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Greek Economic Policy Uncertainty: Does it matter for the European Union?

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Abstract

We examine the propagation of economic policy uncertainty shocks within Greece and across Europe. Our analysis reveals that Greek economic policy uncertainty was dominating the European economic policy uncertainty nearly permanently throughout the period of analysis. In particular, uncertainty related to the Greek banking sector (capital controls) and currency issues (Grexit possibility) had a significant impact on European economic policy uncertainty. Further evidence suggests that, within Greece, fiscal policy uncertainty was driven by shocks related to currency, banking and monetary policy uncertainty.

Keywords: TVP-VAR-SV, Dynamic Connectedness, Dynamic Connectedness Decomposition, Categorical Economic Policy Uncertainty Spillovers
JEL codes: C32, C50, F42

1 Introduction

In the wake of the global financial crisis (GFC) of 2007-2008, when the global economy was still reeling, recovery in Europe (and the world), was delayed due to the Eurozone sovereign debt crisis of 2010. While, the main root of this Eurozone crisis was in Greece, countries like Cyprus, Ireland, Italy, Portugal and Spain also had a role to play. These countries would have been unable to repay or refinance their government debt or to bail out over-indebted banks under their national supervision without the assistance of other Eurozone countries, the European Central Bank (ECB), and the International Monetary Fund (IMF).[1]

While, spillovers within the sovereign debt markets across economies have been widely studied (see, for example, Antonakakis et al., 2018; Apergis and Cooray, 2014; De Santis and Zimic, 2018, and references cited therein), we are not aware of any studies that has quantitatively assessed the spillovers of various types of policy-related uncertainties within Greece and Europe. In this regard, besides Greek sovereign debt uncertainty, we also analyze banking, currency, tax, pension fund, and monetary policies related uncertainties. While studies like Colombo (2013), Ajmi et al. (2014), Klößner and Sekkel (2014), Yin and Han (2014), Biljanovska et al. (2017), and Caggiano et al. (2017) have analyzed the spillover of uncertainties across economies, our study is the first, to examine the spillovers of various types of uncertainties within Greece and Europe, by taking advantage of the newly developed connectedness decomposition approach by Gabauer and Gupta (2018) which allows the calculation of country-internal and external transmission mechanisms.

This is an important line of research, since if the uncertainties across economies are indeed interrelated, as the above-mentioned studies show, then a particular economy can be influenced by the negative impacts of external uncertainty shocks (see for example Castelnuovo et al., 2017; Gupta et al., 2018a,b). On the other side, an increase in domestic uncertainty is likely to have prolonged effects on the domestic economy through international uncertainty feedbacks. Note that this points to the fact that the analysis of within-country policy uncertainty spillovers is essential for policymakers. In an attempt to reveal the internal and external transmission mechanism between Greece and Europe, this paper utilizes the connectedness approach (Diebold and Yılmaz, 2014) based on the fully-fledged time-varying parameter vector autoregression with stochastic volatility algorithm (TVP-VAR-SV) suggested by Antonakakis and Gabauer (2017). This improves the widely-used methodology substantially, since there is no need to arbitrarily set the rolling-window size, there is no loss of observations and the results are not sensitive to outliers. In addition, we are employing the aforementioned decomposition approach that dismantles spillovers in country-internal and external ones, so as to analyze the contribution of within-country and international shocks.

Altogether, to the best of our knowledge, this is the first attempt to analyze spillovers of categorical policy uncertainties within Greece and its associated impact on Europe, using a time-varying decomposed connectedness approach. The results of our empirical analysis reveal that the economic policy uncertainty in Greece is driving the European one, which is mainly caused by the fact that the Greek currency and monetary spillovers driving the European uncertainty, whereas the European economic policy uncertainty is dominating the Greek pension and debt uncertainties. Finally, we find support that fiscal policy uncertainty is overshadowed by shocks

[1] The detailed causes of the debt crisis tend to vary. In several countries, private debts arising from a property bubble were transferred to sovereign debt as a result of banking system bailouts and government responses to slowing economies post-bubble. The structure of the eurozone as a currency union without fiscal union is believed to have contributed to the crisis and limited the ability of European leaders to respond. At the same time, European banks also tend to own a significant amount of sovereign debt, resulting in concerns regarding the solvency of banking systems or sovereigns, which in turn deepened the crisis.

related to currency, banking and monetary policy uncertainty.

The remainder of this paper is organized as follows: Section 2 describes the data and the empirical methodology. The empirical results of our analysis are presented in Section 3, while Section 4 concludes the study.

2 Data & Methodology

The dataset consists of monthly news-based economic policy uncertainty indices for Europea (EEPU) and in terms of Greece categorical uncertainty indices are provided for banking (EPUB), currency (EPUC), taxes (EPUT), debt (EPUD), pension (EPUP), and monetary policy (EPUM). These indices are based on the works of Baker et al. (2016) for Europe and Hardouvelis et al. (2018) for Greece. Our data[2] spans over the period from January, 1998 to May, 2018. To generate stationary time series, all economic policy uncertainty series are converted to annual percentage changes by, $y_{it} = log(x_{it}) - log(x_{it-12})$.

Furthermore, the time-varying relationships among the uncertainty indices are estimated via the TVP-VAR-SV algorithm a la Antonakakis and Gabauer (2017). Since the Bayesian information criterion suggests one lag, the TVP-VAR(1) can be formalised as follows,

$$\boldsymbol{y}_t = \boldsymbol{\Phi}_t \boldsymbol{y}_{t-1} + \boldsymbol{u}_t \qquad \boldsymbol{u}_t|\boldsymbol{\Omega}_{t-1} \sim N(\mathbf{0}, \boldsymbol{\Sigma}_t) \tag{1}$$

$$vec(\boldsymbol{\Phi}_t) = vec(\boldsymbol{\Phi}_{t-1}) + \boldsymbol{\xi}_t \qquad \boldsymbol{\xi}_t|\boldsymbol{\Omega}_{t-1} \sim N(\mathbf{0}, \boldsymbol{\Xi}_t) \tag{2}$$

where $\boldsymbol{\Omega}_{t-1}$ stands for all the information available up to $t-1$, $\boldsymbol{y}_t$ and $\boldsymbol{u}_t$ represent $m \times 1$ dimensional vectors and $\boldsymbol{\Phi}_t$ and $\boldsymbol{\Sigma}_t$ are $m \times m$ dimensional matrices. In addition, $\boldsymbol{\xi}_t$ and $vec(\boldsymbol{\Phi}_t)$ are $m^2 \times 1$ dimensional vectors and $\boldsymbol{\Xi}_t$ is an $m^2 \times m^2$ dimensional matrix[3].

