3	Turkey	Russia	-429.81	-472.19	-341.45	-440.70	-434.00	-433.43
2	4	Turkey	Brazil	-334.82	-338.44	-250.81	-318.19	-316.25	-315.96
2	5	Turkey	Spain	-28.96	-34.26	-29.11	-26.89	-33.46	-32.75
2	6	Turkey	France	-59.14	-57.16	-49.59	-44.28	-53.40	-52.65
2	7	Turkey	German	-47.05	-48.24	-43.47	-41.26	-46.68	-45.92
2	8	Turkey	Mex	-277.14	-282.12	-210.14	-265.58	-274.93	-274.70
2	9	Turkey	China	-177.87	-181.21	-126.99	-173.61	-176.86	-176.12
2	10	Turkey	Korea	-148.00	-164.03	-106.33	-161.20	-161.49	-159.04
2	11	Turkey	Soaf	-435.99	-437.85	-354.88	-392.65	-408.52	-406.16
2	12	Turkey	Jgb	-23.03	-33.85	-24.50	-25.61	-28.47	-28.29
2	13	Turkey	Portug	-37.60	-38.65	-36.30	-30.86	-39.11	-38.28
2	14	Turkey	Hungary	-161.34	-173.30	-131.21	-154.77	-157.57	-157.52
2	15	Turkey	Indon	-187.01	-193.99	-143.52	-174.88	-178.90	-178.89
3	4	Russia	Brazil	-282.17	-304.52	-201.07	-305.22	-299.29	-292.30
3	5	Russia	Spain	-35.63	-37.17	-34.29	-31.45	-37.53	-36.86
3	6	Russia	France	-51.05	-49.76	-44.45	-41.61	-48.29	-47.91
3	7	Russia	German	-38.87	-39.04	-36.45	-32.83	-38.31	-37.58
3	8	Russia	Mex	-302.47	-308.67	-220.10	-305.07	-309.47	-306.44
3	9	Russia	China	-167.94	-178.97	-126.05	-169.84	-176.88	-176.30
3	10	Russia	Korea	-151.33	-171.60	-113.02	-165.77	-169.56	-167.77
3	11	Russia	Soaf	-350.65	-368.31	-286.17	-336.97	-347.82	-347.55
3	12	Russia	Jgb	-22.42	-33.23	-23.22	-23.16	-27.45	-27.22
3	13	Russia	Portug	-27.87	-29.72	-27.08	-23.34	-30.00	-29.11
3	14	Russia	Hungary	-172.26	-178.43	-133.49	-160.26	-156.31	-156.31
3	15	Russia	Indon	-139.21	-148.39	-106.81	-133.25	-141.45	-141.44
4	5	Brazil	Spain	-26.33	-31.98	-25.88	-25.62	-29.88	-29.47
4	6	Brazil	France	-36.73	-35.16	-28.55	-30.45	-34.23	-34.22
4	7	Brazil	German	-26.52	-25.94	-22.54	-22.08	-24.96	-24.72

