Brexit concerns, UK and European equities: A lose-lose scenario?

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A lose-lose scenario?

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Abstract: We assess whether the attention given to "Brexit" (via Google Trends and Twitter) exerts a significant influence on UK, German and French stock markets. While a large body of work has proposed models for the conditional mean and variance of equity returns, this research is undertaken towards modeling the full return distribution (quantile regression approach), and decomposing the covariance into different spectral components (frequency domain causality test). Despite an acute consciousness that it is difficult to quantify the costs of Brexit, on the basis of this article' outcomes, we're being told little of what happens with the growing support for Brexit. Whatever the methods and the internet proxies used, this study inconvertibly reveals that the severeness of Brexit' impact was not uniform across the investigated equities. Germany and France (in this order) suffered heavier losses if the British exit from Europe occurs, while UK experienced puny effect.

Keywords: Brexit; social media; equities; UK; Germany; France.

1. Introduction

Nowadays talks on a possible "Brexit"[1] focus the attention of media. While the issue is of a paramount importance within the UK, a potential Brexit is also extremely substantial for other states within Europe. When looking at outside UK, leaving the Europe (EU) is not just one about is good or worse for UK; instead it appears a question of how such move could change the EU policies. Most experts asserted that both the UK and the Europe would suffer losses if the British exit from EU occurs. The analyses seem divergent and scenarios are numerous. The lack of assuredness on what political and economic arrangement would pursue a Brexit makes quantifying losses for each party very hard. Regardless the fact that Britain may lose international political clout by leaving the EU, the major consequences of the Brexit would be financial and economic. In the event of a vote to leave the EU, the economic costs would outweigh the benefits for both UK and Europe. Exports would suffer substantially, as would investment, and policymakers would get tied up in longest renegotiations of trade relations. A lengthy period of uncertainty on the part of companies and traders would jeopardize the UK and EU economic growth prospects. Accordingly, London School of Economics estimates that a rise in trading costs and a drop of productivity would prompt a decrease of about 2.2 percent of GDP in the most cheerful case and a fall of anywhere among 6.3 percent and 9.5 percent in the most gloomy case, very close to the losses resulting from the global financial collapse. Besides, the German foundation Bertelsmann Stiftung advanced that leaving EU would cost for UK by about 78 billion euros a year (for ten years). This loss is highly expected since being outside the EU implies a great decline in foreign trade, due to the return of customs barriers. They also anticipated a decrease by 0.3 percent of GDP per capita in France and Germany. Beyond the rights and wrongs of staying or leaving the EU, uncertainty is evidently the thing markets hate the most. If the perception of economic and investment risk to the UK raises, the sterling would depreciate, the cost of borrowing for business could increase markedly, and the stock market prices fall. Also, the European markets could roil the great anxiety over this event.

Due to the enormous amount of available information, searching has become growingly dominant in the use of Internet. Millions of users daily interact with search

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[1] It is dubbed "Brexit" following the Greek financial collapse since 2012 when experts and with large extent the media were speculating that Greece would be forced being outside the EU due to the fact that the country defaulted on its debt obligations. Unlike Greece, a Britain leaving from the EU is likely to be self-induced rather than forced.

engines, creating valuable sources of data regarding various aspects of the world. In light of this, the Internet search becomes day-to-day a potential tie helping to better analyze the equities behavior in turbulent times. Behavioral finance research considers that traders' investment decisions are highly driven by emotion (Damasio 1999 and Dolan 2002). For example, some research show how online information predicts "Grexit", crypto-market and oil market (Mitchell et al. 2012, Choi and Varian 2012, Bordino et al. 2012, Kristoufek 2013, Bouoiyour and Selmi 2015 a, b, among others). Notably, information related to Brexit has spread rapidly, causing sizable stock market changes by adjusting the traders' market expectations. With the potent uncertainty surrounding possible Brexit, bloggers and economists start dealing with this issue by revolving around various questions: Is Brexit a threat for investors? What might the possibilities be for the UK outside the EU? What would happen if Britain left the EU? etc…

In light of this apparent great attention to British exit from EU, this paper introduces the concept of internet concern as quantitative measure to address whether extracting public moods related to "Brexit" affect significantly UK and European (with special reference to Germany and France) equities. From a methodological perspective, such complexity in the focal issue makes analyzing the behaviors of equities in an uncertain context heavily difficult with classic methods. The speculative bubbles characterizing asset markets strengthened the focus on models that allow properly capturing dynamic dependencies in data. Bearing these considerations in mind, linear correlation may not be a satisfactory measure of dependence, as it does not account for dependence between tail events. Outside the classical mean variance framework[2], investors with more general preferences need an estimate of the full return distribution to compute expected utility and derive their optimal portfolio holdings. While a large body of work has proposed models for the conditional mean and variance of stock returns, far less work has been undertaken towards modeling the full return distribution. This paper uses a quantile regression (QR) approach that concentrates on predictability of quantiles located at several points of the return distribution. It enables to uncover fresh information about how would react UK and EU equities over an uncertain period surrounding possible Brexit. Obviously, the correlation asymmetries would ensure that market participants (investment advisers, investors, traders and regulators) have the opportunity to make informed

