Online Appendix

Brief review of copula functions, BBN, DAGs and the sequential EM algorithm

A. Copula functions

In this section we provide a brief review of copula functions. For a detailed technical exposition we refer the reader to Nelsen (1998), and Joe (1999). Intuitively, a copula connects a multivariate distribution to its marginals in a way that captures the entire (possibly nonlinear) dependence structure in the multivariate distribution $(u_1,\ldots,u_n)$.

DEFINITION 1: *A multivariate copula is a mapping* $C:[0,1]^n \to [0,1]$ *such that:*

$$\forall (u_1,\ldots,u_n)\in[0,1]^n,\ \begin{cases} C(u_1,\ldots,0)=\cdots=C(0,\ldots,u_n)=0 \\ C(u_1,\ldots,1)=u_1 \text{ and } C(1,\ldots,u_n)=u_n \end{cases}, \text{ and} \tag{A.1}$$

$$\forall (u_{11},\ldots,u_{1n},\ldots,u_{n1},\ldots,u_{nn})\in[0,1]^{n\times n} : u_{11}\le\cdots\le u_{1n}\wedge\ldots\wedge u_{n1}\le\cdots\le u_{nn}, \tag{A.2}$$

$$C(u_{n1},\ldots,u_{nn})-C(u_{11},\ldots,u_{nn})-\cdots-C(u_{nn},\ldots,u_{11})+\cdots+C(u_{11},\ldots,u_{1n})\ge 0.$$

THEOREM 1 (*Sklar's Theorem, for proof see Patton, 2006*): *Let* $X_1,\ldots,X_n$ *be n random variables with joint distribution H. Then there exists a copula C such that:*

$$H(x_1,\ldots,x_n)=C[F_1(x_1),\ldots,F_n(x_n)],\ \forall (x_1,\ldots,x_n)\in\overline{\Re}^n \tag{A.3}$$

where $\overline{\Re}\equiv\Re\cup\{\pm\infty\}$. *If* $F_1,\ldots,F_n$ *are continuous and represent the marginal distribution functions of* $X_1,\ldots,X_n$ *respectively, then there exists a unique C in (A.3) given by:*

$$C(u_1,\ldots,u_n)=H\left(F_1^{-1}(u_1),\ldots,F_n^{-1}(u_n)\right), \tag{A.4}$$

for $u=(u_1,\ldots,u_n)\in\Re^n$ *where* $F_i^{-1}(u_i)=\inf\{x:F_i(x)\ge u\}$ *for* $i=1,\ldots,n$. *Conversely, if C is a copula in* $[0,1]^n$ *and* $F_1,\ldots,F_n$ *are marginal distribution functions on* $\Re$, *then the distribution function defined in (A.3) is a joint distribution function defined on* $\overline{\Re}^n$.

B. Bayesian belief networks (BBN) and directed acyclic graphs (DAG)

For a detailed technical discussion about BBN see Russell and Norvig (1995, ch.19.6).

DEFINITION 2 *(Bayesian Belief Network): A Bayesian Belief Network (BBN) is defined by a causal model* (G,Θ_G) *consisting of a weighted directed acyclic graph (DAG) G representation of the joint probability distribution of a set of n random variables* $X_1, X_2, \ldots, X_n$ *, and a set of parameters* Θ_G *compatible with the DAG G. The set of parameters* Θ_G *assign a functional relation to each variable in the network given the set of parent variables or ancestor nodes from which each node can be reached following a direct path (Markov property). Thus, a BBN defines a unique joint probability distribution suitable to be factored in its marginals* $F(X_1 = x_1 \wedge \ldots \wedge X_n = x_n) = \prod_{i=1}^{n} F(x_i | x_1, \ldots, x_{i-1}) = \prod_{i=1}^{n} F(x_i | Parents(X_i))$ *compatible with some functional (e.g., a non-structural vector autoregression VAR model).*

For a detailed technical discussion about DAGs we refer the reader to Spirtes et al. (1993), Swanson and Granger (1997), and Pearl (2002).

DEFINITION 3 *(Direct Acyclic Graph): A graph G is the ordered tuple* $\langle V, M, E \rangle$*, where* $V = \{X_1, \ldots, X_{n_V}\}$*,* $M = \{M_1, \ldots, M_{n_M}\}$*, and* $E = \{E_1, \ldots, E_{n_E}\}$ *are non-void sets with* n_V *vertices,* n_M *marks, and* n_E *edges. The vertices correspond to the random variables under study, the marks are symbols attached to the end of the undirected edges, and the edges denote relationships that hold for each pair of random variables. A directed graph DG contains only directed edges* $(e.g., \; X_1 \rightarrow X_2)$*. A directed acyclic graph DAG is a directed graph that contains no directed cyclic paths representing feedback processes. A path in a graph is defined as a sequence of edges with weight* $\pi_s = W(E_s)$*, specified by some weight function W that maps edges to numbers measured at the source or at the sink.*

Conditional independence can be stated in graphical terms as the following property:

DEFINITION 4 (*d-Separation, Pearl, 2002*): *A path (pa) is said to be d-separated (or blocked) by a set of nodes Z if and only if: 1) the path contains a chain* $X_1 \rightarrow X_2 \rightarrow X_3$ *or a fork* $X_1 \leftarrow X_2 \rightarrow X_3$ *such that* $X_2 \in Z$ *; or 2) the path contains an inverted fork (or collider)* $X_1 \rightarrow X_2 \leftarrow X_3$ *such that* $X_2 \notin Z$ *and such that no descendant of* X_2 *is in Z.*

THEOREM 2 (*for the proof see Verma and Pearl, 1988*): *If sets* X_1 *and* X_2 *are d-separated by Z in a DAG G, then* X_1 *is independent of* X_2 *conditional on Z in every distribution compatible with G. Conversely, if* X_1 *and* X_2 *are not d-separated by Z in a DAG G, then* X_1 *and* X_2 *are dependent (interactive) conditional on Z in at least one distribution compatible with G.*

To illustrate the property of *d*-separation assume the fork $X_1 \leftarrow X_2 \rightarrow X_3$ such that $X_2 \in Z$. In this case, X_2 is a common cause of X_1 and X_3, which implies an unconditional association (e.g., correlation) between X_1 and X_3 different from zero. If we condition on X_2, the association disappears as the common cause X_2 now blocks the flow of information between the common effects X_1 and X_3. Unconditionally, X_1 and X_3 are d-connected. However, conditionally, X_1 and X_3 are *d*-separated. This property is very important to guarantee an unbiased test of financial contagion given that multi-factor models of asset returns potentially may introduce a simultaneity bias problem. The *d*-separation property of DAGs tackles the endogeneity problem by modeling explicitly conditional independence (for a detailed discussion see Pearl, 2002, page 17).

C. The sequential EM algorithm

Consider the panel of $n \leq N = I \times M$ market returns, where $i \leq I$ is the number of classes of assets e.g., equity, bonds, currencies, etc., and $m \leq M$ denotes the number of countries included in the financial network with *T* realizations (i.e., the sample size). For each pair of assets $i, m = \{1,1\}, \{2,1\}, \cdots, \{I,1\}, \{1,2\}, \{2,2\}, \cdots, \{I,2\}, \cdots, \{1,M\}, \{2,M\}, \cdots, \{I,M\}$, with vector of returns following dynamics as in equations (7)-(8), let $\hat{F}(u^i), \hat{F}(u^m)$ be the empirical marginals (estimated non-parametrically) of the filtered (i.e., using a GARCH(1,1,) specification) *i.i.d.* innovations u^i, u^m, and $H(u^i, u^m; \theta_s) = C\left[\hat{F}(u^i), \hat{F}(u^m); \theta_s\right]$ the *s = 1,…,S* parametric copulas. Then, the mixed copula can be written as:

$$H(u^i, u^m; \Theta, \boldsymbol{\pi}) \equiv MC\left[\hat{F}(u^i), \hat{F}(u^m); \Theta, \boldsymbol{\pi}\right] = \sum_{s=1}^{S} \pi^s C^s\left[\hat{F}(u^i), \hat{F}(u^m); \theta_s\right], \quad \text{(C.1)}$$

where $\Theta = \{\theta_1, \cdots, \theta_S\}$ is the vector of "copula parameters" that depend on the specific copula included; and $\boldsymbol{\pi}$ is the vector of "copula weights". We follow the sequential procedure in Arcidiacono and Jones (2003) to estimate $\left(\hat{\Theta}, \hat{\boldsymbol{\pi}}\right)$. The econometrician knows *s = 1,…,S* (in our case we set *S* = 3) but does not know the "type" of each individual observation in terms of the copula function that best models the dependence between each pair of returns that comes from regime *s*. The joint density function for each observation $\left(u_t^i, u_t^m\right)$ can be written as:

$$L\left(u_t^i, u_t^m; \Theta, \boldsymbol{\pi}\right) = c\left[\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \Theta, \boldsymbol{\pi}\right] \hat{F}\left(u_t^i\right) \hat{F}(u_t^m), \quad \text{(C.2)}$$

where $c\left[\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \Theta, \boldsymbol{\pi}\right] \equiv \partial^2 C\left[\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \Theta, \boldsymbol{\pi}\right] / \partial u_t^i \partial u_t^m$. The unconditional likelihood function is:

$$\mathcal{L}(u^i, u^m; \Theta, \boldsymbol{\pi}) = \sum_{t=1}^{T} \sum_{s=1}^{S} \pi_s L_s\left(u_t^i, u_t^m; \theta_s\right), \quad \text{(C.3)}$$

where $L_s(\,)$ denotes the joint density function for regime *s*. Notice that because the marginal densities are not functions of the copula parameters then we can re-express the unconditional likelihood function as:

$$\sum_{t=1}^{T} \sum_{s=1}^{S} \pi_s c_s\left(\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \theta_s\right). \quad \text{(C.4)}$$

