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Brexit Decision Effects on European Derivatives Markets: A Sectoral Analysis

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This paper examines the Brexit's referendum impacts on quotes of different sectors in the European derivatives market by employing a Vector Autoregression (VAR) approach for detecting bi-directional effects. During nine months after the affirmative decision about the United Kingdom (UK) leaving the European Union (EU), the primary importance British FTSE100 index is found to have influenced the prices of the highly representative of European futures markets Eurostoxx600 index and its components in a positive and statistically significant manner. Interestingly, Automobiles & Parts, Banks, Basic Resources, Construction & Materials, Oil & Gas, as well as Industrial Goods & Services are the futures sectors mostly affected by volatility in the British stock market. We argue that the Brexit decision effects mainly act through principal secondary production sectors of the European economy, whereas reverse effects rely most on financial and banking services, telecommunications, as well as industrial and automobile goods.

INTRODUCTION

An increasing body of literature has been studying the impacts of the affirmative Brexit decision about leaving the European Union at the 23 June, 2016 referendum on the real economies and financial markets in the UK and the European markets. Since the onset of the post – Brexit decision era, large levels of uncertainty have aroused among economic agents such as investors and policymakers in a global context. Bearing in mind that consequences are expected to be influential not only for British but also for European economic agents (Kyriazis and Economou, 2017) and generally international investors, an increasing volume of academic work has been focusing on effects that uncertainty about the City Financial Centre could bring about in

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the general investing framework, mostly in Europe (Busch and Matthes, 2016).

The previous literature has supported that impacts of the Brexit on capital markets were weak, and that most powerful effects appeared during the next two weeks after the relevant referendum. Consequently, the existing literature provides evidence that the Brexit-induced volatility has fainted out in a rather fast pace. A small but rising number of studies have investigated the spillover impact of such extraordinary political decisions on stocks (Pantzalis, Stangeland and Turtle, 2000; Döpke and Pierdzioch, 2006; Oehler, Horn and Wendt, 2016; Białkowski, Gottschalk and Wisniewski, (2008), exchange rates (Adesina, 2007; Plakandaras, Gupta and Wohar, 2017), and investor sentiment (Sita, 2017).

Adesina (2017) by using a standard univariate GARCH (1,1) model explores and compares volatility persistence in FTSE100 and GBP/USD returns six months pre- and post- the Brexit vote. He also investigates volatility persistence in both markets over a one-year period by using an augmented GARCH with structural break model that accommodates for a Brexit-vote structural break. He provides evidence for that by highly persistent volatility in the stock market, which tends to be significantly more pronounced after the Brexit-vote. However, he also finds that the foreign exchange market exhibited lesser volatility persistence which tended to reduce even further following the Brexit vote.

Oehler, Horn and Wendt (2016) examine what were the effects on firm-level internationalization after Brexit. They argue that stocks of firms with higher proportions of domestic sales realized more negative abnormal returns than stocks of firms with more sales abroad, i.e., a higher degree of international diversification. They also provide evidence that while firm-level internationalization largely explains abnormal returns on the trading day after the referendum, it had no relevant pricing effect in the following days after Brexit. Moreover, they support that the very quick adjustment of stock prices reflecting firm-level internationalization indicates a high degree of market efficiency.

Moreover, Sita (2017) investigates how market, exchange rate, and excess residual volatility drive investors' sentiment up on a day of extreme (sentiment estimated as the sensitivity of stock volatility to market and exchange rate volatility). He examines if sentiment contributed to the build-up of volatility of the constituents of the FTSE100 in the aftermath of the "yes" to the UK Brexit. He finds that

the Brexit day, June 24, 2016, was a day of reaction that came from all over the world, capital markets went awry, the UK political establishment was shaken and investors' negative sentiment was particularly intense as both FTSE and the pound lost grounds.

Plakandaras *et al.* (2017) examine whether the sudden depreciation of the pound-dollar exchange rate is the reaction of market participants to the Brexit or whether the exodus of UK from the EU had little impact on the exchange rate. The study verifies that the depreciation is based on the uncertainty caused by the Brexit. Pantzalis, Stangeland and Turtle (2000) investigate the behavior of stock market indices across 33 countries around political election dates during the sample period 1974-1995. They provide evidence of a positive abnormal return during the two-week period prior to the election week and argue that a positive reaction of a stock market to elections is related to a country's degree of political, economic and press freedom.

Döpke and Pierdzioch (2006) analyzed the interaction of stock market movements and politics in Germany by making use of popularity functions and VAR-based evidence. They found weak evidence that the political process has had an impact on the stock market. They have also found that there were no higher market returns no matter whether the government was either left-wing or right-wing. Finally, VAR-based evidence as well as evidence from popularity functions has revealed that stock market returns are followed by changes in the popularity of German governments. In a somewhat similar vein, Białkowski, Gottschalk and Wisniewski (2008), by using a sample of 27 OECD countries test whether national elections induce higher stock market volatility. They argue that the country-specific component of index return variance can easily double during the week around an election, which shows that investors are surprised by the election outcome.