Since the connectedness approach of Diebold and Yılmaz (2014) rests on generalised impulse response functions (GIRF), and generalized forecast error variance decompositions (GFEVD) (developed by Koop et al., 1996; Pesaran and Shin, 1998), we need to convert the TVP-VAR into its TVP-VMA representation via the Wold representation theorem, $\boldsymbol{y}_t = \sum_{i=1}^{p} \boldsymbol{\Phi}_{it}\boldsymbol{y}_{t-i} + \boldsymbol{u}_t = \sum_{j=1}^{\infty} \boldsymbol{\Lambda}_{jt}\boldsymbol{u}_{t-j} + \boldsymbol{u}_t$. The GIRFs ($\Psi_{ij,t}(K)$) represent the K-step ahead forecast dynamics of all variables j following a shock from variable i. Mathematically, this can be written as,

$$GIRF_t(K, \sqrt{\Sigma_{jj,t}}, \boldsymbol{\Omega}_{t-1}) = E(\boldsymbol{y}_{t+K}|\boldsymbol{v}_{j,t} = \sqrt{\Sigma_{jj,t}}, \boldsymbol{\Omega}_{t-1}) - E(\boldsymbol{y}_{t+J}|\boldsymbol{\Omega}_{t-1}) \tag{3}$$

$$\boldsymbol{\Psi}_{j,t}(K) = \Sigma_{jj,t}^{-\frac{1}{2}} \boldsymbol{\Lambda}_{K,t}\boldsymbol{\Sigma}_t \boldsymbol{v}_{j,t} \tag{4}$$

Subsequently, the GFEVD ($\psi_{ij,t}(K)$) is calculated by

$$\psi_{ij,t}(K) = \frac{\sum_{t=1}^{K-1} \Psi_{ij,t}^2}{\sum_{j=1}^{m}\sum_{t=1}^{K-1} \Psi_{ij,t}^2} \qquad \sum_{j=1}^{m} \psi_{ij,t}(K) = 1 \qquad \sum_{i,j=1}^{m} \psi_{ij,t}(K) = m. \tag{5}$$

In a first step, we are interested in the *total directional connectedness*, from variable i, *TO all others* j, which is defined by,

$$\Gamma_{i\to j,t}(K) = \frac{\sum_{j=1, i\neq j}^{m} \psi_{ji,t}(K)}{\sum_{j=1}^{m} \psi_{ji,t}(K)} * 100 \tag{6}$$

[2]The data is available for download from: http://www.policyuncertainty.com/HKKS_Monthly.html and http://www.policyuncertainty.com/europe_monthly.html for Greece and Europe (excluding Greece) respectively.

[3]For details to the Kalman filter algorithm please refer to Antonakakis and Gabauer (2017)

In a second step, we reverse the procedure and calculate the *total directional connectedness*, variable i receives, *FROM all others* j,

$$\Gamma_{i\leftarrow j,t}(K) = \frac{\sum_{j=1,i\neq j}^{m} \psi_{ij,t}(K)}{\sum_{i=1}^{m} \psi_{ij,t}(K)} * 100 \tag{7}$$

Finally, we deduct equation (6) from (7) to attain *NET total directional connectedness* measures, which represent the influence variable i has on the whole network.

$$\Gamma_{i,t}(K) = \Gamma_{i\rightarrow j,t}(K) - \Gamma_{i\leftarrow j,t}(K) \tag{8}$$

A positive (negative) value illustrates that variable i is driving the network more (less) than being driven by it.

In a fourth step, the NET total directional connectedness is broken down to the bilateral level to examine the net pairwise directional connectedness (NPDC),

$$NPDC_{ij}(K) = \left(\frac{\psi_{jit}(K) - \psi_{ijt}(K)}{N}\right) * 100.$$

Finally, the total connectedness index which represents the interrelatedness of the system can be computed by

$$\Gamma_t(K) = \frac{\sum_{i,j=1,i\neq j}^{m} \psi_{ij,t}(K)}{m} * 100. \tag{9}$$

Using the decomposed connectedness approach of Gabauer and Gupta (2018), gives further insights in the country-internal and external spillovers. First, the connectedness table is rewritten by

$$\boldsymbol{\psi}(K) = [\psi]_{ij,t}(K) = \begin{bmatrix} \boldsymbol{\Gamma}_{11} & \boldsymbol{\Gamma}_{12} & \dots & \boldsymbol{\Gamma}_{1k} \\ \boldsymbol{\Gamma}_{21} & \boldsymbol{\Gamma}_{22} & \dots & \boldsymbol{\Gamma}_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ \boldsymbol{\Gamma}_{k1} & \boldsymbol{\Gamma}_{k2} & \dots & \boldsymbol{\Gamma}_{kk} \end{bmatrix}$$

where $\boldsymbol{\Gamma}_{ii}$ includes the internal spillovers of country i and $\boldsymbol{\Gamma}_{ij}$ represents the spillovers between country i and j. Second, for computing internal and external connectedness measures, we have to set $diag(\boldsymbol{\Gamma}_{ii}) = 0$ and calculate,

$$\begin{aligned} TO_{ij} &= \sum_{n=1}^{k} \boldsymbol{\Gamma}_{ij,nm} \\ FROM_{ij} &= \sum_{m=1}^{k} \boldsymbol{\Gamma}_{ji,nm} \\ NET_{ij} &= TO_{ij} - FROM_{ij} \\ EX_{ij} &= \sum_{n=1}^{k}\sum_{m=1}^{k} \boldsymbol{\Gamma}_{ij,nm} - \sum_{n=1}^{k}\sum_{m=1}^{k} \boldsymbol{\Gamma}_{ji,nm} \end{aligned}$$

where TO_{ij}, $FROM_{ij}$ and NET_{ij} are corresponding to the previous interpretation but on the country-level and EX_{ij} is the *net external country-specific connectedness.*

3 Empirical results

In Table 1, we report the estimates of the connectedness indices for each series based on the TVP-VAR-SV methodology. Summarizing the rich information in Table 1, we observe that spillovers of different types of uncertainty in Greece had greater influence on European economic policy uncertainty than vice-versa, with Greek banking uncertainty (related to the capital controls imposed in Greece in June 2015 in an attempt to avoid an uncontrolled bank run) and currency uncertainty (e.g. potential Grexit and adoption of a 'new Drachma') being at the epicenter of the transmission of uncertainty both within Greece and between Greece and Europe. These results are also supported by the estimated net directional connectedness measures. Specifically, within Greece, banking and currency uncertainty are net transmitters of shocks, while debt, tax, monetary policy and pension uncertainty are net receivers. In Table 1, we account for European economic policy uncertainty too and observe that, in addition to Greek banking and currency uncertainty, monetary policy uncertainty is a net transmitter of shocks, while European economic policy uncertainty along with the remaining Greek subcategories of uncertainty are net receivers of shocks.