From Bayes' theorem, the probability that each pair of returns falls in regime *s* conditional on the observation at time *t* is given by:

$$Pr\left(s \middle| u_t^i, u_t^m; \Theta, \boldsymbol{\pi}\right) = \frac{\pi_s c_s\left(\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \theta_s\right)}{\sum_{s=1}^{S} \pi_s L_s\left(u_t^i, u_t^m; \theta_s\right)}. \quad \text{(C.5)}$$

The maximum likelihood estimate $\hat{\pi}_s$ is:

$$\hat{\pi}_s = \frac{1}{T} \sum_{t=1}^{T} Pr\left(s \middle| u_t^i, u_t^m; \hat{\Theta}, \hat{\boldsymbol{\pi}}\right). \quad \text{(C.6)}$$

The maximum likelihood estimate $\widehat{\Theta}$ must solve:

$$\sum_{t=1}^{T}\sum_{s=1}^{S} Pr\left(s\middle|u_t^i, u_t^m; \widehat{\Theta}, \widehat{\boldsymbol{\pi}}\right) \frac{\partial ln\left[\, c_s\left(\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \theta_s\right)\right]}{\partial \Theta} = 0. \tag{C.7}$$

Notice that $\left(\widehat{\Theta}, \widehat{\boldsymbol{\pi}}\right)$ maximizes two different things: i) the log of the unconditional likelihood function (C.4) and ii) the conditional log-likelihood function given the regime or type of the observation. The unconditional likelihood function does not admit sequential estimation but the conditional one does. Arcidiacono and Jones (2003) propose a modified version of the expectation-maximization (EM) algorithm of Dempster, Laird, and Rubin (1977) to estimate the conditional log-likelihood function. In the expectation (E) step the econometrician uses equation (C.5) to find $\left(s\middle|u_t^i, u_t^m; \Theta, \boldsymbol{\pi}\right)$; and in the maximization (M) step the econometrician uses equations (C.6) and (C.7) to find $\left(\widehat{\Theta}_s, \widehat{\boldsymbol{\pi}}\right)$ as follows.

By construction, we can decompose the regime-conditional likelihood function into:

$$\sum_{t=1}^{T} ln\left[c_s\left(\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \theta_s\right)\right] + \sum_{t=1}^{T} ln\left[c_s\left(\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \theta_s, \pi_s\right)\right]. \tag{C.8}$$

Arcidiacono and Jones (2003) show that in this case, consistent estimates of Θ can be found from maximizing in a first-stage the first term of (C.8); and consistent estimates of $\boldsymbol{\pi}$ can be obtained in a second-stage maximizing the second term of (C.8) given $\widehat{\Theta}$.

So we first estimate $\widehat{\Theta}$ using quasi-Maximum Likelihood (QML). Then, given $\widehat{\Theta}$, the $N \times T$ innovations in returns or sample of observations, and an arbitrary initial vector of values $\boldsymbol{\pi}^{(\mathbf{0})}$ for $\ell = 1$ we apply recursively the modified EM algorithm in ℓ iterations:

1) We calculate each $\pi_s^{(\boldsymbol{\ell})} = \frac{\mathbf{1}}{\boldsymbol{T}}\sum_{\boldsymbol{t}=\mathbf{1}}^{\boldsymbol{T}} \frac{\hat{\boldsymbol{\pi}}_s^{(\boldsymbol{\ell}-\mathbf{1})} \boldsymbol{c_s}\left[\hat{F}\left(u_t^i\right), \hat{F}(u_t^m); \widehat{\boldsymbol{\theta}}_s\right]}{\sum_j \hat{\boldsymbol{\pi}}_j^{(\boldsymbol{\ell}-\mathbf{1})} \boldsymbol{c_s}\left[\hat{F}(u_t^i), \hat{F}(u_t^m); \widehat{\boldsymbol{\theta}}_j\right]}$ in $\boldsymbol{\pi}^{(\boldsymbol{\ell})}$ using Bayes' theorem as in equation (A5) assuming that $\boldsymbol{\pi}^{(\boldsymbol{\ell}-\mathbf{1})}$ is correct. This is the (expectations) *E*-step.

2) In the modified (maximization) *M*-step we use $\boldsymbol{\pi}^{(\boldsymbol{\ell})}$ obtained in the previous E-step and estimate the mean value of the return innovations for each regime *s*, which is the weighted average of all observations in the sample. The weight of each observation is proportional to the probability that the period *t* observation falls in regime *s*. The more likely the innovation falls in regime *s*, the more weight the algorithm puts on that observation contributing to estimate the mean innovation of regime *s*. Next, the algorithm estimates the weighted average of the squared deviations of the observations from their mean. With both the mean return innovation in each regime *s* and dispersion of each observation from their mean value, the algorithm recalculates the sample weight $\boldsymbol{\pi}^{(\boldsymbol{\ell}+\mathbf{1})}$ using equation (C.6) and

compares it with $\boldsymbol{\pi}^{(\ell)}$ going back to the E-step iteratively until the change $\left\|\boldsymbol{\pi}^{(\ell+1)} - \boldsymbol{\pi}^{(\ell)}\right\| < \varepsilon$, where ε is some small arbitrary convergence value. That is, the algorithm stops when we achieve the condition for maximization (C.7). Under some technical regularity conditions, it can be shown that if $\boldsymbol{\pi}^{(\ell+1)} = \boldsymbol{\pi}^{(\ell)}$ then the EM algorithm has found the maximum likelihood weight $\hat{\boldsymbol{\pi}}$ (see e.g., Cappé et al., 2005, Theorem 10.5.4, and Proposition 10.5.5).

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Table A1

Panel A: Gumbel-Hougaard Copula Estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	2.332	2.648	1.438	1.898	1.677	1.442	1.518	1.666	1.424	1.233	1.533	1.263	1.409	1.366	1.290	1.368	1.372	1.410	1.411	1.331	1.383	1.430	1.420	1.486	1.495	1.206	-	1.461	1.279
embibra		2.853	1.472	2.058	1.638	1.416	1.459	1.649	1.340	1.352	1.698	1.255	1.309	1.315	1.357	1.415	1.366	1.312	1.453	1.330	1.450	1.412	1.439	1.474	1.475	1.355	-	1.197	1.301
embichi			1.467	2.061	1.733	1.447	1.450	1.642	1.444	1.338	1.610	1.296	1.297	1.266	1.344	1.396	1.354	1.385	1.455	1.396	1.435	1.424	1.431	1.508	1.341	1.334	-	1.572	1.320
embiur				1.402	1.345	1.365	1.453	1.497	1.199	1.255	1.494	1.386	1.289	1.389	1.312	1.362	1.266	1.374	1.465	1.372	1.241	1.257	1.408	1.382	1.476	1.344	1.381	1.442	1.300
embivzla					1.645	1.426	1.569	1.642	1.440	1.262	1.543	1.249	1.396	1.372	1.312	1.439	1.308	1.430	1.479	1.367	1.398	1.313	1.485	1.503	1.450	1.456	-	1.325	1.282
embimex						1.759	1.611	1.649	1.392	1.419	1.646	1.372	1.422	1.327	1.449	1.486	1.329	1.460	1.411	1.411	1.436	1.206	1.252	1.192	1.505	1.295	1.204	1.461	1.341
embiasia							1.470	1.564	1.492	1.352	1.441	1.259	1.358	1.298	1.426	1.452	1.392	1.317	1.273	1.408	1.326	1.214	1.409	1.229	1.448	1.360	1.456	1.468	1.202
embirus								1.698	1.425	1.301	1.589	1.411	1.371	1.409	1.374	1.513	1.235	1.461	1.439	1.471	1.372	1.365	1.350	1.558	1.321	1.425	1.599	1.572	1.433
forexarg									1.479	1.435	1.706	1.512	1.339	1.353	1.386	1.424	1.495	1.576	1.620	1.476	1.451	1.544	1.640	1.711	1.704	1.441	1.718	1.683	1.360
forexbol										1.435	1.610	1.277	1.360	1.318	1.551	1.255	1.342	1.385	1.445	1.431	1.287	1.443	1.398	1.381	1.458	1.413	1.512	1.449	1.253
forexbra											1.621	1.225	1.237	1.333	1.391	1.316	1.292	1.424	1.402	1.317	1.252	1.338	1.421	1.371	1.357	1.330	1.295	1.439	1.271
forexchi												1.380	1.370	1.404	1.347	1.509	1.347	1.479	1.473	1.630	1.447	1.421	1.526	1.434	1.465	1.413	1.480	1.598	1.321
forexpar													1.278	1.350	1.326	1.296	1.335	1.387	1.365	1.351	1.417	1.351	1.334	1.367	1.392	1.238	1.402	1.459	1.352
forexur														1.236	1.389	1.279	1.325	1.300	1.317	1.467	1.409	1.401	1.424	1.312	1.399	1.339	1.438	1.406	1.226
forexvzla															1.355	1.405	1.273	1.273	1.308	1.330	1.305	1.376	1.573	1.402	1.324	1.404	1.331	1.373	1.114
intarg																1.351	1.302	1.367	1.352	1.298	1.494	1.369	1.477	1.456	1.417	1.356	1.316	1.338	1.319
intbol																	1.300	1.300	1.245	1.470	1.456	1.296	1.562	1.514	1.310	1.418	1.531	1.546	1.253
intbra																		1.582	1.344	1.603	1.418	1.407	1.479	1.322	1.391	1.274	1.409	1.546	1.250
intchi																			1.225	1.465	1.421	1.390	1.454	1.535	1.429	1.343	1.490	1.409	1.373
intpar																				1.356	1.448	1.268	1.464	1.382	1.426	1.379	1.441	1.523	1.326
intur																					1.328	1.329	1.357	1.484	1.402	1.332	1.362	1.559	1.346
intvzla																						1.368	1.435	1.435	1.309	1.302	1.405	1.501	1.193
stockarg																							1.638	1.775	1.322	1.581	1.527	1.508	1.239
stockbra																								1.897	1.534	1.522	1.415	1.658	1.344
stockchi																									1.492	1.579	1.505	1.705	1.295
stockur																										1.413	1.563	1.576	1.351
stockvzla																											1.528	1.541	1.379
stockmex																												2.009	1.415
stockasia																													1.426