The aim of this research is to cast light on whether alterations in the UK's stock prices due to the Brexit have brought about modifications in European financial markets' performance and in what extent. This work is closer in concept to Adesina (2017), although we focus on derivatives rather than on spot markets.

The contribution of our paper to the existing literature is far from negligible. Intriguingly, the majority of related studies focus on yields' or stocks' responsiveness to this highly unexpected shock in the UK. Whatsoever, we innovate by investigating how the derivatives markets in European countries have been affected, thereby we explore further consequences than mere spot impacts. Moreover, we differentiate from

existing studies by employing a broad array of sectors as eighteen specific indices are under scrutiny and every aspect of economic activity as well as almost every European country's financial markets are represented in the Eurostoxx 600 futures indices we adopt. The data we use are long and represent two of the financial indices of utmost importance in a European but also a global context.

Interestingly, we employ the FTSE100 which consists of the 100 companies listed on the London Stock Exchange with the highest market capitalization in order to represent the British stock markets. Moreover, we use the Eurostoxx600 overall index and its components indices, which cover a wide spectrum of market segments including the broad market, blue chips, individual sectors and global indexes. Notably, the countries represented in these indices are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Holland, Iceland, Ireland, Italy, Luxembourg, Norway, Portugal, Spain, Sweden, Switzerland, and the UK.

Our analysis focuses on the impact that the general index of the London Stock Exchange could have on European derivatives (Armour, 2017). More specifically, we focus on the Eurostoxx (Eurex) Index and its different sectors one by one for examining the whole spectrum of the European economic activities and track which parts of production and commerce in the European Union constitute the steam engine of financial alterations, by applying a VAR methodology.

To the best of our knowledge, this is the first piece of academic work studying the effects of Brexit on the specific sectors of the Eurex Futures market by employing a VAR methodology (Stock and Watson, 2001). Therefore, we contribute to research about the Brexit decision effects by highlighting and exploring an innovative aspect of them. The rest of this paper is structured as follows: Section 2 describes the data and methodology used for conducting the econometric estimations. Section 3 provides empirical results and comments. Finally, Section 4 concludes.

DATA AND METHODOLOGY

The data employed for this research comprises daily values on the FTSE100 index and on futures derivatives on seventeen different sectors of the Eurostoxx 600, as well as for the overall Eurostoxx600 futures index. All values are transformed into logarithms. The Datastream database has been used for obtaining in a daily frequency the closing prices of the FTSE100 index, which is about the hundred companies listed on the London Stock Exchange having the highest market capitalization.

Moreover, the Eurex Futures Markets quotes are extracted from the same data source. The data intervals span a period of nine months, from the day that the Brexit referendum took place in the 23rd June, 2016, until the 20th of March 2017, when the British Prime Minister took action for the UK about the set off of procedures for activation of the Article 50 of the European Treaty. Therefore, we employ this time period in our dataset in order to study the effect of the June 2016 Brexit decision by taking into consideration in the best possible extent no other external effects or news, as the Brexit shock has been considered to have been by far the most influential political and economic event during the period examined.

The futures indices on which our study focuses all have a June 2017 maturity and have to do with seventeen different Eurostoxx600 industrial sectors indices as well as the Eurostoxx600 overall index. The symbols and explanations of the sectors under scrutiny are presented in Table 1. Furthermore, Table 2 presents some descriptive statistics of the variables employed in this paper. The descriptive statistics show that Eurostoxx 600 futures on Chemicals are found to have higher quotes than the rest of the Eurostoxx 600 sectors, and futures on the Health Care sector, as well as futures on the Automobile and Parts sector follow. Notably, the Eurostoxx 600 Basic Resources futures contracts are found to be the most volatile concerning their quotes, while futures on the Automobile and Parts sector take the second place.

The methodology employed is a VAR specification, where the FTSE100 values are employed together with the values of the futures of the overall Eurostoxx600 or with the values of each sector of the Eurostoxx600 index. This way, both the effect that the FTSE100 has on the Eurostoxx600 or its subsectors is examined, as well as the effect that the Eurostoxx600 or its subsectors have on the FTSE100 is under scrutiny (Johansen, 1991; Toda and Phillips, 1994). Generally, a VAR(1) in two variables can be expressed in matrix form (by employing a more compact notation) as:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} A_{1,1} A_{1,2} \\ A_{2,1} A_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix} \quad (1)$$