4	8	Brazil	Mex	-638.25	-674.89	-469.19	-670.02	-661.13	-648.63
4	9	Brazil	China	-150.32	-154.52	-101.05	-154.18	-153.30	-150.02
4	10	Brazil	Korea	-132.87	-145.45	-90.61	-147.39	-141.60	-137.26
4	11	Brazil	Soaf	-293.55	-295.30	-249.68	-259.05	-287.12	-283.60
4	12	Brazil	Jgb	-14.92	-15.02	-10.62	-15.46	-14.74	-14.55
4	13	Brazil	Portug	-19.34	-22.14	-14.24	-21.06	-21.06	-21.00
4	14	Brazil	Hungary	-134.71	-134.92	-115.55	-112.24	-131.05	-129.25
4	15	Brazil	Indon	-143.20	-155.86	-101.83	-143.89	-142.02	-141.34
5	6	Spain	France	-188.26	-201.73	-151.67	-187.08	-191.76	-191.74
5	7	Spain	German	-81.41	-87.22	-68.57	-76.57	-80.87	-80.65
5	8	Spain	Mex	-21.91	-24.59	-22.04	-20.33	-24.45	-24.16
5	9	Spain	China	-56.92	-58.55	-46.08	-50.07	-55.32	-55.19
5	10	Spain	Korea	-54.16	-53.97	-35.67	-51.53	-51.90	-51.36
5	11	Spain	Soaf	-54.56	-58.58	-44.13	-50.39	-55.56	-55.50
5	12	Spain	Jgb	-18.26	-20.71	-18.33	-13.08	-17.14	-15.89
5	13	Spain	Portug	-317.86	-356.34	-270.56	-325.26	-335.21	-335.07
5	14	Spain	Hungary	-88.06	-90.32	-71.95	-80.10	-87.58	-87.49
5	15	Spain	Indon	-16.80	-16.75	-11.28	-15.42	-15.60	-15.51
6	7	France	German	-244.50	-324.75	-241.94	-260.88	-283.10	-280.17
6	8	France	Mex	-42.77	-40.79	-29.51	-34.05	-37.46	-37.39
6	9	France	China	-55.31	-53.32	-45.08	-42.46	-50.59	-50.09
6	10	France	Korea	-40.27	-40.03	-29.42	-38.66	-40.73	-40.58
6	11	France	Soaf	-67.29	-65.79	-54.48	-58.64	-63.44	-63.37
6	12	France	Jgb	-39.79	-39.10	-30.79	-31.50	-34.33	-34.27
6	13	France	Portug	-127.52	-162.33	-101.93	-143.34	-145.38	-144.66
6	14	France	Hungary	-63.30	-68.35	-58.92	-57.09	-67.48	-66.71
6	15	France	Indon	-17.83	-15.84	-14.61	-10.55	-14.69	-14.26
7	8	German	Mex	-22.99	-22.25	-18.80	-21.07	-22.24	-22.24
7	9	German	China	-40.92	-46.86	-38.94	-38.31	-44.19	-43.74
7	10	German	Korea	-37.91	-39.80	-33.25	-34.34	-39.47	-39.27
7	11	German	Soaf	-49.05	-53.98	-46.31	-46.39	-52.12	-51.46
7	12	German	Jgb	-16.45	-24.85	-16.52	-17.82	-17.87	-12.83
7	13	German	Portug	-67.18	-82.48	-46.31	-78.86	-75.97	-73.76
7	14	German	Hungary	-45.24	-48.62	-43.06	-39.52	-48.59	-47.19
7	15	German	Indon	-22.29	-22.04	-16.70	-20.62	-21.72	-17.60
8	9	Mex	China	-176.87	-187.67	-135.21	-181.02	-189.05	-188.20
8	10	Mex	Korea	-153.16	-164.15	-111.05	-163.15	-165.94	-163.76
8	11	Mex	Soaf	-289.34	-291.94	-246.62	-260.09	-293.42	-291.42
8	12	Mex	Jgb	-26.92	-35.23	-20.86	-32.65	-30.73	-29.98
8	13	Mex	Portug	-19.27	-27.02	-16.63	-20.38	-23.13	-19.68
8	14	Mex	Hungary	-138.39	-138.23	-118.58	-117.43	-138.72	-137.20
8	15	Mex	Indon	-146.16	-158.50	-107.42	-149.40	-150.44	-149.73
9	10	China	Korea	-500.17	-555.94	-419.66	-510.08	-523.70	-523.68
9	11	China	Soaf	-194.76	-201.55	-141.51	-194.57	-201.30	-200.20
9	12	China	Jgb	-68.68	-90.69	-56.65	-79.18	-82.16	-81.61
9	13	China	Portug	-49.12	-47.44	-45.67	-35.20	-48.46	-46.42
9	14	China	Hungary	-99.93	-99.21	-69.12	-95.94	-98.35	-97.73

9	15	China	Indon	-220.32	-255.57	-153.91	-246.71	-241.17	-235.76
10	11	Korea	Soaf	-157.53	-168.15	-115.92	-161.31	-167.14	-166.10
10	12	Korea	Jgb	-58.44	-68.52	-47.30	-62.97	-67.40	-67.19
10	13	Korea	Portug	-46.70	-45.02	-34.83	-39.17	-44.08	-44.05
10	14	Korea	Hungary	-91.69	-94.30	-54.73	-95.14	-93.35	-89.69
10	15	Korea	Indon	-234.43	-246.14	-172.32	-233.62	-238.00	-236.73
11	12	Soaf	Jgb	-29.33	-40.29	-25.91	-33.02	-35.63	-35.63
11	13	Soaf	Portug	-37.82	-39.37	-30.62	-34.90	-39.57	-39.55
11	14	Soaf	Hungary	-219.14	-231.41	-183.63	-204.35	-215.74	-214.92
11	15	Soaf	Indon	-183.95	-195.21	-135.39	-186.02	-186.78	-186.07
12	13	Jgb	Portug	-11.80	-14.44	-14.58	-6.71	-13.81	-1.69
12	14	Jgb	Hungary	-17.60	-24.91	-21.71	-16.71	-20.73	-15.29
12	15	Jgb	Indon	-40.98	-55.14	-32.94	-49.38	-50.48	-50.10
13	14	Portug	Hungary	-62.52	-62.16	-62.19	-45.93	-63.81	-59.48
13	15	Portug	Indon	-26.34	-26.64	-26.84	-18.94	-29.11	-27.31
14	15	Hungary	Indon	-89.39	-96.81	-65.36	-93.31	-92.12	-91.78