Panel B: Adjusted standard errors of the Gumbel-Hougaard copula estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	0.151	0.183	0.066	0.111	0.089	0.067	0.074	0.089	0.065	0.047	0.076	0.050	0.064	0.060	0.052	0.060	0.060	0.064	0.063	0.056	0.061	0.065	0.064	0.071	0.072	0.045	-	0.068	0.051
embibra		0.202	0.069	0.126	0.085	0.064	0.068	0.087	0.058	0.058	0.091	0.049	0.054	0.055	0.058	0.064	0.060	0.054	0.067	0.056	0.067	0.064	0.067	0.070	0.070	0.059	-	0.044	0.053
embichi			0.069	0.126	0.094	0.067	0.068	0.087	0.067	0.057	0.084	0.053	0.053	0.050	0.057	0.063	0.058	0.061	0.068	0.062	0.066	0.065	0.066	0.073	0.058	0.057	-	0.079	0.055
embiur				0.063	0.058	0.059	0.068	0.073	0.044	0.049	0.072	0.061	0.052	0.062	0.055	0.059	0.050	0.060	0.068	0.060	0.047	0.049	0.064	0.061	0.070	0.057	0.061	0.066	0.053
embivzla					0.086	0.065	0.079	0.086	0.066	0.050	0.077	0.048	0.062	0.060	0.054	0.067	0.054	0.065	0.069	0.059	0.062	0.054	0.071	0.073	0.068	0.068	-	0.056	0.052
embimex						0.097	0.083	0.087	0.062	0.064	0.086	0.060	0.064	0.056	0.067	0.071	0.056	0.068	0.063	0.063	0.066	0.044	0.049	0.043	0.073	0.053	0.044	0.068	0.057
embiasia							0.069	0.079	0.072	0.057	0.067	0.049	0.058	0.053	0.065	0.068	0.062	0.055	0.050	0.063	0.055	0.045	0.064	0.047	0.067	0.059	0.068	0.069	0.044
embirus								0.090	0.065	0.053	0.081	0.063	0.060	0.064	0.060	0.073	0.047	0.068	0.066	0.069	0.060	0.059	0.058	0.078	0.055	0.065	0.080	0.078	0.065
forexarg									0.071	0.067	0.095	0.074	0.057	0.059	0.062	0.066	0.073	0.080	0.084	0.072	0.068	0.077	0.087	0.093	0.093	0.068	0.093	0.091	0.059
forexbol										0.066	0.083	0.051	0.059	0.055	0.076	0.049	0.057	0.061	0.066	0.065	0.052	0.067	0.063	0.061	0.068	0.064	0.073	0.067	0.049
forexbra											0.084	0.046	0.047	0.056	0.061	0.055	0.052	0.065	0.062	0.055	0.049	0.057	0.065	0.060	0.058	0.056	0.053	0.066	0.050
forexchi												0.061	0.060	0.063	0.058	0.073	0.058	0.070	0.070	0.085	0.068	0.065	0.076	0.066	0.070	0.064	0.070	0.082	0.055
forexpar													0.051	0.057	0.056	0.053	0.057	0.061	0.059	0.058	0.064	0.058	0.057	0.060	0.062	0.047	0.063	0.068	0.058
forexur														0.047	0.061	0.051	0.055	0.053	0.054	0.068	0.063	0.062	0.065	0.055	0.062	0.057	0.066	0.063	0.046
forexvzla															0.058	0.063	0.051	0.051	0.053	0.056	0.053	0.061	0.079	0.063	0.055	0.063	0.056	0.060	0.036
intarg																0.058	0.053	0.059	0.057	0.053	0.071	0.060	0.070	0.068	0.064	0.058	0.055	0.057	0.055
intbol																	0.053	0.053	0.048	0.069	0.068	0.053	0.078	0.074	0.054	0.064	0.075	0.076	0.049
intbra																		0.080	0.057	0.081	0.064	0.063	0.070	0.055	0.061	0.051	0.064	0.076	0.049
intchi																			0.046	0.068	0.064	0.062	0.068	0.076	0.065	0.058	0.071	0.064	0.060
intpar																				0.059	0.067	0.050	0.068	0.061	0.065	0.061	0.066	0.074	0.055
intur																					0.056	0.056	0.059	0.071	0.063	0.056	0.059	0.078	0.057
intvzla																						0.059	0.066	0.066	0.054	0.054	0.063	0.072	0.043
stockarg																							0.086	0.098	0.055	0.080	0.075	0.073	0.047
stockbra																								0.110	0.075	0.074	0.064	0.087	0.057
stockchi																									0.071	0.080	0.072	0.091	0.053
stockur																										0.064	0.077	0.079	0.058
stockvzla																											0.074	0.076	0.061
stockmex																												0.119	0.064
stockasia																													0.065

Notes: Panel A reports the parameters for the Gumbel-Hougaard copula functions given the non-parametric marginals included in the analysis. When the maximum likelihood estimation procedure gives a parameter value outside the boundaries established by its restrictions we show a dash. Panel B shows the adjusted standard errors following the procedure in Chen and Fan (2006a). The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Table A2