(only a single A matrix appears here because this example has a maximum lag p equal to 1). Alternatively, it can be expressed as (with no change in meaning) as the following system of two equations:

$$1y_{1,t} = c_1 + A_{1,1} y_{1,t-1} + A_{1,2} y_{2,t-1} + e_{1,t} \quad (2)$$

$$y_{2,t} = c_2 + A_{2,1} y_{1,t-1} + A_{2,2} y_{2,t-1} + e_{2,t} \quad (3)$$

Notably, there is only one equation for each variable in the model. The current (time *t*) observation of each variable depends not only on its own lagged values but also on the lagged values of each other variable in the VAR. More specifically, the system of equations employed is as follows:

$$FTSE100_t = a_0 + a_1 \times FTSE100_{-1} + a_2 \times FTSE100_{-2} + a_3 \times EUROSTOXX600_{-1} + a_4 \times EUROSTOXX600_{-2} \quad (4)$$

$$EUROSTOXX600_t = \beta_0 + \beta_1 \times FTSE100_{-1} + \beta_2 \times FTSE100_{-2} + \beta_3 \times EUROSTOXX600_{-1} + \beta_4 \times EUROSTOXX600_{-2} \quad (5)$$

This model enables us to capture in a secure manner the bi-directional causality between the spot stock exchange in the UK and the futures derivatives market in the EU, as it takes into consideration all interactions between each pair of variables (FTSE100 with each of Eurostoxx600 sectors or the overall Eurostoxx600).

Table 1
Symbols and explanations of the Eurostoxx 600 futures indices

Symbol	*Explanation*
STOXX 600 Auto. &Parts	Automobile and Parts
STOXX 600 Banks	Banks
STOXX 600 Basic Resources	Basic Resources
STOXX 600 Chemicals	Chemicals
STOXX 600 Cons. & Mat.	Construction and Materials
STOXX 600 Financial Serv.	Financial Services
STOXX 600 Food & Beverage	Food and Beverage
STOXX 600 Health Care	Health Care
STOXX 600 Ind. Gd&Ser.	Industrial Goods and Services
STOXX 600 Insurance	Insurance
STOXX 600 Media	Media
STOXX 600 Oil & Gas	Oil and Gas
STOXX 600 Retail	Retail
STOXX 600 Technology	Technology
STOXX 600 Telecom	Communications
STOXX 600 Trvl& Lei.	Travel and Leisure
STOXX 600 Utilities	Utilities

Table 2
Descriptive Statistics

	FTSE100		EUROSTOXX600		STOXX 600 Auto. & Parts		STOXX 600 Banks		STOXX 600 Basic Resources		STOXX 600 Chemicals		STOXX 600 Cons. & Mat		STOXX 600 Financial Serv.		STOXX 600 Food & Bev.		STOXX 600 Health Care	
	Percentile	Smallest	Percentile	Smallest	Percentile	Smallest	Percentile	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest
1%	6138.69	5982.2	314.8	309.2	413.4	411.3	117.6	117.3	267.7	262.1	720.8	708.3	351.1	340.3	344.6	341.6	573.5	570.9	662.9	657.5
5%	6545.37	6138.69	328.5	314.8	434	413.4	125.4	117.6	294.3	267.7	748.1	720.8	366	351.1	369.9	344.6	578.7	573.5	670.1	662.9
10%	6680.69	6140.39	335	316.6	464.8	414.5	130.6	118.9	306.1	268.5	766.4	722.3	381.7	353	384.2	351.3	585.6	574	680.3	664
25%	6781.51	6338.1	338.9	319	481.3	416.2	138.9	119.2	317.3	281.3	795.6	725.4	402	357.4	393.9	353.4	605.4	574.6	698.6	665.6
50%	6931.55		343.2		495.3		154		355.6		809.5		409.4		402.8		627		721	
		Largest		Largest		Largest		Largest		Largest		Largest		Largest		Largest		Largest		Largest
75%	7188.82	7382.9	361.5	374.6	548.6	566.2	171.9	177.6	414.5	446.4	864.2	886.5	426.5	450	420.8	440.9	642	655.4	744.1	768.3
90%	7334.61	7415.95	370	375.1	558.7	566.9	174.2	177.7	431.7	447	879.7	887.3	441.7	450.2	435.9	441.3	647.2	656.2	757.3	769.3
95%	7368.64	7424.96	372.6	375.7	563.7	567.7	176.4	177.7	439.4	447.6	884.2	889	447.1	450.4	438.6	441.9	650.7	656.8	762.3	769.8
99%	7424.96	7429.81	375.7	377.6	567.7	569.8	177.7	177.9	447.6	448.3	889	890.4	450.4	451.4	441.9	444.9	656.8	657.5	769.8	770.8
Obs	197		197		197		197		197		197		197		197		197		197	
Sum of Wgt.	197		197		197		197		197		197		197		197		197		197	
Mean	6962.128		348.9584		507.6548		153.8832		364.5503		820.6695		411.7076		405.8447		621.9147		719.9477	
Std. Dev.	268.1896		14.51353		39.96603		17.75804		50.76633		43.36819		22.3945		20.86154		22.16613		28.56678	
Variance	71925.66		210.6425		1597.283		315.3481		2577.221		1880.8		501.5138		435.2037		491.3373		816.061	
Skewness	-.3833731		.1280189		-.1508097		-.2000314		.0442683		-.1295694		-.4386338		-.2767269		-.4893073		-.1962465	
Kurtosis	3.354958		2.276781		2.171576		1.646857		1.589541		2.171762		3.234946		3.04306		2.255798		2.011833	