[Insert Table 1 around here]

Turning our attention to the interpretation of the NPDC plots strengthens our findings. According to Figure 1, Greek banking and currency policy uncertainty are the main net transmitters throughout the sample, with the later reaching peaks during the beginning of 2010 (possibly associated with the concerns related to a Grexit scenario), and in the summer of 2015 when capital controls were introduced. By contrast, European economic policy uncertainty, as well as the remaining subcategories of Greek policy uncertainty was at the receiving ends of the net transmission of uncertainty.

[Insert Figure 1 around here]

Figure 2 shows that the Greek economic policy uncertainty mainly dominates the European economic policy uncertainty. Two peaks are reached during the GFC and the start of the European sovereign debt crisis and at the beginning of 2015 when Greece requested another bailout package.

[Insert Figure 2 around here]

Figure 3 and Figure 4 represent the internal and external NPDC measures, respectively, which strengthen our previous findings. This becomes evident in Figure 3 which reveals the dominance of Greek currency, banking and, to some extent, monetary policy uncertainty in the transmission of Greece-internal economic policy uncertainty spillovers. Note that the tax, debt, and pension uncertainty indices (and hence fiscal policy uncertainty in general) are permanently net receivers of shocks. This implies that monetary shocks dominate fiscal shocks which is in line with the result of Gabauer and Gupta (2018).

Figure 4 indicates that banking, currency, debt and monetary policy uncertainties are driving the European economic policy uncertainty, while the Greek pension and tax uncertainty is driven by European economic policy uncertainty.

[Insert Figures 3 and 4 around here]

Last but not least, the generalized impulse responses presented in Figure 5 indicate that Greek currency, banking and monetary policy shocks had a long-lasting impact (up to 6 months) both internally and externally, especially during the the GFC and the late 2009 to 2011.

[Insert Figure 5 around here]

4 Conclusion

In this study, we examine whether and which subcategories of Greek economic policy uncertainty were associated with changes in European economic policy uncertainty. Our results revealed that Greek economic policy uncertainty mainly dominates the European economic policy uncertainty throughout the period of analysis. Specifically, the Greek banking, currency, debt and monetary policy uncertainty were at the epicenter of this transmission process dominating the European economic policy uncertainty, while the European economic policy uncertainty was driving the Greek tax and pension uncertainty. Greek-internal spillovers have illustrated the dominance of currency, banking, and monetary policy uncertainty over debt, pension, and tax uncertainty which implies that shocks related to monetary policy uncertainty dominate fiscal policy uncertainty shocks.

References

Ajmi, A. N., Gupta, R., and Kanda, P. (2014). Causality between economic policy uncertainty across countries: Evidence from linear and nonlinear tests. *Frontiers in Finance and Economics*, 11:73–102.

Antonakakis, N. and Gabauer, D. (2017). Refined Measures of Dynamic Connectedness based on TVP-VAR. MPRA Paper 78282, University Library of Munich, Germany.

Antonakakis, N., Gabauer, D., Gupta, R., and Plakandaras, V. (2018). Dynamic connectedness of uncertainty across developed economies: A time-varying approach. *Economics Letters*, 166:63–75.

Apergis, N. and Cooray, A. (2014). Convergence in sovereign debt ratios across heavily indebted eu countries: evidence from club convergence. *Applied Economics Letters*, 21(11):786–788.

Baker, S. R., Bloom, N., and Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, 131(4):1593–1636.

Biljanovska, N., Grigoli, F., and Hengge, M. (2017). Fear Thy Neighbor: Spillovers from Economic Policy Uncertainty. IMF Working Papers 17/240, International Monetary Fund.

Caggiano, G., Castelnuovo, E., and Figueres, J. M. (2017). Economic policy uncertainty spillovers in booms and busts.

Castelnuovo, E., Lim, G., and Pellegrino, G. (2017). A short review of the recent literature on uncertainty. *Australian Economic Review*, 50(1):68–78.

Colombo, V. (2013). Economic policy uncertainty in the us: Does it matter for the euro area? *Economics Letters*, 121(1):39–42.

De Santis, R. A. and Zimic, S. (2018). Spillovers among sovereign debt markets: Identification through absolute magnitude restrictions. *Journal of Applied Econometrics.*

Diebold, F. X. and Yılmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1):119–134.

Gabauer, D. and Gupta, R. (2018). On the transmission mechanism of country-specific and international economic uncertainty spillovers: Evidence from a tvp-var connectedness decomposition approach. *Economics Letters (forthcoming).*

Gupta, R., Lau, C. K. M., and Wohar, M. E. (2018a). The impact of US uncertainty on the Euro area in good and bad times: evidence from a quantile structural vector autoregressive model. *Empirica (in press).*

Gupta, R., Ma, J., Risse, M., Wohar, M. E., et al. (2018b). Common business cycles and volatilities in us states and msas: The role of economic uncertainty. *Journal of Macroeconomics.*

Hardouvelis, G. A., Karalas, G., Karanastasis, D., and Samartzis, P. (2018). Economic policy uncertainty, political uncertainty and the greek economic crisis. Available at SSRN: https://ssrn.com/abstract=3155172.

Klößner, S. and Sekkel, R. (2014). International spillovers of policy uncertainty. *Economics Letters*, 124(3):508–512.

Koop, G., Pesaran, M. H., and Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics*, 74(1):119–147.

Pesaran, H. H. and Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics Letters*, 58(1):17–29.