Panel A: Clayton copula estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	2.388	3.183	0.209	1.367	0.597	0.153	0.176	-0.014	-0.087	-0.088	0.187	-0.044	0.134	-0.128	-0.016	0.046	0.064	-0.097	0.129	-0.005	0.101	-0.099	-0.148	-0.060	-0.035	-0.290	-0.533	-0.324	-0.035
embibra		3.670	0.347	1.727	0.871	0.120	0.111	-0.017	0.021	0.063	0.406	-0.058	0.004	0.016	0.079	-0.143	0.057	-0.014	0.213	-0.002	0.200	-0.110	-0.113	-0.077	-0.105	-0.207	-0.630	-0.473	-0.191
embichi			0.339	1.822	1.046	0.163	0.102	0.016	-0.065	0.040	0.283	-0.004	-0.010	-0.045	0.057	0.082	0.043	-0.122	0.204	0.078	0.180	-0.123	-0.164	-0.044	0.004	-0.217	-0.657	-0.394	-0.196
embiur				0.118	0.038	-0.103	0.130	0.156	-0.292	-0.037	-0.059	0.183	-0.145	0.165	0.015	0.057	-0.046	-0.119	0.328	0.068	-0.069	-0.067	-0.106	-0.193	0.210	0.045	-0.197	-0.161	0.020
embivzla					0.552	0.131	0.232	-0.026	0.153	-0.043	0.205	-0.060	0.139	0.093	0.005	-0.106	-0.008	-0.094	0.274	0.050	0.110	-0.015	-0.061	-0.124	-0.143	-0.033	-0.544	-0.234	-0.029
embimex						1.143	0.040	-0.006	0.088	0.532	0.338	0.146	0.162	0.030	0.274	-0.066	0.019	0.174	0.124	-0.143	0.218	-0.391	-0.469	-0.446	-0.019	-0.240	-0.472	-0.320	-0.144
embiasia							0.137	-0.029	0.271	0.124	0.106	-0.039	0.091	0.006	0.188	-0.092	0.104	-0.006	-0.042	-0.066	-0.173	-0.388	-0.418	-0.385	-0.083	-0.192	-0.148	-0.112	-0.286
embirus								0.057	0.121	-0.001	0.242	0.160	0.087	0.142	-0.127	-0.041	-0.276	-0.075	0.141	-0.073	-0.135	-0.204	-0.218	-0.018	-0.232	-0.152	-0.007	-0.046	0.231
forexarg									0.135	0.128	-0.051	0.001	0.008	0.023	0.076	0.075	-0.110	-0.038	0.007	-0.160	-0.044	0.184	-0.055	-0.006	0.022	0.104	-0.011	-0.056	0.036
forexbol										0.333	0.053	-0.024	0.072	-0.210	0.525	-0.377	-0.211	0.080	0.189	-0.086	-0.021	0.131	-0.185	0.048	-0.074	0.125	0.007	0.110	-0.062
forexbra											0.373	-0.078	-0.066	0.070	0.320	-0.006	-0.234	0.152	0.117	-0.228	-0.057	-0.211	-0.315	-0.195	0.059	-0.178	-0.036	0.128	-0.018
forexchi												0.064	0.046	0.112	0.030	-0.072	0.021	0.167	0.158	0.024	0.149	-0.335	-0.255	-0.333	-0.160	-0.178	-0.154	-0.092	0.001
forexpar													-0.024	0.128	0.044	-0.020	-0.183	0.092	0.082	0.032	0.235	-0.165	-0.217	-0.203	-0.074	-0.083	0.079	-0.068	0.087
forexur														-0.061	0.484	-0.035	0.048	-0.010	0.026	0.205	0.273	0.124	0.141	-0.015	-0.132	0.066	-0.047	0.093	-0.072
forexvzla															0.088	0.117	-0.046	-0.048	0.018	0.012	0.020	-0.078	0.403	-0.109	-0.221	0.120	0.004	0.051	-0.333
intarg																-0.163	-0.008	0.069	0.061	-0.022	0.430	-0.091	-0.058	-0.116	-0.054	-0.140	-0.016	0.001	-0.168
intbol																	-0.021	-0.029	-0.080	-0.077	0.203	-0.032	0.003	-0.054	-0.023	-0.079	0.021	0.220	-0.063
intbra																		0.421	-0.194	0.416	0.207	-0.112	0.189	-0.014	-0.072	-0.051	0.080	-0.011	-0.061
intchi																			-0.279	-0.083	0.227	-0.169	-0.104	-0.016	-0.144	0.026	0.172	0.063	0.101
intpar																				0.032	0.265	-0.057	0.177	0.069	0.131	0.095	-0.129	-0.037	0.073
intur																					0.028	0.001	0.026	-0.008	0.081	0.010	0.020	0.232	0.051
intvzla																						-0.093	0.131	0.114	-0.011	-0.019	-0.160	-0.040	-0.120
stockarg																							0.854	0.817	-0.011	0.441	-0.062	0.185	-0.081
stockbra																								1.209	-0.038	0.234	0.065	0.034	-0.106
stockchi																									-0.128	0.295	0.160	0.029	-0.022
stockur																										-0.078	0.013	-0.039	0.059
stockvzla																											0.013	-0.038	0.114
stockmex																												0.952	0.193
stockasia																													0.163

Panel B: Adjusted standard errors of the Clayton copula estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	0.244	0.465	0.004	0.087	0.022	0.002	0.003	0.000	0.000	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embibra		0.697	0.009	0.133	0.041	0.002	0.001	0.000	0.000	0.001	0.012	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.004	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embichi			0.009	0.145	0.055	0.003	0.001	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.004	0.001	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embiur				0.002	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000	0.008	0.001	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000
embivzla					0.019	0.002	0.005	0.000	0.002	0.000	0.004	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.006	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embimex						0.064	0.000	0.000	0.001	0.018	0.009	0.002	0.003	0.000	0.006	0.000	0.000	0.003	0.002	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embiasia							0.002	0.000	0.006	0.002	0.001	0.000	0.001	0.000	0.003	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
embirus								0.000	0.002	0.000	0.005	0.003	0.001	0.002	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
forexarg									0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.001	0.000	0.000	0.000
forexbol										0.008	0.000	0.000	0.001	0.000	0.018	0.000	0.000	0.001	0.003	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.001	0.000
forexbra											0.010	0.000	0.000	0.001	0.008	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.002	0.000
forexchi												0.001	0.000	0.001	0.000	0.000	0.000	0.003	0.003	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
forexpar													0.000	0.002	0.000	0.000	0.000	0.001	0.001	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001
forexur														0.000	0.016	0.000	0.000	0.000	0.000	0.004	0.006	0.002	0.002	0.000	0.000	0.001	0.000	0.001	0.000
forexvzla															0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.002	0.000	0.000	0.000
intarg																0.000	0.000	0.001	0.001	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
intbol																	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000
intbra																		0.012	0.000	0.012	0.004	0.000	0.003	0.000	0.000	0.000	0.001	0.000	0.000
intchi																			0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.003	0.001	0.001
intpar																				0.000	0.006	0.000	0.003	0.001	0.002	0.001	0.000	0.000	0.001
intur																					0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.005	0.000
intvzla																						0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000
stockarg																							0.040	0.037	0.000	0.013	0.000	0.003	0.000
stockbra																								0.071	0.000	0.005	0.001	0.000	0.000
stockchi																									0.000	0.007	0.003	0.000	0.000
stockur																										0.000	0.000	0.000	0.001
stockvzla																											0.000	0.000	0.001
stockmex																												0.049	0.004
stockasia																													0.003

Notes: Panel A reports the parameters for the Clayton copula functions given the non-parametric marginals included in the analysis. When the maximum likelihood estimation procedure gives a parameter value outside the boundaries established by its restrictions we show a dash. Panel B shows the adjusted standard errors following the procedure in Chen and Fan (2006a). The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Table A3

Panel A: Frank copula estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	6.604	8.320	0.490	4.245	2.163	0.420	0.306	-	-	-	0.776	-	0.454	-	-	0.671	0.691	-	0.634	-	0.702	-	-	-	-	-	-	-	-
embibra		9.345	1.355	5.108	2.956	0.499	0.466	-	1.081	0.788	1.556	-	0.948	0.897	0.635	-	0.655	-	0.416	-	0.370	-	-	-	-	-	-	-	-
embichi			1.328	5.329	3.428	0.469	0.502	0.072	-	0.585	1.131	-	-	-	0.788	0.644	0.597	-	0.451	0.569	0.510	-	-	-	0.998	-	-	-	-
embiur				0.566	0.889	-	0.503	0.654	-	-	-	0.540	-	0.516	0.862	0.665	-	-	1.290	0.759	-	-	-	-	0.372	1.067	-	-	1.095
embivzla					2.023	0.476	0.945	-	0.410	-	0.842	-	0.471	0.625	1.123	-	-	-	1.097	0.703	0.560	-	-	-	-	-	-	-	-
embimex						3.680	0.976	-	0.600	1.962	1.324	0.521	0.449	0.799	1.097	-	1.016	0.517	0.566	-	0.395	-	-	-	-	-	-	-	-
embiasia							0.540	-	1.087	0.629	0.372	-	0.581	1.315	0.549	-	0.629	-	-	-	-	-	-	-	-	-	-	-	-
embirus								0.249	0.545	-	0.982	0.508	0.612	0.475	-	-	-	-	0.521	-	-	-	-	-	-	-	-	-	0.941
forexarg									0.569	0.543	-	0.118	0.770	0.966	1.549	0.324	-	-	0.160	-	-	0.764	-	-	0.098	0.446	-	-	0.800
forexbol										1.307	0.397	-	0.568	-	1.940	-	-	0.645	0.484	-	-	0.485	-	0.667	-	0.489	0.768	0.446	-
forexbra											1.444	-	-	0.794	1.259	-	-	0.491	0.540	-	-	-	-	-	0.779	-	-	0.457	-
forexchi												0.497	0.597	0.472	0.787	-	1.058	0.391	0.319	0.311	0.419	-	-	-	-	-	-	-	1.039
forexpar													-	0.602	0.644	-	-	0.685	0.854	0.851	0.482	-	-	-	-	-	0.612	-	0.651
forexur														-	1.809	-	0.696	-	0.730	0.375	1.093	0.574	0.497	-	-	0.827	-	0.720	-
forexvzla															0.669	0.565	-	-	0.992	1.325	1.101	-	1.546	-	-	0.580	0.944	0.693	-
intarg																-	-	0.787	0.732	-	1.635	-	-	-	-	-	-	1.064	-
intbol																	-	-	-	-	0.386	-	0.646	-	-	-	1.064	0.898	-
intbra																		1.605	-	1.589	0.555	-	0.489	-	-	-	0.619	-	-
intchi																			-	-	0.508	-	-	-	-	0.717	0.410	0.692	0.586
intpar																				0.840	1.066	-	0.343	0.730	0.442	0.650	-	-	0.751
intur																					0.753	1.047	0.691	-	0.627	0.560	1.031	0.943	0.707
intvzla																						-	0.481	0.461	-	-	-	-	-
stockarg																							2.908	2.806	-	1.672	-	0.768	-
stockbra																								3.849	-	0.950	0.466	0.851	-
stockchi																									-	1.174	0.399	0.635	-
stockur																										-	0.692	-	0.727
stockvzla																											0.688	-	0.660
stockmex																												3.176	0.537
stockasia																													0.448