	STOXX 600 Ind. Gd&Ser.		STOXX 600 Insurance		STOXX 600 Media		STOXX600 Oil & Gas		STOXX 600 Retail		STOXX 600 Technology		STOXX 600 Telecom		STOXX 600 Trvl& Lei.		STOXX 600 Utilities	
	Percentile	Smallest	Percentile	Smallest	Percentile	Smallest	Percentile	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest	Percentiles	Smallest
1%	391.8	381	182.6	181.6	254.3	248.6	266.5	263	278.8	272.4	306.2	299.3	270.4	270.3	207.2	204	254.6	254
5%	406.4	391.8	193.1	182.6	257.3	254.3	269.5	266.5	290	278.8	319.1	306.2	273	270.4	213.8	207.2	257.3	254.6
10%	422.2	391.9	195.8	184.3	259.4	254.5	276.4	267	298.5	281.1	331.9	308	276.5	271	215.7	208.4	263	255
25%	437.6	395.1	205.1	186.5	267.8	255.4	282.8	267.6	301.5	283	347.9	311.4	284.5	271.4	222.6	211.5	270.5	255.4
50%	445		223.4		275.3		291.1		306.5		360.5		291.8		227.4		277	
		Largest		Largest		Largest		Largest		Largest		Largest		Largest		Largest		Largest
75%	468	487.3	245	252.1	278.9	284.8	308.2	324	308.7	315	371.4	403.5	298	304.3	233.2	241.2	286.4	300.2
90%	483.3	487.6	248.8	253.4	281.8	284.9	317.5	324.1	311.5	315.3	398.2	404.6	301.5	305.4	239.3	242.1	295.5	301
95%	486	489.9	250.8	253.9	283	285.3	320.6	324.6	313.1	316.1	401.3	405.3	302.5	305.8	240.1	242.2	297.2	301.4
99%	489.9	491	253.9	254.5	285.3	285.5	324.6	325.1	316.1	316.1	405.3	405.4	305.8	312.2	242.2	242.6	301.4	302
Obs	197		197		197		197		197		197		197		197		197	
Sum of Wgt.	197		197		197		197		197		197		197		197		197	
Mean	449.6756		224.0599		272.8299		294.7239		304.8233		361.2731		290.5746		227.6289		277.9772	
Std. Dev.	23.14237		21.07647		8.324587		15.64188		6.762151		22.73742		9.05776		8.224158		11.88046	
Variance	535.5691		444.2175		69.29874		244.6684		45.72669		516.9904		82.04302		67.63677		141.1452	
Skewness	-.2037045		-.1797517		-.7353889		.1758599		-1.659277		-.0297979		-.4022155		-.2699316		.0949275	
Kurtosis	2.71833		1.550535		2.475719		1.96211		7.286213		2.914341		2.367552		2.482745		2.28972	

EMPIRICAL RESULTS AND COMMENTS

In Table 3 we provide the results from the VAR econometric estimations between the FTSE 100 index quotes and the quotes for the overall Eurostoxx600 futures index, as well as each of the sectoral Eurostoxx600 futures indices. Estimations are conducted by the latest version (14^{th}) of the STATA software (Baum, 2006).

Intriguingly, there is evidence that the sectors most affected by the Brexit in terms of the previous day's impacts in a 1% level of statistical significance are: the Stoxx600 Basic Resources (0.7558987), Construction & Materials (0.6392772), Automobiles & Parts (0.6411735), Oil & Gas (0.582255), Industrial Goods & Services (0.5755639), Banks (0.5251286), Chemicals (0.4972375), Media (0.4676263), and Insurance (0.4522527). Notably, the sectors of Travel & Leisure (0.4135), Technology (0.4055802), Telecommunications (0.405532), Food & Beverage (0.3837511), Utilities (0.3633191), Health Care (0.2640309), Retail (0.2003838), as well as Financial Services (0.198887) are found to be less influenced by alterations in the main British stock index during the nine months after the Brexit decision.

It can be easily observed that the European secondary production has received a much larger impact from volatility in the British stock markets, than the services production sectors. This could be attributable to the large interdependence of the EU countries with the UK regarding exchanges in terms of manufactured goods. Furthermore, the high interconnectedness between financial sectors of the two regions can be seen in the relatively high coefficients of the Banks and Insurance sectors that the EU variables equations take. It should be emphasized that all estimations regarding the first lag take a positive sign and are highly statistically significant, thereby higher prices in the British stock markets bring about higher demand for hedging or speculation via futures derivatives in European markets. It should be noted that this is in accordance with rational investing behavior. Nevertheless, according to results about the second lag it can be seen that a significant portion of this effect unwinds due to the negative impact that takes place two days before. Whatsoever, this negative effect is smaller, therefore the overall outcome concerning each sector is positive. This also holds for the overall Eurostoxx600 futures index.