Table C.2. Bayesian Information Criteria Results

i	k	Country i	Country k	Gaussian	Student- t	Clayton	Gumbel	SJC	Nested SJC
1	2	Italy	Turkey	-42.96	-40.98	-52.22	-32.62	-46.52	-41.45
1	3	Italy	Russia	-34.63	-35.08	-38.09	-31.24	-35.95	-34.69
1	4	Italy	Brazil	-28.68	-27.01	-34.32	-21.09	-29.77	-26.94
1	5	Italy	Spain	-364.48	-412.63	-353.97	-353.92	-390.44	-381.91
1	6	Italy	France	-149.27	-174.87	-122.82	-158.09	-163.13	-163.10
1	7	Italy	German	-76.51	-108.03	-56.92	-97.71	-90.12	-88.38
1	8	Italy	Mex	-23.54	-21.36	-31.64	-15.75	-26.39	-22.29
1	9	Italy	China	-55.57	-49.84	-43.84	-47.24	-50.45	-50.31
1	10	Italy	Korea	-43.58	-37.40	-32.14	-35.93	-35.49	-35.48
1	11	Italy	Soaf	-57.27	-53.58	-52.48	-50.00	-57.12	-56.39
1	12	Italy	Jgb	-15.55	-14.92	-13.43	-14.09	-10.93	-10.82
1	13	Italy	Portug	-287.41	-318.23	-267.73	-279.24	-308.62	-305.32
1	14	Italy	Hungary	-101.60	-99.53	-92.06	-83.55	-98.29	-96.33
1	15	Italy	Indon	-18.35	-16.61	-16.00	-17.10	-16.37	-12.95
2	3	Turkey	Russia	-425.50	-463.58	-337.15	-436.39	-425.39	-424.83
2	4	Turkey	Brazil	-330.51	-329.83	-246.51	-313.89	-307.64	-307.35
2	5	Turkey	Spain	-24.65	-25.65	-24.80	-22.59	-24.85	-24.14
2	6	Turkey	France	-54.84	-48.55	-45.29	-39.97	-44.79	-44.05
2	7	Turkey	German	-42.75	-39.63	-39.17	-36.96	-38.07	-37.31
2	8	Turkey	Mex	-272.83	-273.51	-205.83	-261.28	-266.32	-266.09
2	9	Turkey	China	-173.56	-172.60	-122.69	-169.31	-168.25	-167.51
2	10	Turkey	Korea	-143.70	-155.42	-102.03	-156.90	-152.88	-150.43
2	11	Turkey	Soaf	-431.68	-429.24	-350.58	-388.34	-399.91	-397.55
2	12	Turkey	Jgb	-18.73	-25.24	-20.20	-21.30	-19.86	-19.68
2	13	Turkey	Portug	-33.29	-30.04	-31.99	-26.56	-30.50	-29.67
2	14	Turkey	Hungary	-157.04	-164.69	-126.91	-150.46	-148.96	-148.91
2	15	Turkey	Indon	-182.71	-185.38	-139.21	-170.57	-170.29	-170.28
3	4	Russia	Brazil	-277.87	-295.91	-196.76	-300.91	-290.68	-283.69
3	5	Russia	Spain	-31.32	-28.56	-29.99	-27.15	-28.92	-28.25
3	6	Russia	France	-46.74	-41.15	-40.14	-37.31	-39.69	-39.30
3	7	Russia	German	-34.56	-30.43	-32.15	-28.53	-29.70	-28.98
3	8	Russia	Mex	-298.16	-300.06	-215.80	-300.76	-300.86	-297.83
3	9	Russia	China	-163.63	-170.36	-121.74	-165.54	-168.27	-167.69
3	10	Russia	Korea	-147.03	-162.99	-108.71	-161.47	-160.95	-159.16
3	11	Russia	Soaf	-346.35	-359.70	-281.87	-332.67	-339.21	-338.94
3	12	Russia	Jgb	-18.11	-24.62	-18.91	-18.85	-18.84	-18.61
3	13	Russia	Portug	-23.56	-21.11	-22.77	-19.04	-21.39	-20.51
3	14	Russia	Hungary	-167.95	-169.82	-129.18	-155.95	-147.71	-147.70
3	15	Russia	Indon	-134.91	-139.78	-102.50	-128.95	-132.85	-132.83
4	5	Brazil	Spain	-22.02	-23.37	-21.58	-21.32	-21.27	-20.87
4	6	Brazil	France	-32.43	-26.55	-24.24	-26.15	-25.63	-25.61
4	7	Brazil	German	-22.21	-17.33	-18.23	-17.78	-16.35	-16.11
4	8	Brazil	Mex	-633.94	-666.28	-464.89	-665.72	-652.53	-640.02