Panel B: Adjusted standard errors of the Frank copula estimates

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	2.045	2.462	0.401	1.515	1.039	0.308	0.263	-	-	-	0.994	-	0.312	-	-	0.484	0.526	-	0.429	-	0.474	-	-	-	-	-	-	-	-
embibra		2.641	1.130	1.710	1.218	0.357	0.399	-	0.956	0.539	1.034	-	0.655	0.594	0.394	-	0.499	-	0.283	-	0.252	-	-	-	-	-	-	-	-
embichi			1.091	1.770	1.310	0.341	0.433	0.086	-	0.370	0.937	-	-	-	0.520	0.502	0.416	-	0.320	0.458	0.381	-	-	-	0.904	-	-	-	-
embiur				0.417	0.684	-	0.395	0.805	-	-	-	0.383	-	0.352	0.556	0.477	-	-	1.069	0.545	-	-	-	-	0.284	0.816	-	-	0.769
embivzla					1.068	0.361	1.164	-	0.311	-	0.864	-	0.310	0.436	0.881	-	-	-	1.329	0.501	0.377	-	-	-	-	-	-	-	-
embimex						1.321	0.910	-	0.444	0.979	0.983	0.346	0.292	0.534	1.284	-	0.800	0.416	0.391	-	0.262	-	-	-	-	-	-	-	-
embiasia							0.435	-	1.299	0.370	0.331	-	0.363	0.981	0.394	-	0.448	-	-	-	-	-	-	-	-	-	-	-	-
embirus								0.222	0.450	-	0.894	0.372	0.423	0.352	-	-	-	-	0.394	-	-	-	-	-	-	-	-	-	3.191
forexarg									0.499	0.662	-	0.122	1.459	2.418	2.434	0.380	-	-	0.252	-	-	0.563	-	-	0.091	0.588	-	-	1.385
forexbol										1.115	0.406	-	0.351	-	0.959	-	-	0.421	0.353	-	-	0.366	-	0.516	-	0.349	0.559	0.376	-
forexbra											1.035	-	-	0.466	1.398	-	-	0.317	0.341	-	-	-	-	-	0.555	-	-	0.345	-
forexchi												0.420	0.527	0.387	0.653	-	1.034	0.405	0.288	0.371	0.383	-	-	-	-	-	-	-	0.929
forexpar													-	0.356	0.358	-	-	0.442	0.548	0.625	0.354	-	-	-	-	-	0.430	-	0.393
forexur														-	0.910	-	0.391	-	0.415	0.264	1.319	0.382	0.354	-	-	0.522	-	0.513	-
forexvzla															0.402	0.373	-	-	0.600	1.068	0.725	-	1.054	-	-	0.391	0.675	0.492	-
intarg																-	-	0.512	0.457	-	0.968	-	-	-	-	-	-	0.803	-
intbol																	-	-	-	-	0.276	-	0.537	-	-	-	1.087	1.147	-
intbra																		0.976	-	0.971	0.433	-	0.480	-	-	-	0.477	-	-
intchi																			-	-	0.356	-	-	-	-	0.471	0.327	0.610	0.380
intpar																				0.675	1.131	-	0.265	0.576	0.359	0.463	-	-	0.458
intur																					0.511	0.947	0.583	-	0.573	0.404	0.893	1.132	0.500
intvzla																						-	0.359	0.362	-	-	-	-	-
stockarg																							1.272	1.225	-	0.988	-	2.311	-
stockbra																								1.582	-	1.060	0.433	0.959	-
stockchi																									-	0.845	0.488	0.917	-
stockur																										-	0.655	-	0.544
stockvzla																											0.507	-	0.446
stockmex																												1.404	0.459
stockasia																													0.347

Notes: Panel A reports the parameters for the Frank copula functions given the non-parametric marginals included in the analysis. When the maximum likelihood estimation procedure gives a parameter value outside the boundaries established by its restrictions we show a dash. Panel B shows the adjusted standard errors following the procedure in Chen and Fan (2006a). The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Table A4. Gumbel-Hougaard copula weights

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	0.3295	0.3478	0.3619	0.2863	0.3448	0.3551	0.2504	0.2016	0.2988	0.4089	0.3661	0.3100	0.3907	0.4970	0.2378	0.4054	0.3554	0.2672	0.3634	0.4213	0.3540	0.4026	0.1864	0.6132	0.3924	0.4196	0.3344	0.1244	0.4326
embibra		0.2727	0.3565	0.2202	0.2940	0.5373	0.4600	0.6464	0.2833	0.4211	0.4510	0.3799	0.2926	0.2826	0.2964	0.2650	0.2782	0.3797	0.2694	0.3364	0.2079	0.4105	0.3072	0.1924	0.3456	0.3089	0.3367	0.3662	0.2415
embichi			0.2905	0.3516	0.3408	0.2632	0.2904	0.0400	0.3705	0.3302	0.3075	0.2739	0.5110	0.3412	0.4028	0.3529	0.2772	0.3480	0.2911	0.2710	0.4000	0.1982	0.3633	0.4375	0.2629	0.3783	0.2283	0.3176	0.3753
embiur				0.2548	0.4285	0.2502	0.2220	0.0600	0.2232	0.4048	0.1777	0.2557	0.2887	0.4602	0.2372	0.3146	0.2257	0.3586	0.3295	0.4020	0.3570	0.4361	0.4661	0.1657	0.4129	0.3583	0.2075	0.3772	0.4318
embivzla					0.2767	0.2206	0.4689	0.4356	0.2481	0.3741	0.3320	0.4179	0.4346	0.3516	0.4321	0.1680	0.3975	0.3170	0.2526	0.2570	0.3313	0.4603	0.3729	0.1940	0.3421	0.3470	0.4062	0.4925	0.2313
embimex						0.2960	0.2800	0.1925	0.2717	0.3999	0.3284	0.4300	0.2866	0.4188	0.3507	0.4479	0.3201	0.3916	0.3001	0.5754	0.3223	0.3174	0.3896	0.2306	0.3939	0.5078	0.3668	0.2976	0.3421
embiasia							0.4799	0.3467	0.3797	0.3395	0.3457	0.2580	0.3315	0.1879	0.3702	0.3308	0.3550	0.2811	0.4455	0.4653	0.2853	0.3168	0.2449	0.3396	0.3985	0.4878	0.2415	0.1785	0.3861
embirus								0.4100	0.2590	0.4987	0.1821	0.3725	0.2839	0.3210	0.2379	0.1557	0.2903	0.2608	0.3618	0.1409	0.1344	0.3973	0.6132	0.6131	0.6217	0.3652	0.3411	0.3778	0.3298
forexarg									0.1797	0.3237	0.2414	0.4022	0.4577	0.3677	0.3283	0.3689	0.2003	0.4060	0.5546	0.2768	0.3085	0.3679	0.3013	0.6153	0.2187	0.3203	0.3010	0.3836	0.3387
forexbol										0.2518	0.3752	0.4098	0.2975	0.2315	0.3282	0.2070	0.4486	0.4097	0.2294	0.4527	0.1115	0.4235	0.4343	0.4097	0.1751	0.3876	0.3268	0.2611	0.4381
forexbra											0.3325	0.3534	0.2660	0.3352	0.3011	0.3003	0.2749	0.3492	0.5333	0.2992	0.2638	0.2736	0.4177	0.3390	0.3326	0.3767	0.3592	0.2969	0.4366
forexchi												0.3712	0.2845	0.2039	0.3374	0.5617	0.3359	0.3899	0.3389	0.1618	0.3212	0.4177	0.4652	0.1676	0.1890	0.3144	0.2939	0.3152	0.3380
forexpar													0.2576	0.3269	0.3737	0.3039	0.3782	0.2794	0.2298	0.3711	0.2992	0.3333	0.3104	0.1691	0.3230	0.1155	0.2385	0.2859	0.3411
forexur														0.3578	0.3662	0.4859	0.3288	0.2066	0.2394	0.2770	0.2786	0.1891	0.3893	0.3426	0.3463	0.2796	0.2721	0.2836	0.3453
forexvzla															0.2177	0.3619	0.2672	0.3478	0.2795	0.4520	0.3200	0.3188	0.3075	0.4351	0.3693	0.3265	0.2730	0.3474	0.2399
intarg																0.2755	0.2443	0.3794	0.1987	0.2757	0.3636	0.2304	0.2815	0.2573	0.3911	0.1399	0.2228	0.3714	0.2954
intbol																	0.2201	0.2299	0.3201	0.3448	0.3095	0.4201	0.3883	0.4033	0.3579	0.3612	0.3104	0.3911	0.5002
intbra																		0.3089	0.3458	0.2873	0.2997	0.2974	0.2767	0.2353	0.2826	0.3675	0.4627	0.1812	0.2992
intchi																			0.2016	0.5416	0.3581	0.2555	0.2568	0.4299	0.1569	0.2872	0.2387	0.2775	0.3754
intpar																				0.1821	0.3063	0.2971	0.4023	0.3406	0.2998	0.4598	0.2721	0.1781	0.3421
intur																					0.2785	0.2966	0.1907	0.1525	0.3627	0.3241	0.3468	0.3470	0.1948
intvzla																						0.5321	0.3489	0.1679	0.5206	0.1753	0.2935	0.2353	0.4687
stockarg																							0.3794	0.2483	0.3574	0.3065	0.2399	0.2174	0.3297
stockbra																								0.5000	0.2652	0.2770	0.2605	0.2818	0.4263
stockchi																									0.3274	0.2136	0.3522	0.4133	0.3022
stockur																										0.2115	0.3374	0.5477	0.3844
stockvzla																											0.3271	0.2655	0.1753
stockmex																												0.1829	0.3044
stockasia																													0.4243