Furthermore, by examining reverse causality, it can be observed that the overall index exerts a modest and positive impact (0.2159631) on the British stock markets when the first lag is examined. Intriguingly enough, there is evidence that some of the sub sectors that are found to receive a smaller effect from the British stock markets have a larger

Table 3
Estimation results

	FTSE100			EUROSTOXX600		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.026766	.8867164	1.166816)	.5169229	.3739743	.6598715
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1508784	-2837748	-.012982)	-.4939722	(-.6347228.	.3522217
	(0.032)**			(0.000)***		
EUROSTOXX600(-1)	.2159631	.1068389	.3250873)	.8927248	.781342	1.004.108
	(0.000)***			(0.000)***		
EUROSTOXX600(-2)	-.1391099	-2398577	-383621	.0628216	-.0400114	.1656546
	(0.007)***			(0.231)		
Constant	.6489924	.3676769	.9303079	.0576213	-.2295167	.3447593
	(0.000)***			(0.694)		
RMSE	.006851			.006993		
R-sq	0.9672			0.9717		
chi2	5749.075			6684.715		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Auto. &Parts		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. interval]	
FTSE100(1)	1.083303	.9434839	1.223123	.6411735	.4100529	.8722942
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1973557		-.0572706	-.5556026	-.7871625	-.3240427
	(0.006)***			(0.000)***		
STOXX 600 Auto. & Parts (-1)	.0951116	.0167661	.1734571	.9219948	.7924902	1.051499
	(0.017)**			(0.000)***		
STOXX 600 Auto. & Parts (-2)	-.059089	-.1325586	.0143807	.0257294	-.0957155	.1471743
	(0.115)			(0.678)		
Constant	.7855511	.397266	1.173836	-.4307688	-1.072602	.211064
	(0.000)***			(0.188)		
RMSE	.006982			.011541		
R-sq	0.9659			0.9792		
chi2	5528.428			9182.217		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Banks		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.06499	.9288298	1.201151	.5251286	.2327025	.8175547
	(0.000)			(0.000)***		
FTSE100(-2)	-.1554211	-.289345	-.0214972	-.4938476	-.7814701	-.2062251
	(0.023)**			(0.001)***		
STOXX 600 Banks (-1)	.0912164	.0365332	.1458996	1.040669	.9232287	1.15811
	(0.001)***			(0.000)***		
STOXX 600 Banks (-2)	-.0748138	-.1274597	-.0221679	-.0608908	-.1739561	.0521745
	(0.005)***			(0.291)		
Constant	.7183778	.3774522	1.059303	-.1738857	-.9060769	.5583055
	(0.000)***			(0.642)		
RMSE	.00691			.014841		
R-sq	0.9666			0.9844		
chi2	5647.961			12303.9		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Basic Resources		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.150268	1.016745	1.283791	.7558987	.4452781	1.066519
	(0.000)***			(0.000)***		
FTSE100(-2)	-.2293212	-.3625427	-.0960997	-.7672279	-1.077147	-.4573084
	(0.001)***			(0.000)***		
STOXX 600 Basic Res.(-1)	-.0035762	-.0595544	.052402	.966836	.8366113	1.097061
	(0.900)			(0.000)***		
STOXX 600 Basic Res.(-2)	.0156285	-.0397507	.0710077	.0198379	-.1089934	.1486691
	(0.580)			(0.763)		
Constant	.6292403	.2887585	.9697221	.1802461	-.6118328	.972325
	(0.000)***			(0.656)		
RMSE	.007059			.016423		
R-sq	0.9652			0.9863		
chi2	5403.511			14022.23		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Chemicals		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. interval]	
FTSE100(-1)	1.146876	1.008983	1.284769	.4972375	.3483376	.6461373
	(0.000)***			(0.000)***		
FTSE100(-2)	-.2809526	-.4216782	-.140227	-.4193904	-.5713492	-.2674317
	(0.000)***			(0.000)***		
STOXX 600 Chemicals(-1)	.0066386	-.1208421	.1341192	.9320847	.7944282	1.069741
	(0.919)			(0.000)***		
STOXX 600 Chemicals(-2)	.0647148	-.054929	.1843586	.0002767	-.1289173	.1294708
	(0.289)			(0.997)		
Constant	.7083361	.3748843	1.041788	-.2344725	-.5945413	.1255964
	(0.000)***			(0.202)		
RMSE	.006987			.007545		
R-sq	0.9659			0.9799		
chi2	5519.857			9502.105		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Cons. & Mat.		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.138069	.9932755	1.282862	.6392772	.4566266	.8219278
	(0.000)***			(0.000)***		
FTSE100(-2)	-.2215247	-.3712901	-.0717593	-.529295	-.7182183	-.3403717
	(0.004)***			(0.000)***		
STOXX 600 Cons. & Mat.-1)	.0357073	-.0685964	.140011	.9193744	.7877994	1.05095
	(0.502)			(0.000)***		
STOXX 600 Cons. & Mat.(-2)	-.0057281	-.1028585	.0914022	-.0132584	-.1357846	.1092678
	(0.908)			0.832		
Constant	.55871	.1840197	.9334004	-.4073355	-.879993	.0653221
	(0.003)***			(0.091)*		
RMSE	.007104			.008962		
R-sq	0.9647			0.9735		
chi2	5333.068			7164.477		
P>chi2	(0.000)***			(0.000)***		