4	9	Brazil	China	-146.02	-145.91	-96.75	-149.88	-144.69	-141.41
4	10	Brazil	Korea	-128.57	-136.84	-86.31	-143.09	-132.99	-128.65
4	11	Brazil	Soaf	-289.24	-286.69	-245.37	-254.74	-278.51	-274.99
4	12	Brazil	Jgb	-10.61	-6.42	-6.32	-11.15	-6.14	-5.94
4	13	Brazil	Portug	-15.03	-13.53	-9.94	-16.75	-12.46	-12.39
4	14	Brazil	Hungary	-130.41	-126.31	-111.25	-107.94	-122.45	-120.64
4	15	Brazil	Indon	-138.90	-147.25	-97.53	-139.59	-133.41	-132.73
5	6	Spain	France	-183.95	-193.12	-147.37	-182.77	-183.15	-183.14
5	7	Spain	German	-77.11	-78.62	-64.26	-72.26	-72.26	-72.05
5	8	Spain	Mex	-17.61	-15.98	-17.73	-16.03	-15.84	-15.55
5	9	Spain	China	-52.61	-49.94	-41.78	-45.77	-46.72	-46.58
5	10	Spain	Korea	-49.85	-45.36	-31.36	-47.22	-43.29	-42.75
5	11	Spain	Soaf	-50.26	-49.97	-39.83	-46.09	-46.95	-46.90
5	12	Spain	Jgb	-13.96	-12.10	-14.02	-8.78	-8.53	-7.28
5	13	Spain	Portug	-313.56	-347.74	-266.25	-320.95	-326.60	-326.46
5	14	Spain	Hungary	-83.75	-81.71	-67.64	-75.80	-78.97	-78.89
5	15	Spain	Indon	-12.49	-8.14	-6.97	-11.11	-6.99	-6.90
6	7	France	German	-240.19	-316.15	-237.63	-256.57	-274.49	-271.56
6	8	France	Mex	-38.47	-32.18	-25.20	-29.75	-28.86	-28.78
6	9	France	China	-51.00	-44.72	-40.77	-38.15	-41.98	-41.48
6	10	France	Korea	-35.97	-31.42	-25.11	-34.36	-32.12	-31.97
6	11	France	Soaf	-62.99	-57.18	-50.17	-54.33	-54.83	-54.76
6	12	France	Jgb	-35.49	-30.49	-26.49	-27.19	-25.72	-25.66
6	13	France	Portug	-123.21	-153.72	-97.63	-139.03	-136.77	-136.06
6	14	France	Hungary	-58.99	-59.74	-54.61	-52.79	-58.87	-58.10
6	15	France	Indon	-13.53	-7.23	-10.31	-6.25	-6.08	-5.65
7	8	German	Mex	-18.69	-13.64	-14.49	-16.77	-13.63	-13.63
7	9	German	China	-36.62	-38.25	-34.63	-34.00	-35.58	-35.14
7	10	German	Korea	-33.61	-31.19	-28.95	-30.04	-30.86	-30.67
7	11	German	Soaf	-44.74	-45.37	-42.01	-42.08	-43.51	-42.85
7	12	German	Jgb	-12.14	-16.24	-12.21	-13.52	-9.26	-4.22
7	13	German	Portug	-62.88	-73.87	-42.01	-74.56	-67.37	-65.15
7	14	German	Hungary	-40.93	-40.01	-38.76	-35.21	-39.98	-38.58
7	15	German	Indon	-17.99	-13.43	-12.40	-16.32	-13.12	-8.99
8	9	Mex	China	-172.56	-179.06	-130.90	-176.72	-180.45	-179.59
8	10	Mex	Korea	-148.85	-155.54	-106.75	-158.85	-157.33	-155.15
8	11	Mex	Soaf	-285.04	-283.34	-242.32	-255.78	-284.81	-282.81
8	12	Mex	Jgb	-22.62	-26.62	-16.55	-28.35	-22.12	-21.37
8	13	Mex	Portug	-14.97	-18.41	-12.32	-16.07	-14.52	-11.07
8	14	Mex	Hungary	-134.08	-129.62	-114.28	-113.13	-130.11	-128.59
8	15	Mex	Indon	-141.86	-149.89	-103.11	-145.09	-141.84	-141.12
9	10	China	Korea	-495.86	-547.33	-415.35	-505.78	-515.09	-515.07
9	11	China	Soaf	-190.46	-192.94	-137.21	-190.27	-192.69	-191.59
9	12	China	Jgb	-64.38	-82.08	-52.35	-74.87	-73.55	-73.00
9	13	China	Portug	-44.81	-38.83	-41.36	-30.90	-39.85	-37.81
9	14	China	Hungary	-95.63	-90.60	-64.81	-91.63	-89.74	-89.12
9	15	China	Indon	-216.01	-246.96	-149.60	-242.41	-232.56	-227.15