Notes: This table reports the weights for the Gumbel-Hougaard copula in the mixed copula functions. The weights of the mixed copula functions are obtained using an EM-based clustering estimation procedure. The Gumbel, Clayton, and Frank copula functions were included. The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Table A5. Clayton copula weights

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	0.3904	0.2659	0.2783	0.4000	0.3653	0.2076	0.2896	0.3885	0.4108	0.3430	0.3040	0.4586	0.3040	0.1705	0.5007	0.3095	0.3030	0.2745	0.4133	0.2661	0.3265	0.4250	0.4918	0.2232	0.4602	0.3180	0.2175	0.4983	0.3329
embibra		0.3276	0.3467	0.3599	0.2521	0.2077	0.2908	0.2498	0.3285	0.2496	0.3367	0.2060	0.2563	0.3298	0.3031	0.4445	0.3501	0.3236	0.2956	0.1889	0.4711	0.1424	0.3267	0.6357	0.3725	0.2749	0.3741	0.3367	0.4827
embichi			0.4498	0.3780	0.3308	0.5174	0.2496	0.0200	0.4382	0.4028	0.3030	0.5132	0.1639	0.4239	0.2833	0.2748	0.3544	0.2978	0.4038	0.3795	0.2797	0.5054	0.3860	0.2169	0.4562	0.2164	0.4220	0.4469	0.4085
embiur				0.4068	0.2807	0.2587	0.3180	0.5670	0.3327	0.1723	0.1852	0.3323	0.3535	0.3599	0.3136	0.2470	0.1844	0.3291	0.2007	0.1628	0.3533	0.2940	0.2750	0.4905	0.2911	0.2854	0.4326	0.3548	0.2707
embivzla					0.3565	0.2739	0.1813	0.2687	0.3837	0.2918	0.4051	0.3581	0.2905	0.3088	0.3107	0.5490	0.2109	0.3988	0.4222	0.2572	0.3200	0.2236	0.3861	0.2455	0.2275	0.3292	0.2693	0.1539	0.3638
embimex						0.3811	0.4600	0.1817	0.2618	0.3414	0.2629	0.4185	0.3784	0.3333	0.3086	0.2382	0.3320	0.3476	0.2665	0.2343	0.3475	0.3661	0.2816	0.1801	0.3931	0.2037	0.3083	0.3403	0.3957
embiasia							0.2347	0.3027	0.3121	0.3783	0.2598	0.3799	0.2773	0.3755	0.4390	0.3373	0.2231	0.3799	0.2989	0.2074	0.4500	0.2465	0.3867	0.5043	0.2934	0.2317	0.2949	0.3019	0.1180
embirus								0.0600	0.4904	0.3623	0.4202	0.2586	0.3077	0.3908	0.4127	0.2421	0.3797	0.3084	0.3187	0.4398	0.5202	0.4765	0.2372	0.1784	0.2015	0.3272	0.1897	0.3454	0.3368
forexarg									0.4302	0.3716	0.4065	0.3153	0.2423	0.2310	0.4123	0.2981	0.2245	0.2562	0.1838	0.2546	0.3036	0.3769	0.1775	0.1071	0.3303	0.3304	0.1994	0.3452	0.2684
forexbol										0.3895	0.2287	0.3745	0.3546	0.5241	0.3910	0.3967	0.1835	0.2345	0.3375	0.4177	0.4327	0.2906	0.2789	0.3631	0.4152	0.2952	0.4119	0.3364	0.4129
forexbra											0.2424	0.2423	0.3622	0.3908	0.3589	0.2378	0.5074	0.3293	0.1699	0.3181	0.4643	0.3945	0.2987	0.2617	0.3315	0.1538	0.3414	0.3217	0.2624
forexchi												0.2394	0.2591	0.4023	0.3722	0.3133	0.2686	0.4112	0.2916	0.3415	0.2787	0.1940	0.2636	0.5170	0.1788	0.2258	0.4776	0.3932	0.3555
forexpar													0.2739	0.4390	0.3877	0.3356	0.2627	0.3869	0.3879	0.4203	0.3102	0.3215	0.4894	0.2326	0.4976	0.3831	0.3985	0.5010	0.3784
forexur														0.3907	0.4502	0.1961	0.3057	0.5404	0.5227	0.4142	0.3930	0.3224	0.4284	0.3123	0.3008	0.3291	0.3813	0.3801	0.1718
forexvzla															0.3200	0.1989	0.4238	0.3572	0.4796	0.2983	0.3314	0.2648	0.1419	0.2468	0.2767	0.4013	0.4587	0.2736	0.4866
intarg																0.3193	0.1924	0.3609	0.3574	0.3833	0.3909	0.2027	0.3672	0.4962	0.4026	0.5278	0.3796	0.2592	0.4421
intbol																	0.4348	0.3229	0.2122	0.3154	0.3706	0.3394	0.2819	0.3309	0.3827	0.2400	0.3543	0.3091	0.3096
intbra																		0.3281	0.3098	0.3182	0.3316	0.3252	0.3917	0.3408	0.2057	0.4290	0.2423	0.4474	0.2869
intchi																			0.2037	0.2240	0.3304	0.4206	0.4920	0.4374	0.4970	0.4193	0.3493	0.3604	0.2964
intpar																				0.5904	0.3950	0.3194	0.3624	0.1992	0.2705	0.2996	0.4410	0.6699	0.3210
intur																					0.3101	0.5029	0.5477	0.6757	0.3800	0.3844	0.2754	0.2942	0.3950
intvzla																						0.2062	0.4433	0.4039	0.1169	0.4714	0.3464	0.2374	0.1889
stockarg																							0.3082	0.3905	0.3167	0.3360	0.4388	0.4154	0.4353
stockbra																								0.2804	0.3107	0.4220	0.4656	0.2718	0.3110
stockchi																									0.3639	0.3200	0.2962	0.3713	0.3241
stockur																										0.3087	0.3432	0.1682	0.3100
stockvzla																											0.4147	0.4147	0.2730
stockmex																												0.3517	0.2684
stockasia																													0.3972