Table 3 (continued)

	FTSE100			STOXX 600 Financial Serv.		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.003503	.8595956	1.14741	.198887	-.0381334	.4359074
	(0.000)***			(0.100)*		
FTSE100(-2)	-.1082607	-.2475469	.0310255	-.1199583	-.3493673	.1094507
	(0.128)			(0.305)		
TOXX 600 Financial Serv. (-	.1751891	.0911266	.2592517	1.081994	.9435398	1.220447
	(0.000)***			(0.000)***		
TOXX 600 Financial Serv. (-	-.1290371	-.2067079	-.0513663	-.1655696	-.2934961	-.0376432
	(0.001)***			(0.011)**		
Constant	.6505785	.3639659	.9371911	-.1958186	-.6678792	.2762421
	(0.000)***			(0.416)		
RMSE	.006834			.011256		
R-sq	0.9674			0.9538		
chi2	5778.795			4029.487		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Food & Beverage		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.132285	.9915398	1.273031	.3837511	.2427614	.5247408
	(0.000)***			(0.000)***		
FTSE100(-2)	-.177321	-.3163497	-.0382923	-.3987342	-.5380041	-.2594644
	(0.012)**			(0.000)***		
TOXX 600 Food & Beverage(-1	.0459299	-.0914982	.183358	.8966018	.7589353	1.034268
	(0.512)			(0.000)***		
TOXX 600 Food & Beverage(-2	-.0630329	-.2007398	.0746741	.0782768	-.059669	.2162227
	(0.370)			(0.266)		
Constant	.5092667	.2072592	.8112743	.2939937	-.0085377	.5965252
	(0.001)***			(0.057)*		
RMSE	.007092			.007104		
R-sq	0.9648			0.9622		
chi2	5352.237			4960.484		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Health Care		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.141067	1.008552	1.273581	.2640309	.099489	.4285729
	(0.000)***			(0.002)***		
FTSE100(-2)	-.1839907	-.3154441	-.0525372	-.2871685	-.450393	-.123944
	(0.006)***			(0.001)***		
STOXX 600 Health Care(-1)	.0559634	-.0533329	.1652597	.905728	.7700158	1.04144
	(0.316)			(0.000)***		
STOXX 600 Health Care(-2)	-.0552135	-.1643205	.0538935	.0658018	-.0696753	.2012789
	(0.321)			(0.341)		
Constant	.3756321	.0894562	.6618081	.3920756	.0367336	.7474175
	(0.010)***			(0.031)**		
RMSE	.007111			.00883		
R-sq	0.9647			0.9524		
chi2	5322.346			3900.627		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Ind. Gd&Ser.		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.098046	.9555815	1.24051	.5755639	.4080963	.7430316
	(0.000)***			(0.000)***		
FTSE100(-2)	-.2101416	-.3534434	-.0668398	-.5089255	-.6773774	-.3404736
	(0.004)***			(0.000)***		
STOXX 600 Ind Gd&Ser.(-1)	.1000659	-.0074148	.2075466	.960251	.8339069	1.086595
	(0.068)*			(0.000)***		
STOXX 600 Ind Gd&Ser.(-2)	-.0460538	-.1459876	.05388	-.0240874	-.14156	.0933853
	(0.366)			(0.588)		
Constant	.6626856	.3297159	.9956552	-.1991782	-.5905856	.1922292
	(0.000)***			(0.319)		
RMSE	.007026			.00826		
R-sq	0.9655			0.9748		
chi2	5456.296			7545.885		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Insurance		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.105141	.9694456	1.240837	.4522527	.1849036	.7196019
	(0.000)***			(0.001)***		
FTSE100(-2)	-.1886945	-.3225678	-.0548212	-.418755	-.6825137	-.1549964
	(0.006)***			(0.002)***		
STOXX 600 Insurance(-1)	.0642012	-.0001945	.1285969	1.075394	.9485213	1.202268
	(0.051)*			(0.000)***		
STOXX 600 Insurance(-2)	-.0453195	-.1077514	.0171124	-.1008577	-.2238618	.0221463
	(0.155)			(0.108)		
Constant	.6379252	.3243228	.9515277	-.1579937	-.7758566	.4598692
	(0.000)***			(0.616)		
RMSE	.00701			.013811		
R-sq	0.9657			0.9795		
chi2	5483.143			9305.02		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Media		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.119895	.9753672	1.264423	.4676263	.2763093	.6589434
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1623738	-.3049687	-.0197788	-.4678505	-.6566089	-.2790922
	(0.026)*			(0.000)***		
STOXX 600 Media(-1)	.0541292	-.0462494	.1545079	.9216486	.7887736	1.054524
	(0.291)			(0.000)***		
STOXX 600 Media(-2)	-.0584254	-.1576252	.0407744	.0162551	-.1150595	.1475696
	(0.248)			(0.808)		
Constant	.4007505	.1594884	.6420127	.3500838	.0307159	.6694516
	(0.001)***			(0.032)**		
RMSE	.007105			.009406		
R-sq	0.9647			0.9088		
chi2	5331.439			1943.171		
P>chi2	(0.000)***			(0.000)***		