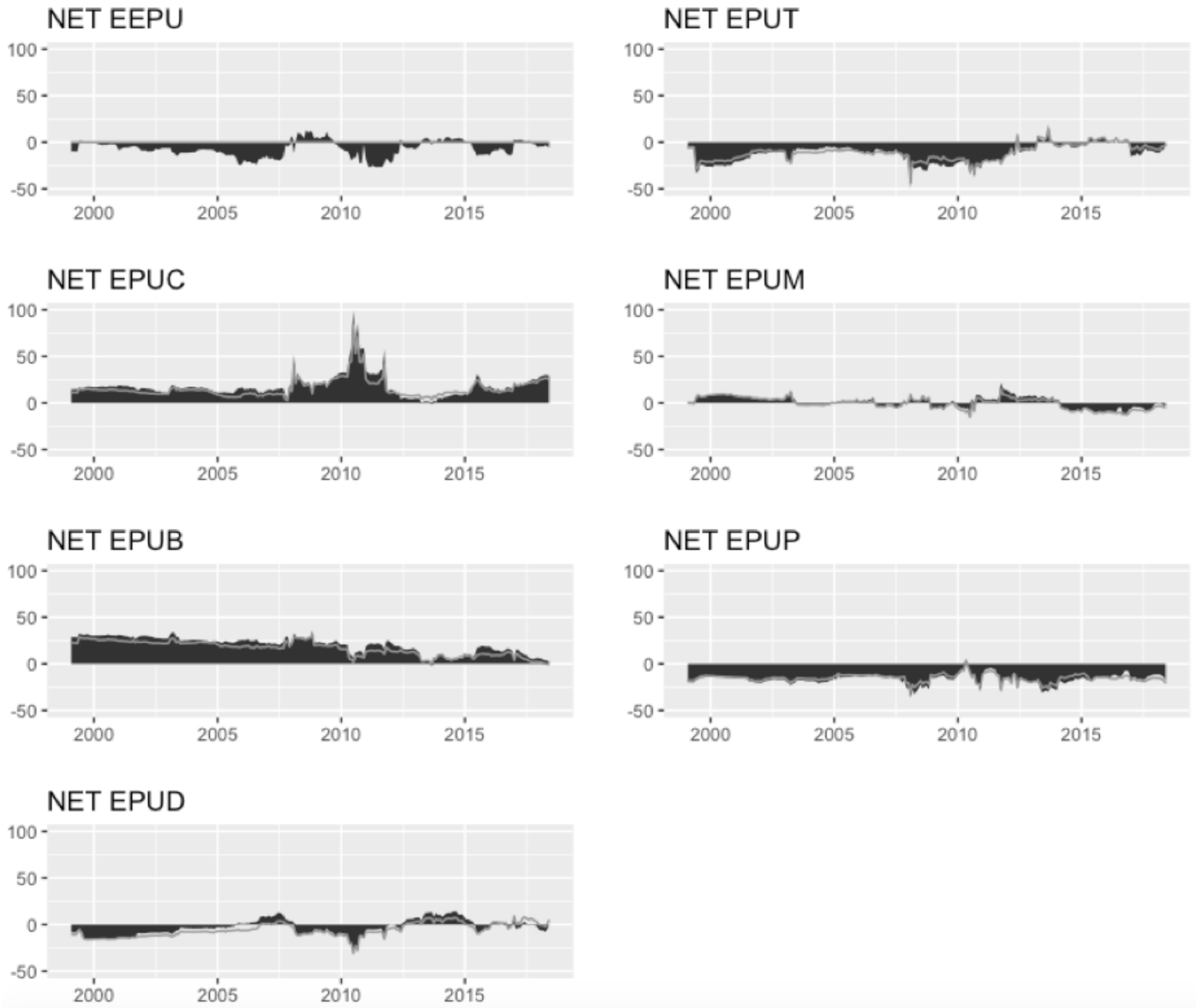
Yin, L. and Han, L. (2014). Spillovers of macroeconomic uncertainty among major economies. *Applied Economics Letters*, 21(13):938–944.

Table 1: Connectedness table

	EEPU	EPUC	EPUB	EPUD	EPUT	EPUM	EPUP	$FROM_i$	$FROM$
EEPU	45.5	12.4	14.6	10.0	5.5	8.9	3.2		54.5
EPUC	9.8	41.3	17.6	10.1	5.5	10.2	5.4	48.9	58.7
EPUB	10.6	18.6	33.5	9.3	7.2	13.5	7.5	56.0	66.5
EPUD	7.5	14.1	11.9	39.0	11.3	10.0	6.1	53.5	61.0
EPUT	7.2	9.6	10.5	12.4	46.2	7.5	6.6	46.6	53.8
EPUM	7.6	10.4	18.4	8.9	4.7	47.5	2.5	44.9	52.5
EPUP	4.6	12.0	13.9	7.2	7.0	3.3	52.0	43.4	48.0
TO_i		64.7	72.3	47.8	35.8	44.6	28.1	TCI_i	
NET_i		15.8	16.3	-5.7	-10.8	-0.3	-15.3	48.9	
TO	47.2	77.1	86.9	57.8	41.3	53.5	31.3		TCI
NET	-7.3	18.4	20.4	-3.2	-12.5	1.0	-16.7		56.4

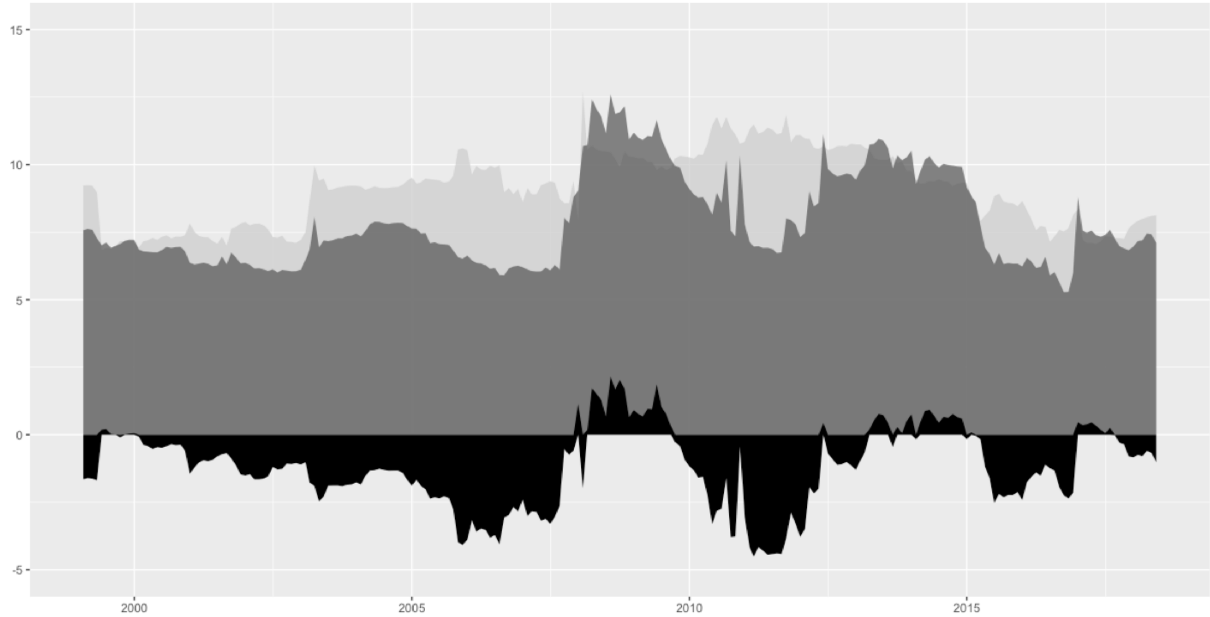
Notes: Light grey highlighted cells indicate connectedness within Greece, while dark grey highlighted ones denote connectedness between Greece and Europe.

Figure 1: NET Directional Connectedness



Notes: The black shaded area illustrates connectedness with external spillovers, whereas the grey line illustrates the internal spillovers.

Figure 2: External Directional Connectedness



Notes: The light-grey shaded area illustrates dynamic international spillovers from Greece to European Union, the dark-grey shaded area shows dynamic international spillovers from European Union to Greece and the black area represents net international spillovers from European Union to Greece.