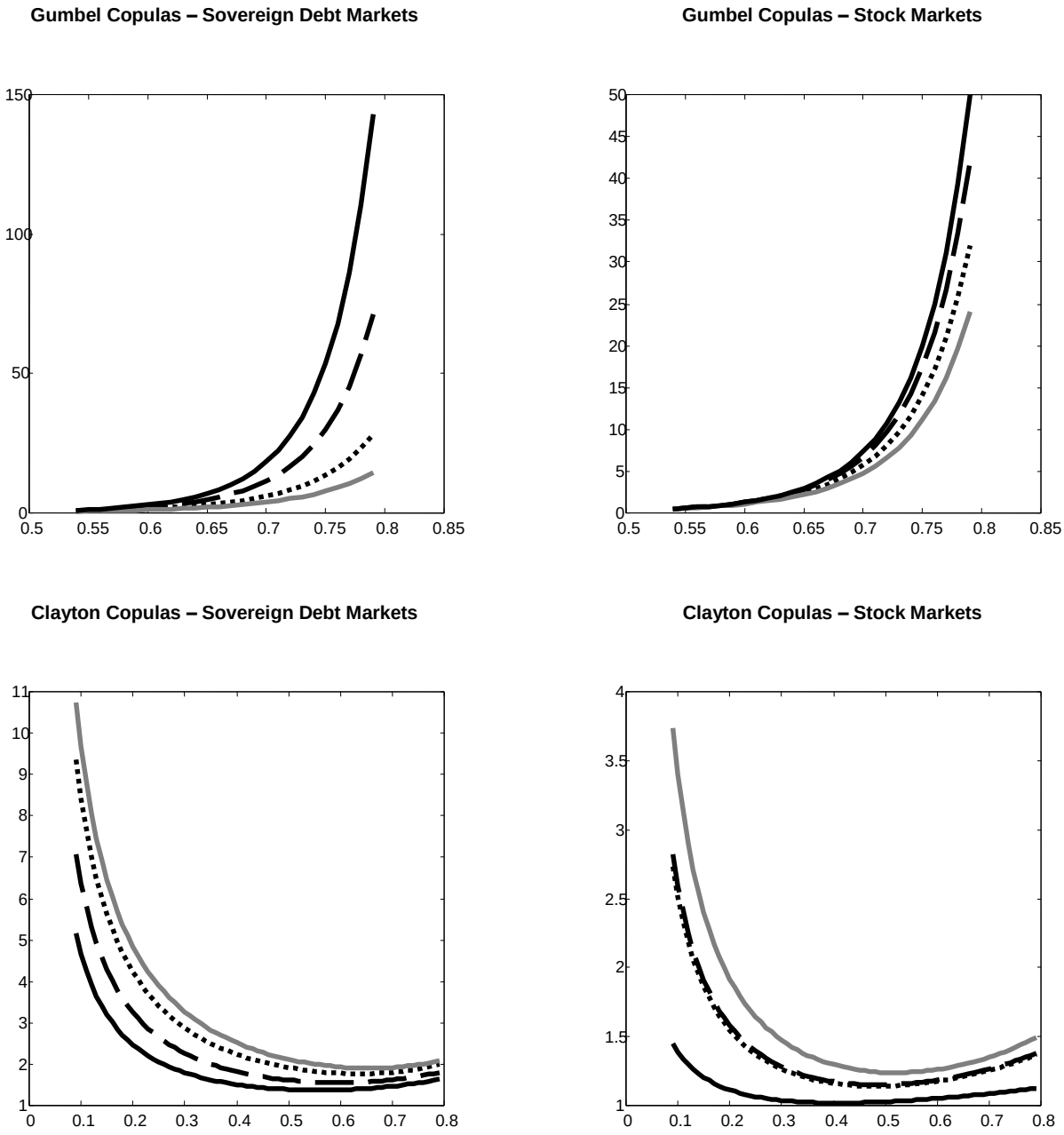
Notes: This table reports the weights for the Clayton copula in the mixed copula functions. The weights of the mixed copula functions are obtained an EM-based clustering estimation procedure. The Gumbel, Clayton, and Frank copula functions were included. The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Table A6. Frank copula weights

	embibra	embichi	embiur	embivzla	embimex	embiasia	embirus	forexarg	forexbol	forexbra	forexchi	forexpar	forexur	forexvzla	intarg	intbol	intbra	intchi	intpar	intur	intvzla	stockarg	stockbra	stockchi	stockur	stockvzla	stockmex	stockasia	stockrus
embiarg	0.2802	0.3863	0.3597	0.3136	0.2899	0.4373	0.4600	0.4098	0.2903	0.2481	0.3298	0.2314	0.3053	0.3325	0.2614	0.2851	0.3416	0.4584	0.2233	0.3126	0.3195	0.1724	0.3218	0.1636	0.1474	0.2624	0.4482	0.3773	0.2345
embibra		0.3997	0.2968	0.4199	0.4539	0.2550	0.2492	0.1038	0.3882	0.3293	0.2123	0.4141	0.4511	0.3876	0.4005	0.2905	0.3716	0.2967	0.4350	0.4748	0.3210	0.4471	0.3661	0.1719	0.2819	0.4162	0.2892	0.2971	0.2758
embichi			0.2596	0.2703	0.3284	0.2194	0.4600	0.9400	0.1912	0.2670	0.3895	0.2129	0.3251	0.2349	0.3139	0.3723	0.3684	0.3542	0.3051	0.3495	0.3203	0.2964	0.2507	0.3455	0.2810	0.4053	0.3497	0.2355	0.2162
embiur				0.3384	0.2907	0.4912	0.4600	0.3730	0.4441	0.4229	0.6371	0.4120	0.3579	0.1799	0.4492	0.4385	0.5899	0.3123	0.4698	0.4352	0.2897	0.2699	0.2588	0.3438	0.2960	0.3563	0.3599	0.2680	0.2974
embivzla					0.3668	0.5055	0.3498	0.2957	0.3682	0.3340	0.2629	0.2240	0.2749	0.3396	0.2572	0.2830	0.3916	0.2842	0.3252	0.4858	0.3487	0.3161	0.2410	0.5605	0.4304	0.3238	0.3245	0.3536	0.4048
embimex						0.3229	0.2600	0.6258	0.4665	0.2586	0.4087	0.1515	0.3350	0.2480	0.3406	0.3139	0.3479	0.2608	0.4334	0.1903	0.3302	0.3165	0.3288	0.5893	0.2130	0.2885	0.3249	0.3621	0.2622
embiasia							0.2854	0.3506	0.3083	0.2822	0.3945	0.3622	0.3912	0.4366	0.1908	0.3319	0.4219	0.3389	0.2555	0.3274	0.2647	0.4367	0.3683	0.1561	0.3081	0.2805	0.4635	0.5196	0.4959
embirus								0.5300	0.2507	0.1390	0.3977	0.3690	0.4084	0.2882	0.3494	0.6021	0.3300	0.4308	0.3195	0.4192	0.3455	0.1262	0.1496	0.2085	0.1768	0.3076	0.4692	0.2768	0.3335
forexarg									0.3901	0.3047	0.3521	0.2826	0.3000	0.4013	0.2594	0.3330	0.5752	0.3378	0.2616	0.4686	0.3878	0.2552	0.5212	0.2777	0.4510	0.3493	0.4996	0.2711	0.3929
forexbol										0.3587	0.3961	0.2157	0.3480	0.2444	0.2808	0.3963	0.3679	0.3558	0.4331	0.1296	0.4558	0.2859	0.2869	0.2272	0.4097	0.3171	0.2614	0.4026	0.1490
forexbra											0.4250	0.4043	0.3718	0.2740	0.3400	0.4620	0.2176	0.3214	0.2968	0.3827	0.2719	0.3320	0.2836	0.3993	0.3358	0.4695	0.2994	0.3815	0.3010
forexchi												0.3894	0.4564	0.3937	0.2904	0.1250	0.3955	0.1990	0.3696	0.4967	0.4001	0.3882	0.2712	0.3154	0.6323	0.4597	0.2285	0.2916	0.3065
forexpar													0.4685	0.2342	0.2385	0.3605	0.3590	0.3337	0.3823	0.2086	0.3906	0.3453	0.2002	0.5983	0.1795	0.5014	0.3630	0.2132	0.2805
forexur														0.2515	0.1836	0.3180	0.3656	0.2530	0.2379	0.3088	0.3284	0.4885	0.1822	0.3451	0.3529	0.3913	0.3467	0.3363	0.4828
forexvzla															0.4623	0.4392	0.3090	0.2950	0.2408	0.2497	0.3486	0.4164	0.5506	0.3180	0.3540	0.2721	0.2684	0.3790	0.2734
intarg																0.4052	0.5632	0.2598	0.4438	0.3410	0.2455	0.5669	0.3512	0.2466	0.2064	0.3323	0.3976	0.3694	0.2625
intbol																	0.3450	0.4472	0.4677	0.3398	0.3199	0.2406	0.3299	0.2657	0.2594	0.3987	0.3353	0.2998	0.1902
intbra																		0.3630	0.3444	0.3945	0.3687	0.3774	0.3316	0.4239	0.5118	0.2035	0.2951	0.3714	0.4138
intchi																			0.5947	0.2344	0.3115	0.3239	0.2512	0.1327	0.3461	0.2935	0.4120	0.3620	0.3281
intpar																				0.2275	0.2987	0.3835	0.2353	0.4602	0.4296	0.2406	0.2869	0.1520	0.3369
intur																					0.4114	0.2005	0.2616	0.1718	0.2573	0.2915	0.3778	0.3588	0.4102
intvzla																						0.2617	0.2078	0.4282	0.3625	0.3533	0.3601	0.5273	0.3423
stockarg																							0.3123	0.3612	0.3259	0.3575	0.3213	0.3672	0.2350
stockbra																								0.2196	0.4241	0.3010	0.2740	0.4464	0.2628
stockchi																									0.3086	0.4664	0.3516	0.2154	0.3737
stockur																										0.4798	0.3194	0.2841	0.3056
stockvzla																											0.2582	0.3198	0.5517
stockmex																												0.4654	0.4272
stockasia																													0.1785