Table 3 (continued)

	FTSE100			STOXX 600 Oil & Gas		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.111789	.9756868	1.24789	.582255	.3695293	.7948808
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1781115	-.3128188	-.0434042	-.5848284	-.7952757	-.3743812
	(0.010)***			(0.000)***		
STOXX 600 Oil & Gas (-1)	.0733053	-.0093582	.1559687	.9251649	.7960235	1.054306
	(0.082)*			(0.000)***		
STOXX 600 Oil & Gas (-2)	-.051758	-.1338162	.0303001	.0442917	-.0839042	.1724875
	(0.216)			(0.498)		
Constant	.4650995	.2156	.7145989	.1965178	-.1912701	.5861937
	(0.000)***			(0.323)		
RMSE	.007051			.011016		
R-sq	0.9653			0.9573		
chi2	5416.536			4356.7		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Retail		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.118798	.9645186	1.273078	.2001838	.0060275	.39474
	0.000)***			(0.048)**		
FTSE100(-2)	-.1519266	-.2852363	.0223821	-.1651576	-.3598506	.0289353
	(0.394)*			(0.055)*		
STOXX 600 Retail(-1)	-.0104213	-.1167706	.0959279	.9911137	.8578385	1.125789
	(0.848)			(0.000)***		
STOXX 600 Retail(-2)	-.0733139	-.1804068	.033779	-.1625577	-.3974697	.0276456
	(0.180)			(0.013)**		
Constant	.5959095	.327422	.8643971	.6677952	.3295636	1.006027
	0.000)***			(0.000)***		
RMSE	.006985			.008599		
R-sq	0.9659			0.8454		
chi2	5523.92			1066519		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Technology		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.077705	.9210724	1.234337	.4055802	.1902086	.6209519
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1663668	-.3210711	-.0116625	-.4133352	-.6290555	-.2036148
	(0.035)**			(0.000)***		
STOXX 600 Technology(-1)	.0883898	-.0212949	.1980744	.9707645	.8199466	1.121582
	(0.114)			(0.000)***		
STOXX 600 Technology(-2)	-.0577596	-.1666716	.0511524	.017113	-.1326424	.1668685
	(0.299)			(0.823)		
Constant	.6048654	.2779985	.9317323	.1675737	-.2818726	.6170201
	(0.000)***			(0.465)		
RMSE	.007044			.008685		
R-sq	0.9653			0.9764		
chi2	5428.263			8077.126		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Telecom		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.066043	.9515655	1.206929	.4055321	.2159703	.5950937
	(0.000)***			(0.000)***		
FTSE100(-2)	-.1134955	-.2518668	.0248758	-.4241178	-.6102965	-.2379392
	(0.108)			(0.000)***		
STOXX 600 Telecom(-1)	.1124929	.0133582	.2036276	1.00659	.8839684	1.129211
	(0.016)**			(0.000)***		
STOXX 600 Telecom(-2)	-.1365433	-.2268772	-.0462094	-.0691728	-.1907166	.052371
	(0.003)***			(0.265)		
Constant	.5712094	.2119465	.8422933	.5192055	.1355086	.9029103
	0.000			(0.008)***		
RMSE	.006955			.009358		
R-sq	0.9662			0.9113		
chi2	5573.135			2002.923		
P>chi2	(0.000)***			(0.000)***		

	FTSE100			STOXX 600 Trvl& Lei.		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.17925	1.019111	1.339388	.4135	.1777613	.6492387
	0.000)***			(0.001)***		
FTSE100(-2)	-.2223583	-.3779431	-.0667736	-.3492552	-.5789606	-.1208894
	0.005)***			(0.003)***		
STOXX 600 Trvl& Lei.(-1)	-.0221482	-.1253043	.080008	.9660104	.8141547	1.117866
	(0.674)			(0.000)***		
STOXX 600 Trvl& Lei.(-2)	.0242953	-.0728405	.1214311	-.0640576	-.1070508	.0789356
	(0.624)			(0.330)		
Constant	.3705232	.1340268	.6070195	-.0303302	-.1784754	.317815
	0.002)***			(0.854)		
RMSE	.007125			.010389		
R-sq	0.9645			0.9179		
chi2	5300.783			2181.97		
P>chi2	0.000)***			(0.000)***		