10	11	Korea	Soaf	-153.23	-159.54	-111.61	-157.01	-158.54	-157.49
10	12	Korea	Jgb	-54.14	-59.91	-43.00	-58.67	-58.79	-58.58
10	13	Korea	Portug	-42.40	-36.41	-30.53	-34.86	-35.47	-35.44
10	14	Korea	Hungary	-87.39	-85.69	-50.43	-90.84	-84.74	-81.08
10	15	Korea	Indon	-230.13	-237.53	-168.02	-229.32	-229.39	-228.12
11	12	Soaf	Jgb	-25.02	-31.68	-21.60	-28.71	-27.02	-27.02
11	13	Soaf	Portug	-33.52	-30.76	-26.31	-30.60	-30.96	-30.94
11	14	Soaf	Hungary	-214.83	-222.80	-179.32	-200.05	-207.13	-206.32
11	15	Soaf	Indon	-179.65	-186.60	-131.09	-181.71	-178.17	-177.46
12	13	Jgb	Portug	-7.49	-5.83	-10.27	-2.41	-5.20	6.92
12	14	Jgb	Hungary	-13.29	-16.30	-17.41	-12.40	-12.12	-6.68
12	15	Jgb	Indon	-36.68	-46.53	-28.63	-45.07	-41.87	-41.50
13	14	Portug	Hungary	-58.21	-53.55	-57.89	-41.63	-55.20	-50.87
13	15	Portug	Indon	-22.03	-18.03	-22.53	-14.63	-20.50	-18.70
14	15	Hungary	Indon	-85.09	-88.20	-61.06	-89.00	-83.51	-83.17