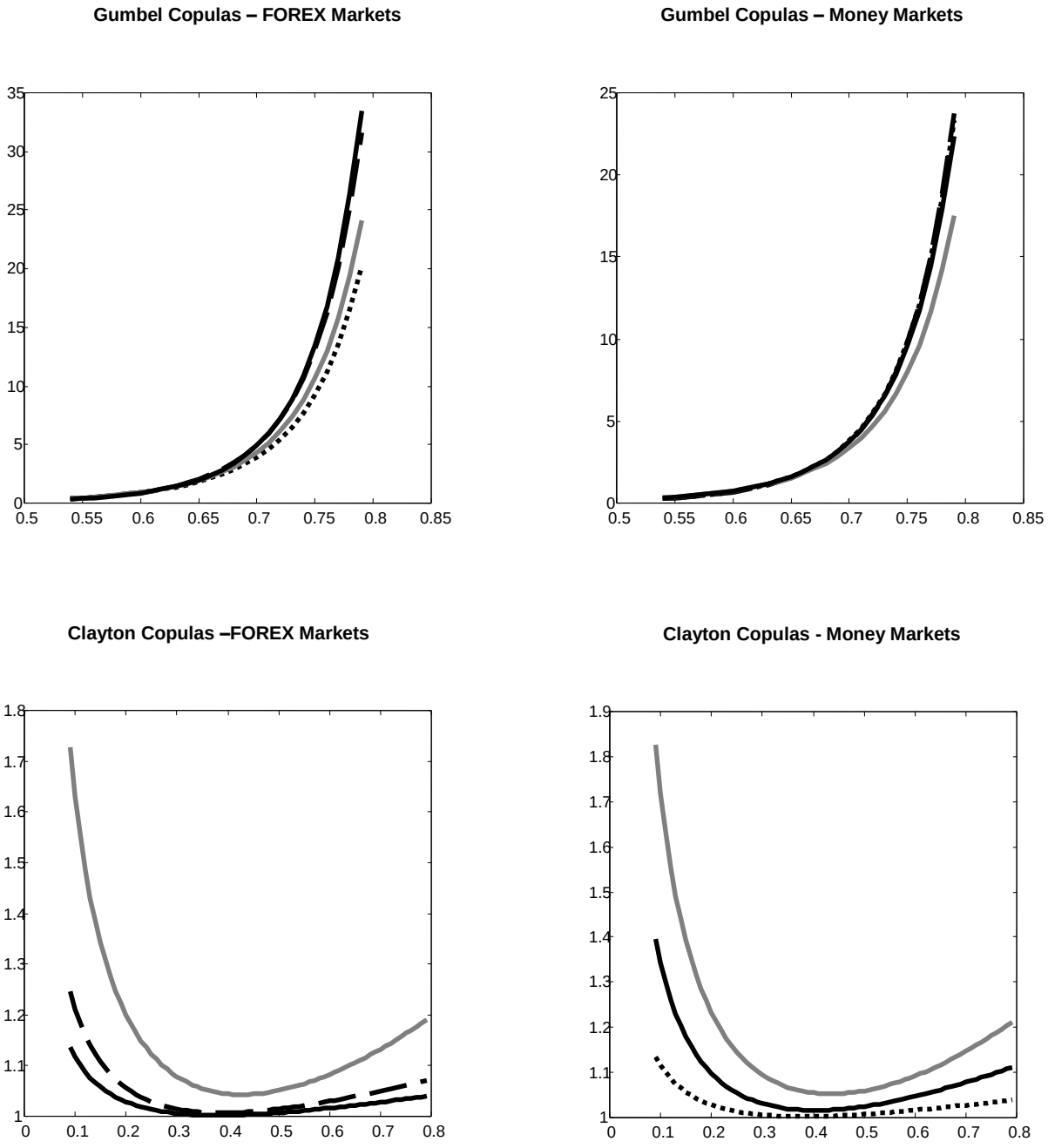
Notes: This table reports the weights for the Frank copula in the mixed copula functions. The weights of the mixed copula functions are obtained an EM-based clustering estimation procedure. The Gumbel, Clayton, and Frank copula functions were included. The sample period is 02/1994-06/2002. Embiarg denotes Argentina's EMBI index, Embimex, Mexico's EMBI index, Intvzla, the monthly interest rate in Venezuela, Stockbra, the stock market returns in Brazil, and so on for each asset and country.

Figure A1. Asymmetric dependence in the sovereign debt and stock markets



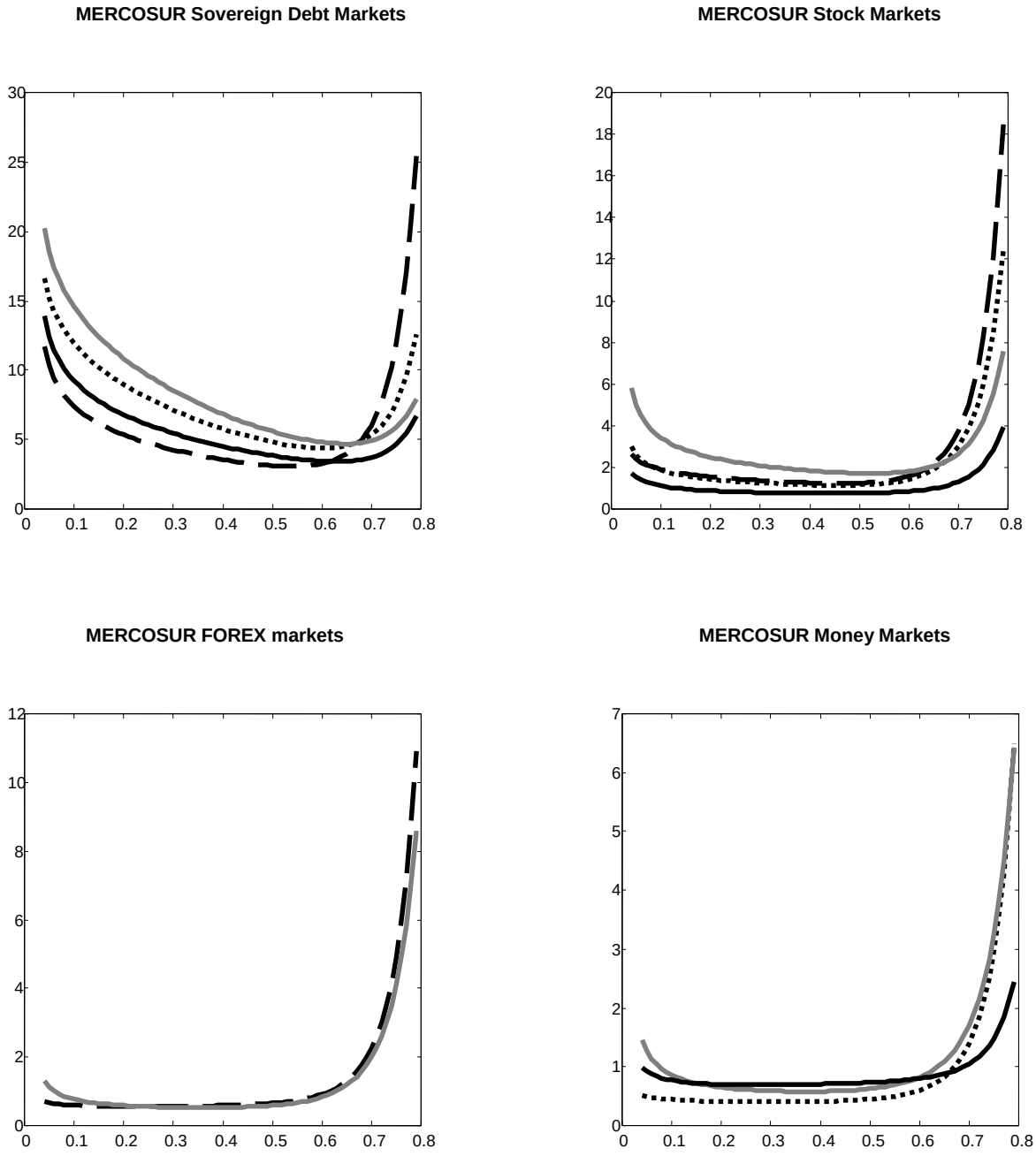
Note: This figure shows the degree of statistical dependence in the major sovereign debt and stock markets in Mercosur at the right and left tails of the distributions. The black dashed line represents the relation Argentina-Brazil, the black dotted line Argentina-Chile, the grey line Brazil-Chile, and the black solid line the relation Brazil-Venezuela, respectively.

Figure A2. Asymmetric dependence in the forex and money markets



Note: This figure shows the degree of statistical dependence in the major foreign exchange and money markets in Mercosur at the right and left tails of the distributions. The black dashed line represents the relation Argentina-Brazil, the black dotted line Argentina-Chile, the grey line Brazil-Chile, and the black solid line the relation Brazil-Venezuela, respectively.

Figure A3. Mixed copula functions for selected Mercosur countries



Note: This figure shows the degree of statistical dependence in the major Mercosur financial markets using the mixed copula function. The black dashed line represents the relation Argentina-Brazil, the black dotted line Argentina-Chile, the grey line Brazil-Chile, and the black solid line the relation Brazil-Venezuela, respectively.