Figure 3: Internal Net Pairwise Directional Connectedness

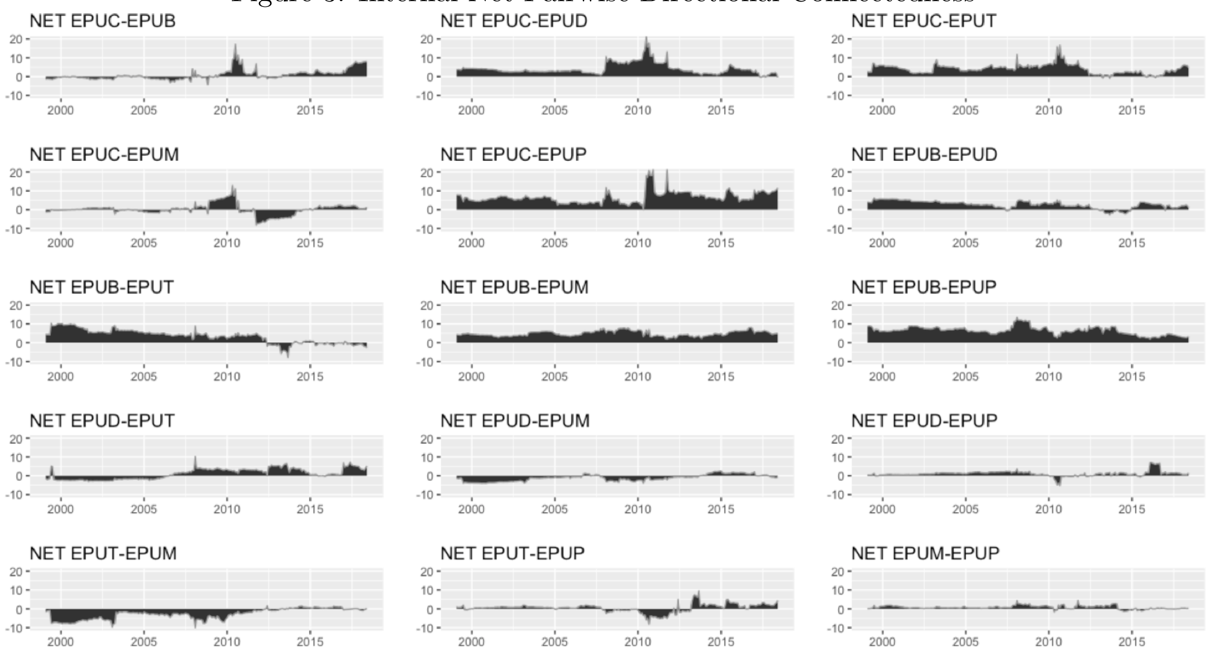


Figure 4: External Net Pairwise Directional Connectedness

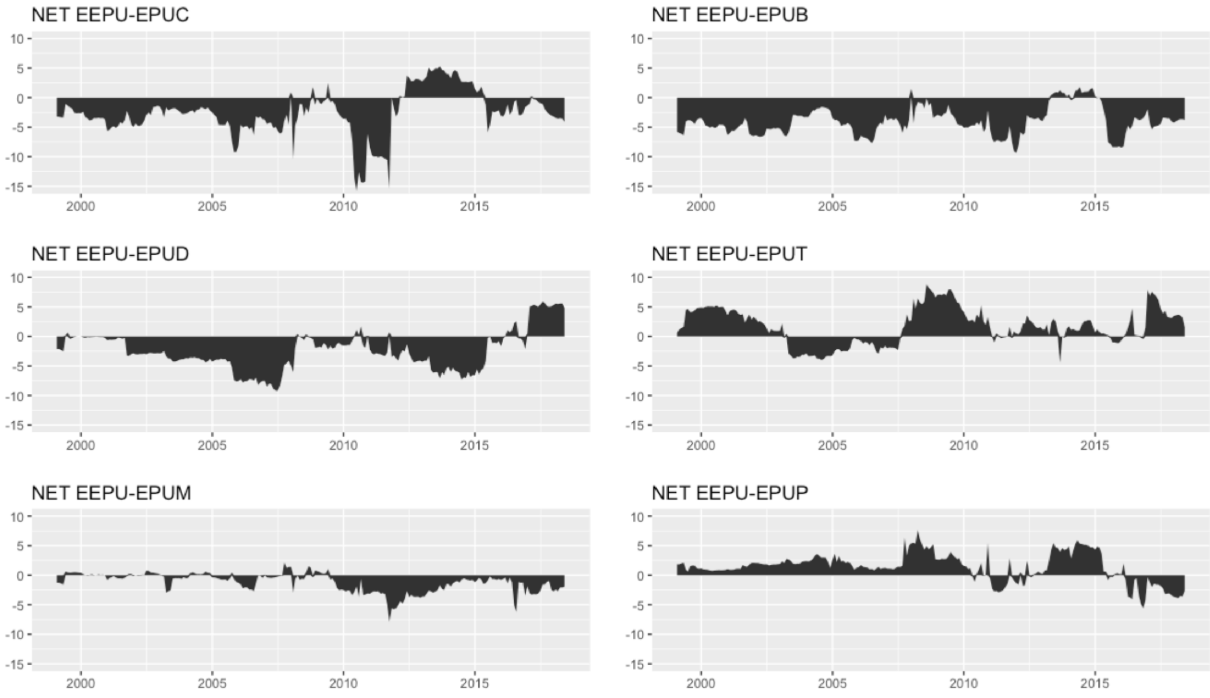
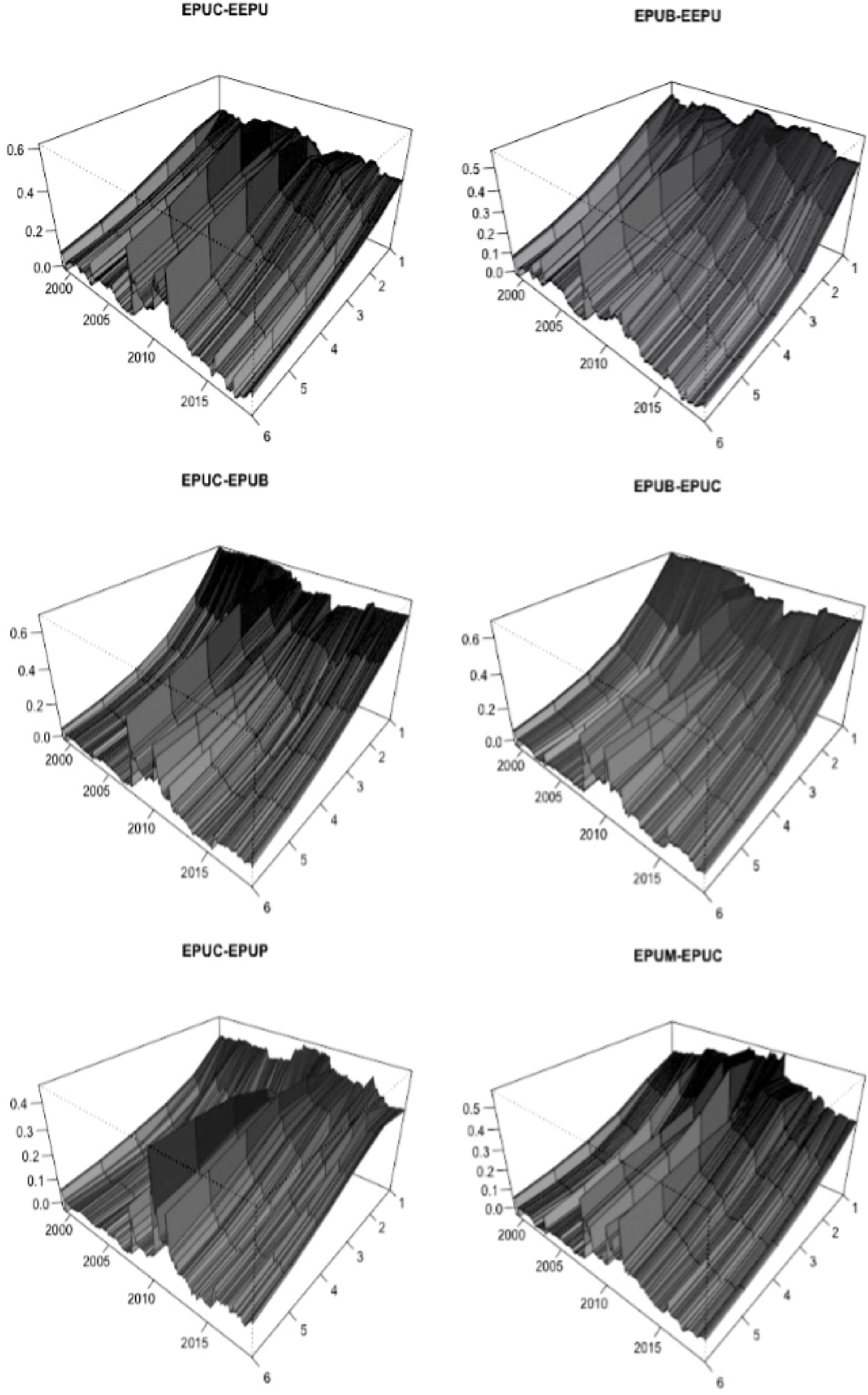