Table C.3. Empirical Copula Test Results

i	k	Country i	Country k	Gaussian	Student-t	Clayton	Gumbel	SJC	Nested SJC
1	2	Italy	Turkey	70.01*	66.39*	67.26*	77.66*	65.01*	67.66*
1	3	Italy	Russia	111.56	108.15	115.24	114.88	107.85	107.92
1	4	Italy	Brazil	78.07*	78.06*	80.55*	84.52*	77.40*	77.67*
1	5	Italy	Spain	186.56	94.72*	141.43	147.32	107.51	112.36
1	6	Italy	France	96.01*	73.35*	107.79	93.54*	81.61*	81.50*
1	7	Italy	German	120.25	76.98*	129.22	102.98	102.29	102.21
1	8	Italy	Mex	98.02*	95.30*	92.36*	107.22	90.29*	93.82*
1	9	Italy	China	81.02*	80.64*	88.07*	88.46*	81.51*	81.76*
1	10	Italy	Korea	90.07*	89.29*	100.20*	92.45*	88.19*	88.17*
1	11	Italy	Soaf	102.64	97.78*	100.20*	107.68	92.87*	94.29*
1	12	Italy	Jgb	78.95*	78.58*	83.37*	80.58*	79.37*	79.26*
1	13	Italy	Portug	129.61	101.26*	140.91	126.88	101.14	101.94
1	14	Italy	Hungary	97.28*	93.74*	110.78	107.80	92.50*	92.44*
1	15	Italy	Indon	78.65*	73.65*	80.16*	78.47*	74.99*	80.13*
2	3	Turkey	Russia	213.36	64.60*	143.33	92.48*	87.29*	86.87*
2	4	Turkey	Brazil	116.11	94.15*	155.68	102.97	104.44	104.87
2	5	Turkey	Spain	80.22*	77.22*	81.90*	82.29*	77.41*	77.75*
2	6	Turkey	France	69.89*	69.93*	76.79*	79.73*	69.44*	70.11*
2	7	Turkey	German	98.43*	90.28*	104.56	96.54*	89.45*	89.32*
2	8	Turkey	Mex	92.33*	79.96*	127.04	84.39*	78.00*	78.46*
2	9	Turkey	China	87.28*	80.08*	115.38	87.41*	80.65*	80.32*
2	10	Turkey	Korea	76.84*	59.72*	111.20	65.51*	60.19*	61.19*
2	11	Turkey	Soaf	83.48*	83.05*	136.63	110.32	94.55*	95.91*
2	12	Turkey	Jgb	78.14*	74.87*	77.80*	80.22*	75.53*	75.95*
2	13	Turkey	Portug	68.35*	66.04*	68.26*	72.64*	65.80*	66.68*
2	14	Turkey	Hungary	84.73*	80.76*	105.62	96.47*	86.19*	86.51*
2	15	Turkey	Indon	81.28*	75.62*	117.91	83.32*	81.99*	81.90*
3	4	Russia	Brazil	129.70	81.76*	146.12	95.11*	96.66*	96.47*
3	5	Russia	Spain	72.38*	72.99*	78.60*	77.13*	72.44*	72.23*
3	6	Russia	France	92.16*	92.53*	95.09*	100.09*	92.38*	93.17*
3	7	Russia	German	104.65	101.87	107.98	107.82	99.04*	99.45*
3	8	Russia	Mex	95.78*	81.21*	138.28	85.25*	81.10*	83.22*
3	9	Russia	China	107.73	89.78*	120.96	107.26	94.50*	93.38*
3	10	Russia	Korea	104.94	100.03*	139.82	104.33	97.31*	98.09*
3	11	Russia	Soaf	119.93	80.37*	128.35	104.90	85.43*	86.23*
3	12	Russia	Jgb	75.40*	68.42*	74.57*	76.54*	72.18*	72.58*
3	13	Russia	Portug	89.01*	87.65*	92.30*	91.49*	88.00*	87.96*
3	14	Russia	Hungary	85.26*	80.23*	122.35	91.11*	92.61*	92.57*
3	15	Russia	Indon	77.18*	71.06*	99.38*	83.66*	73.01*	72.98*
4	5	Brazil	Spain	61.71*	58.06*	62.29*	63.08*	58.70*	59.04*
4	6	Brazil	France	65.65*	66.35*	72.56*	71.98*	67.54*	67.59*
4	7	Brazil	German	88.86*	84.89*	91.06*	89.26*	85.35*	85.53*
4	8	Brazil	Mex	108.23	80.13*	201.55	88.66*	84.27*	86.22*