	FTSE100			STOXX 600 Utilities		
	Coeff.	[95% Conf. Interval]		Coeff.	[95% Conf. Interval]	
FTSE100(-1)	1.040799	.9029905	1.178608	.3633191	.1719826	.5546555
	(0.000)***			(0.000)***		
FTSE100(-2)	-.0950668	-.2310315	.040898	-.4089053	-.5976817	-.2201288
	(0.171)			(0.000)***		
STOXX 600 Utilities-1)	.1517972	.0629365	.2406578	.9840795	.8607034	1.107456
	(0.001)***			(0.000)***		
STOXX 600 Utilities-2)	-.1756142	-.2644407	-.0867876	-.0314531	-.1547818	.0918757
	(0.000)***			(0.617)		
Constant	.6150487	.3.91633	.910934	.663818	.2590042	1.080632
	(0.000)***			(0.001)***		
RMSE	.006833			.009487		
R-sq	0.9674			0.9516		
chi2	5780.393			3835.236		
P>chi2	(0.000)***			(0.000)***		

Notes: Estimation results by Vector Autoregressions. AIC lag selection criteria indicate 2 lags as appropriate lag length. Numbers under the estimated coefficients denote p-values. "***" , "**" and "*" represent significance at 1%, 5% and 10% level. RMSE stands for Root Mean Squared Error, R-sq denotes the R^2 criterion for robustness, chi2 is the X^2statistic estimated, and P>chi2 also provides testing of robustness of estimations.

impact on the FTSE100 than other sectors. More specifically, the Financial Services (0.1751891), Utilities (0.15117972), Telecommunications (0.1124929), Industrial Goods & Services (0.1000659), Automobiles & Parts (0.0951116), as well as Banks (0.0912164) are found to be the most influential sectors concerning effects with one lag. It should be emphasized that in the great majority of sectors as well as concerning the overall Eurostoxx600 index, there is a negative coefficient on the second lag, and the latter is in most cases not statistically significant.

Thereby, the analysis in this section has some major economic implications. Although the main drivers of volatility from the British stock markets towards European derivatives during the post Brexit decision era are the secondary production sectors as outlaid above, the reverse causality mainly stems from services, such as financial and banking services, and telecommunications, in combination with industrial goods and automobile goods. Admittedly, our results abide by the highly industrialized character of the UK as well as with the credit-fed and financially sophisticated character of EU countries.

CONCLUSIONS

In this paper we investigate whether in the time period after the Brexit decision on June 23rd 2016 the performance of the London Stock Exchange has affected the Eurostoxx 600 futures index among its different sectors. VAR estimations are performed by employing high-frequency (daily) data starting from the day of the referendum until March 20th 2017.

The main advantage of our methodological approach is that bi-directional causality between the British spot stock markets and European futures derivatives markets can be tested with less ambiguity through the use of the VAR methodology we employ. Mindful of the necessity for representativeness of the sophisticated character of European financial derivatives markets, we consider the most representative derivatives index, that is the Eurostoxx600 futures index and its sectoral sub-indices. The serves for answering the intriguing policy question of which sectors of the European economy were the main transmission routes for this suddenly higher volatility.

Estimations provide evidence that during nine months after the affirmative decision about the United Kingdom (UK) leaving the European Union (EU), the British FTSE100 index is found to have influenced the prices of the highly representative of European futures markets Eurostoxx600 index and its components in a positive and

statistically significant manner. To be more precise, the Automobiles & Parts, Banks, Basic Resources, Construction & Materials, Oil & Gas, as well as Industrial Goods & Services are the sectors on which their derivatives are found as mostly affected by volatility in the British stock market. Furthermore, we provide evidence that impacts of the Brexit decision mainly function through the primordial secondary production sectors of the European economy.

On the other hand, reverse effects rely most on the tertiary sector such as Financial Services, Banks, Utilities, Telecommunications, Industrial Goods & Services, but also Automobiles & Parts. Results indicate that both directions of causality are positive on average concerning each sub sector and by taking both two lags into consideration. Moreover, it is worth noting that our findings are in tight accordance with the special characteristics of the UK and the EU economies and totally abide by rationality in investment decisions.

We argue that the improvement in understanding the Brexit effects on European financial markets due to this paper is far from negligible. Our study provides an unadulterated insight into how investment decisions in the EU have been affected by the Brexit-led movements in the British stock markets, in terms of speculator and hedging incentives. Moreover, building on the results, a central planner could adjust her policymaking in order to boost economic activity by assigning more emphasis on regulating the most influential for transmission economic sectors in the EU.

The main motivation for this paper has been to cast light on the Brexit's effectiveness on several strands of economic action in terms of different economic sectors and disentangle to the best possible extent the various sectoral transmission channels in view of the complexity of the financial derivatives structures.

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