Figure 5: Generalized impulse responses



A Appendix

A.1 Summary statistics and further results

In Figure A.1, the raw data is visualized whereby certain amount of uncertainty co-movements of country-specific categorical uncertainty can be observed. Since, all raw series of economic policy uncertainty are non-stationary, we use annual percentage changes, $y_{it} = log(x_{it}) - log(x_{it-12})$ as illustrated in Figure A.2. Table A.1 shows that all series are significantly positively skewed, leptokurtic, not normally distributed, and stationary on the 1% significance level.

[Insert Figures A.1 and A.2, and Table A.1 around here]

Figure A.3 presents the results for the dynamic total connectedness index. According to this figure, we observe that the total connectedness index exhibits a large variation and is responsive to extreme economic events, such as the global financial crisis in 2008, the first Greek bailout package in May 2010, and the sovereign-debt restructuring of Greece finalized in February 2012 with the private sector involvement (PSI). Furthermore, the difference (black area) which can be interpreted as the external TCI increased with the beginning of the GFC which means that external spillovers amplified.

[Insert Figure A.3 around here]

In Figures A.4 and A.5 the dynamic directional connectedness TO and FROM all others are illustrated, respectively. The grey line in each figure illustrates the amount of internal spillover whereas the difference between the grey line and black area can be interpreted as the fraction that is caused by European economic policy uncertainty spillovers.

[Insert Figures A.4 and A.5 around here]

Table A.1: Summary Statistics

	Mean	Median	Max	Min	Std.Dev.	Skewness	Kurtosis	Jarque-Bera	ERS	Obs.
EEPU	0.119	-0.003	2.052	-0.659	0.475	1.247 ***	5.024 ***	99.7 ***	-3.411 ***	232
EPU	0.070	-0.019	1.949	-0.591	0.406	1.256 ***	5.217 ***	108.5 ***	-4.256 ***	232
EPUC	0.150	-0.098	5.067	-0.759	0.763	2.239 ***	10.951 ***	805.0 ***	-4.567 ***	232
EPUB	0.086	-0.037	2.694	-0.672	0.517	1.465 ***	6.071 ***	174.1 ***	-3.912 ***	232
EPUD	0.233	-0.010	10.184	-0.891	1.120	5.873 ***	49.120 ***	21895.3 ***	-5.403 ***	232
EPUT	0.089	-0.001	2.708	-0.654	0.464	1.710 ***	8.906 ***	450.2 ***	-5.667 ***	232
EPUM	0.128	-0.062	3.595	-0.810	0.711	2.034 ***	8.379 ***	439.7 ***	-5.638 ***	232
EPUP	0.178	0.001	2.755	-0.775	0.678	1.278 ***	4.516 ***	85.4 ***	-4.878 ***	232