4	9	Brazil	China	80.75*	77.73*	113.33	80.25*	81.85*	83.13*
4	10	Brazil	Korea	92.51*	90.51*	122.65	89.82*	93.29*	95.30*
4	11	Brazil	Soaf	81.95*	83.07*	117.88	102.69	85.19*	86.01*
4	12	Brazil	Jgb	73.60*	73.06*	76.87*	74.28*	73.16*	73.17*
4	13	Brazil	Portug	70.55*	66.34*	71.85*	71.11*	68.92*	68.78*
4	14	Brazil	Hungary	82.91*	83.41*	101.50*	96.58*	89.14*	89.17*
4	15	Brazil	Indon	106.99	102.22	132.04	112.12	110.29	109.86
5	6	Spain	France	115.62	100.81*	137.76	117.43	105.92	105.82
5	7	Spain	German	79.42*	68.23*	83.84*	81.86*	72.11*	72.57*
5	8	Spain	Mex	87.60*	86.43*	90.19*	91.87*	85.22*	85.56*
5	9	Spain	China	74.26*	64.70*	73.45*	72.66*	67.63*	67.88*
5	10	Spain	Korea	72.75*	72.67*	85.00*	78.31*	74.56*	74.16*
5	11	Spain	Soaf	90.50*	79.13*	91.57*	87.18*	83.12*	83.16*
5	12	Spain	Jgb	83.44*	80.38*	86.07*	85.14*	83.43*	83.12*
5	13	Spain	Portug	126.08	73.38*	122.26	116.74	86.51*	87.51*
5	14	Spain	Hungary	84.25*	75.01*	94.62*	81.62*	75.86*	75.70*
5	15	Spain	Indon	83.42*	80.20*	88.74*	82.03*	80.17*	80.33*
6	7	France	German	199.71	80.66*	147.59	143.46	128.42	129.44
6	8	France	Mex	86.45*	86.54*	99.40*	93.55*	88.94*	89.04*
6	9	France	China	64.41*	64.64*	69.43*	72.16*	64.26*	64.76*
6	10	France	Korea	85.88*	86.81*	97.42*	89.76*	87.18*	87.35*
6	11	France	Soaf	90.97*	88.18*	100.88*	89.27*	87.15*	86.94*
6	12	France	Jgb	74.19*	74.82*	83.91*	79.58*	77.47*	77.31*
6	13	France	Portug	89.87*	66.86*	107.73	80.78*	77.32*	77.76*
6	14	France	Hungary	74.48*	66.05*	80.39*	76.94*	65.37*	65.54*
6	15	France	Indon	63.04*	63.07*	65.67*	66.84*	63.16*	63.23*
7	8	German	Mex	76.88*	76.31*	80.31*	77.84*	75.13*	75.12*
7	9	German	China	108.19	105.67	110.92	109.99	104.81	105.13
7	10	German	Korea	94.28*	94.09*	104.45	95.61*	90.93*	90.64*
7	11	German	Soaf	90.78*	84.31*	93.84*	94.16*	83.46*	84.34*
7	12	German	Jgb	74.83*	57.92*	69.34*	74.26*	67.90*	75.39*
7	13	German	Portug	116.58	106.59	144.77	105.61	105.30	109.04
7	14	German	Hungary	72.95*	68.29*	72.26*	79.64*	66.89*	68.42*
7	15	German	Indon	76.11*	75.77*	78.08*	79.98*	74.20*	78.64*
8	9	Mex	China	83.72*	77.94*	118.31	82.36*	75.87*	76.79*
8	10	Mex	Korea	99.48*	94.27*	127.42	97.42*	92.53*	93.35*
8	11	Mex	Soaf	88.60*	88.69*	118.54	113.90	85.00*	86.43*
8	12	Mex	Jgb	81.32*	80.11*	90.60*	80.14*	79.12*	79.66*
8	13	Mex	Portug	86.85*	82.26*	90.34*	87.06*	83.63*	89.34*
8	14	Mex	Hungary	91.47*	92.81*	103.91	108.52	93.39*	94.65*
8	15	Mex	Indon	78.75*	78.27*	108.47	84.20*	79.20*	79.19*
9	10	China	Korea	175.22	70.17*	178.59	100.50*	84.97*	84.80*
9	11	China	Soaf	80.76*	75.67*	116.66	80.45*	73.09*	73.65*
9	12	China	Jgb	106.34	93.05*	122.07	96.62*	96.66*	97.93*
9	13	China	Portug	65.06*	64.92*	65.55*	75.11*	63.59*	65.38*
9	14	China	Hungary	93.11*	91.19*	117.04	92.76*	90.05*	90.73*
9	15	China	Indon	100.80*	76.23*	161.50	79.59*	77.79*	82.59*

10	11	Korea	Soaf	96.90*	94.50*	136.53	97.04*	91.84*	92.84*
10	12	Korea	Jgb	108.59	92.47*	123.35	97.82*	96.34*	97.14*
10	13	Korea	Portug	77.21*	77.35*	86.66*	84.14*	77.99*	78.04*
10	14	Korea	Hungary	76.41*	72.89*	111.03	69.23*	69.43*	73.86*
10	15	Korea	Indon	107.11	100.71*	167.63	97.34*	94.18*	97.21*
11	12	Soaf	Jgb	82.52*	68.77*	83.91*	78.33*	76.40*	76.39*
11	13	Soaf	Portug	77.75*	74.17*	79.51*	80.60*	75.42*	75.50*
11	14	Soaf	Hungary	103.36	87.40*	110.25	107.14	92.17*	93.63*
11	15	Soaf	Indon	82.21*	70.20*	109.86	80.57*	74.77*	74.68*
12	13	Jgb	Portug	92.23*	89.40*	93.08*	94.23*	91.41*	104.44
12	14	Jgb	Hungary	74.82*	68.21*	71.17*	76.64*	69.93*	78.70*
12	15	Jgb	Indon	96.22*	86.77*	106.59	89.85*	89.57*	90.28*
13	14	Portug	Hungary	90.56*	89.24*	88.42*	105.41	85.22*	88.86*
13	15	Portug	Indon	66.12*	63.41*	64.20*	71.69*	61.09*	62.81*
14	15	Hungary	Indon	82.98*	81.20*	105.51	83.82*	81.61*	81.97*