Figure A.1: Raw Series

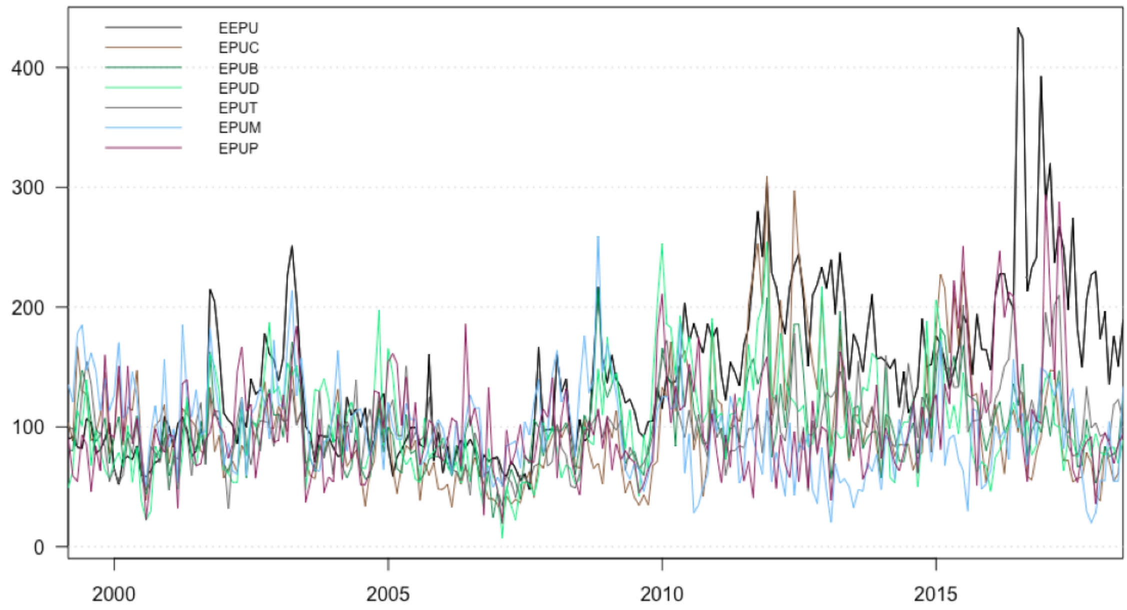


Figure A.2: First Differenced Series

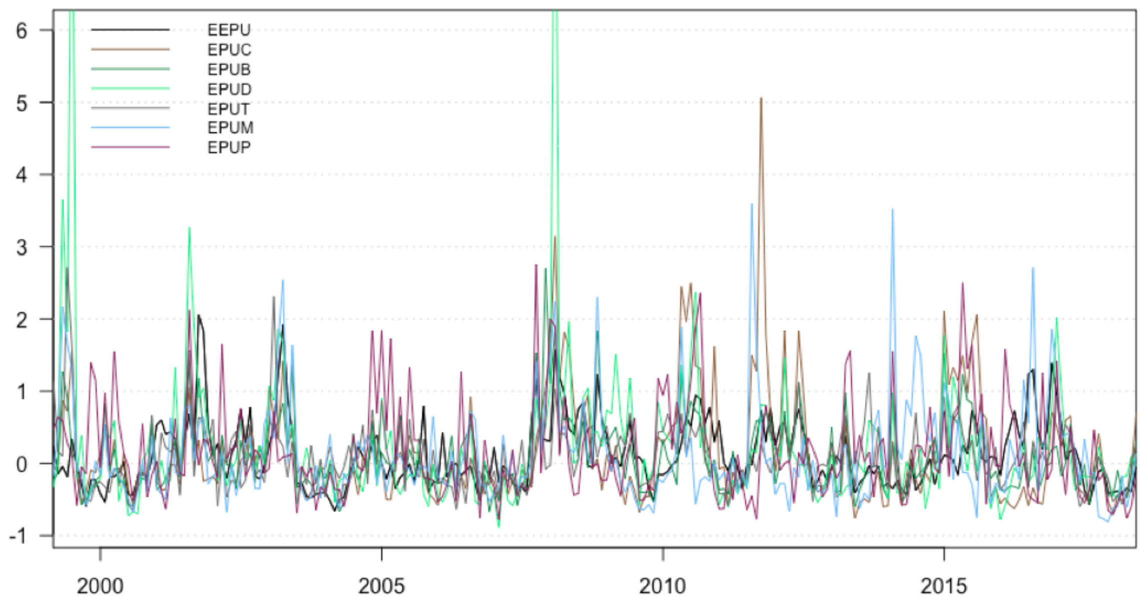
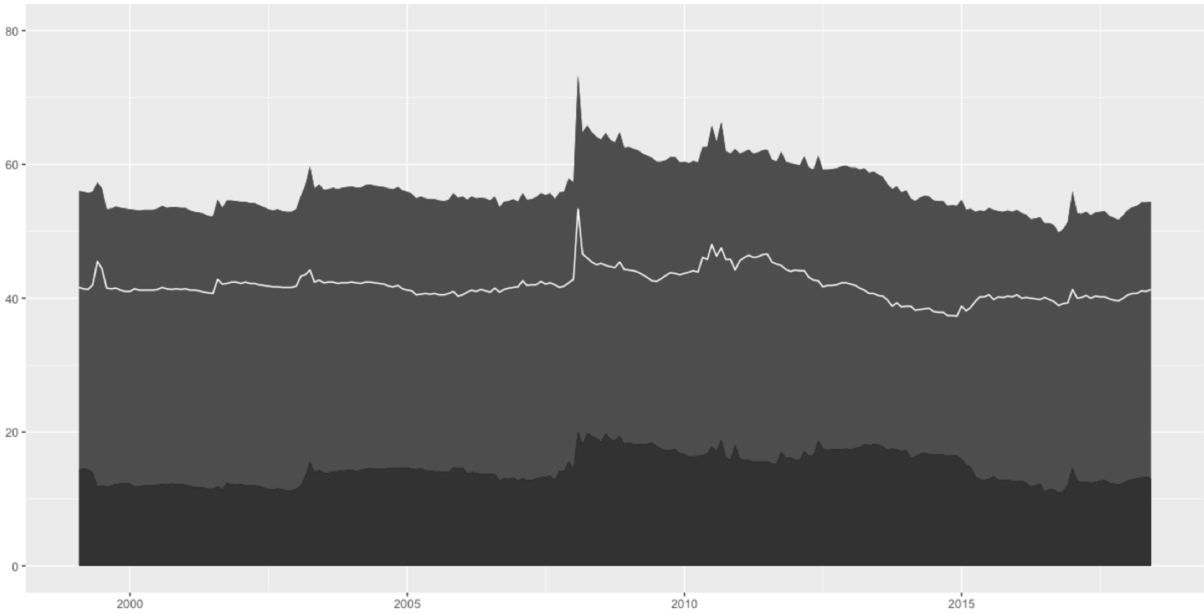
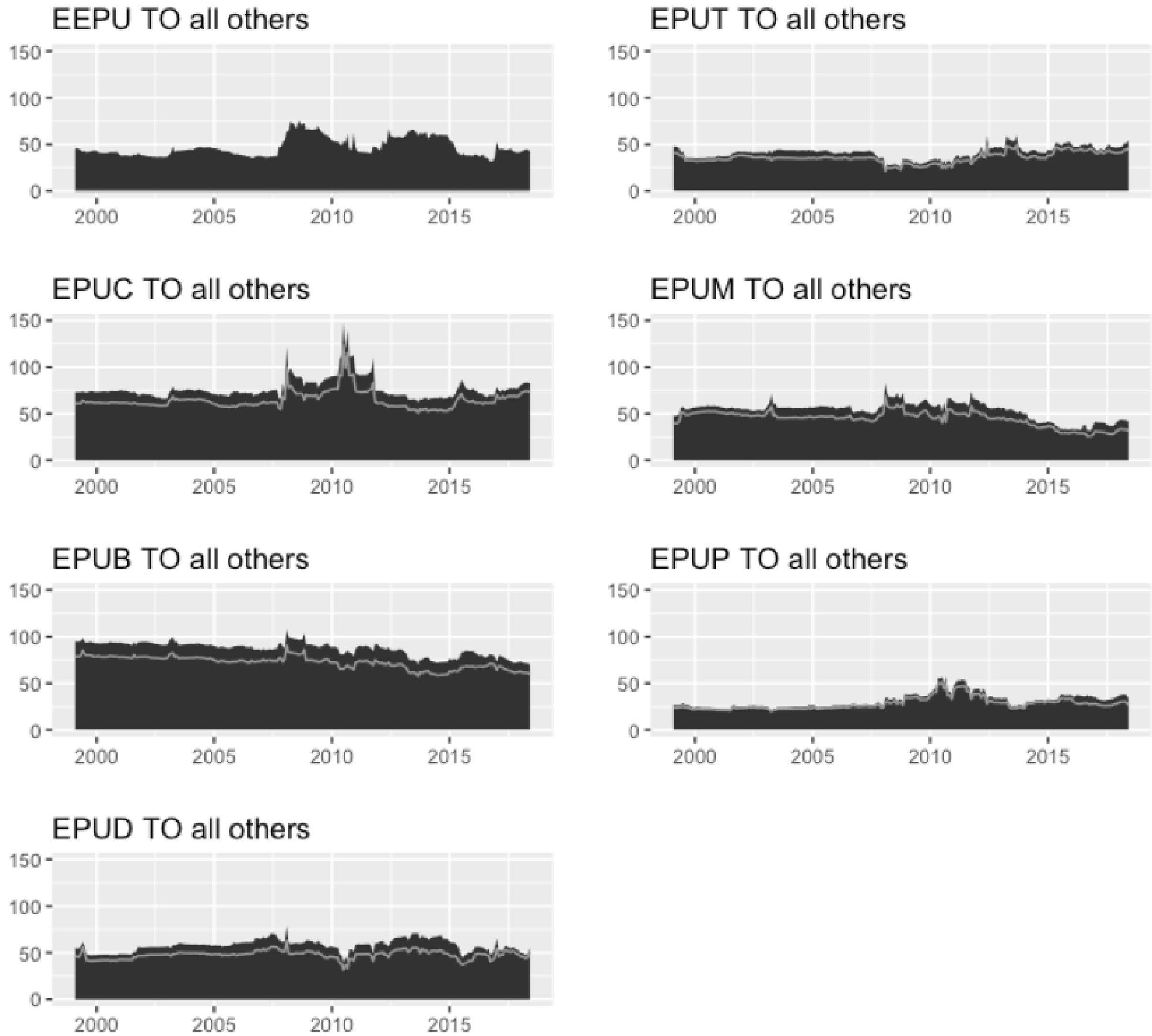