χ^2 statistics ($\alpha=0.05$): 101.879. * indicates 5% significance

Central Bank of the Republic of Turkey
Recent Working Papers

The complete list of Working Paper series can be found at Bank's website
[\(http://www.tcmb.gov.tr\)](http://www.tcmb.gov.tr)

Disentangling Age and Cohorts Effects on Home-Ownership and Housing Wealth in Turkey
(Evren Ceritoglu Working Paper No. 17/06, March 2017)

The Impact of Syrian Refugees on Natives' Labor Market Outcomes in Turkey: Evidence from a Quasi-Experimental Design
(Evren Ceritoglu, Hatice Burcu Gürcihan-Yüncüler, Huzyeafe Torun, Semih Tümen Working Paper No. 17/05, February 2017)

Rebalancing Turkey's Growth by Improving Resource Allocation and Productivity in Manufacturing
(Aslıhan Atabek, Dan Andrews, Rauf Gönenç Working Paper No. 17/04, February 2017)

Mean-Reversion in Unprocessed Food Prices
(Kurmaş Akdoğan Working Paper No. 17/03, February 2017)

Rise of Services and Female Employment: Strength of the Relationship
(Şerife Genç İleri, Gönül Şengül Working Paper No. 17/02, February 2017)

Self-Insurance and Consumption Risk-Sharing between Birth-Year Cohorts in Turkey
(Evren Ceritoglu Working Paper No. 17/01, January 2017)

Welfare Gains from Reducing the Implementation Delays in Public Investment
(H. Murat Özbilgin Working Paper No. 16/28, December 2016)

Estimating Light-Vehicle Sales in Turkey
(Ufuk Demiroğlu, Çağlar Yüncüler Working Paper No. 16/27, December 2016)

Childcare Prices and Maternal Employment: A Meta-Analysis
(Yusuf Emre Akgündüz, Janneke Plantenga Working Paper No. 16/26, December 2016)

Real Wages and the Business Cycle in Turkey
(Altan Aldan, H. Burcu Gürcihan Yüncüler Working Paper No. 16/25, November 2016)

Exports, Real Exchange Rates and External Exposures: Empirical Evidence From Turkish Manufacturing Firms
(Nazlı Toraganlı, Cihan Yalçın Working Paper No. 16/24, November 2016)

Entrepreneurship in the Shadows: Wealth Constraints and Government Policy
(Semih Tümen Working Paper No. 16/23, November 2016)

Ex-Ante Labor Market Effects of Compulsory Military Service
(Huzyeafe Torun Working Paper No. 16/22 November 2016)

Co-movement of Exchange Rates with Interest Rate Differential, Risk Premium and FED Policy in "Fragile Economies"
(M. Utku Özmen, Erdal Yılmaz Working Paper No. 16/21 September 2016)

Job Security and Housing Credits
(Kurmaş Akdoğan, Ayşe Tatar, Ayşe Arzu Yavuz Working Paper No. 16/20 September 2016)

Cyclical Variation of Fiscal Multiplier in Turkey
(Cem Çebi, K. Azim Özdemir Working Paper No. 16/19 September 2016)

Unemployment Hysteresis and Structural Change in Europe
(Kurmaş Akdoğan Working Paper No. 16/18 August 2016)

Asymmetric Government Expenditure: A Comparison of Advanced and Developing Countries
(Ali Aşkin Çulha Working Paper No. 16/17 August 2016)

Firmaların Sabit Sermaye Yatırım Kararlarının Analizi: Türkiye İmalat Sanayine Dair Bulgular
(Evren Erdoğan Coşar Çalışma Tebliği No. 16/16 Temmuz 2016)