Figure A.3: Dynamic Total Connectedness



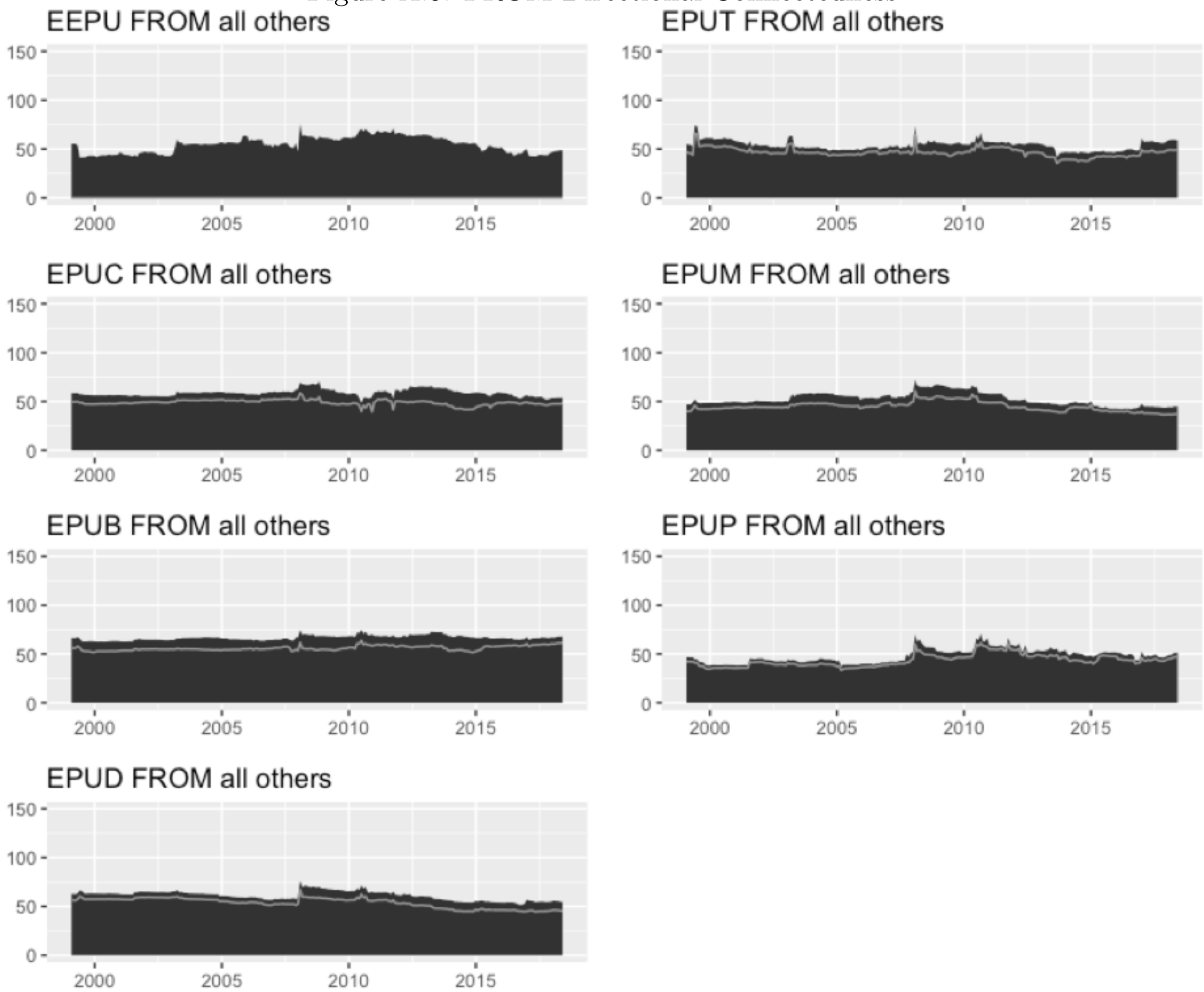
Notes: The dark grey shaded area illustrates the TCI with external spillovers, while the grey line illustrates the TCI without external spillovers, and the black shaded area illustrates the differences of the previous two.

Figure A.4: To Directional Connectedness



Notes: Black shaded areas illustrate the connectedness with external spillovers whereas the grey lines represent the internal spillovers.

Figure A.5: FROM Directional Connectedness



Notes: Black shaded areas illustrate the connectedness with external spillovers whereas the grey lines represent the internal spillovers.