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[2] We believe that the traditional methods (OLS, VECM, etc.) are malapropos to effectively depict a vacillating framework. These techniques seem unable to give solid and unambiguous results since they do not account for possible nonlinearity and asymmetry.

decisions. In addition to the correlation variation among tail-distributions, the direction of the Granger causality from the attention to Brexit to UK, German and French stock returns have been computed for distinct frequency components (frequency domain causality test). In this case, the stationary process can be depicted as a weighted sum of sinusoidal components with a certain frequency, allowing us to evaluate different cyclical components.

By considering a wide range of quantiles, the reactions of UK and EU stock markets to possible Brexit appear as highly heterogeneous among tail distributions, where consistent with the notion of asymmetry. The German stock market is typically more responsive than French and UK equities towards the possible British exit from EU. With respect the causality' strength, the results do not fundamentally change whatever the internet proxy used (Google Trends or Twitter). In particular, the cyclical component seems longer for Germany followed by France and UK.

The body of this paper is organized in four major sections. Section 2 outlines the methodology followed in this paper, and presents a brief data overview. Section 3 reports and discusses our main findings. Section 4 concludes.

2. Methodology, data and hypotheses

2.1. The quantile regression approach

Compared to the standard estimation of the conditional mean function (OLS), QR approach assesses each link accurately across random variables (Koenker and Bassett 1978; Koenker and Xiao 2002). It provides a complete description of asymmetric samples, which is one of the main distinguishing characteristics of financial data. Since its introduction by Koenker and Bassett (1978), QR continues to be an interesting tool as it accounts for a set of regression curves that differ across distinct quantiles of the conditional distribution of the dependent variable. A QR is suited to determine how evolve time series for all portions of a probability distribution (i.e., slopes from the minimum to the maximum responses). Hence, it can underscore a broader picture in helping gauge the correlation between current returns and various parts of the lagged conditional returns which presents outstanding when extreme values are present. QR bestows the role of different rhythms in the connectivity between the attention oriented to Brexit and UK, German and French equities.

QR is a generalization of median regression analysis to other quantiles. The coefficients of the τth conditional quantile distribution are estimated as follows:

$$\hat{\beta}(\tau) = \arg\min \sum_{t=1}^{\tau} (\tau - 1_{\{y_t \prec x'_t \beta(\tau)\}}) |y_t - x'_t \beta(\tau)|$$

(1)

where the quantile regression coefficient *β(τ)* determines the connection between the vector *x* (independent variables) and the τth conditional quantile of *y* (the dependent variable). To determine *y* in function of specific independent series, the values of quantile coefficients could be constant where the values of *β(τ)* do not change markedly for the values *τ*. Moreover, it should be symmetric (asymmetric) where the values of *β(τ)* seem similar (dissimilar) for lower and upper quantiles.

We specify then the conditional quantile function for different quantile levels (such as the 10th, 20th... 90th percentiles):

$$Q_y(\tau \mid x) = \alpha(\tau) + \sum_k \beta_k(\tau) x_k + \sum_k \delta_k(\tau) z_k$$

(2)

where *z* corresponds to the relevant control variables (to be described later).

Using QR, we can see if the return is indicative of a rapidly improving UK, German and French equities or associated with a market that is highly contracting among various slopes (quantiles from the 10th to the 90th). Although the variant correlation via QR can be relevant for market participants to act efficaciously, this technique seems insufficient to fully judge a "complex" issue in an uncertain context. The methodological critical way arises from the fact that correlation does not necessarily imply causality.

2.2. The frequency domain causality test

The majority of previous empirical researches are limited in scope to the applications of linear models. However, the great speculation, the hefty uncertainty surrounding financial markets and the " convoluted" asset prices dynamics can prompt structural alterations in the pattern of financial markets' responses for a given time period. Given these considerations, this study seeks to scrupulously address this issue in a nonlinear framework by utilizing a recently developed nonparametric approach of Breitung and Candelon (2006). Instead of

computing a single Granger causality measure for the entire link, the Granger causality is determined here for each individual frequency component. This frequency-by-frequency examination will make it possible to identify if the predictive power is concentrated at the quickly fluctuating components (high frequencies or short-run time horizons) or at the slowly fluctuating components (low frequencies or long-term).

To define the frequency causality test, we start by considering $z_t = [x_t, y_t]$ as a two-dimensional time series vector with t = 1... T. It is supposed that z_t has a finite-order VAR representation $\theta(L)z_t = \varepsilon_t$ where $\theta(L)z_t = 1 - \theta_1 L - ... - \theta_p L^p$ is a 2 × 2 lag polynomial with $L^k z_t = z_{t \to k}$. It is assumed that the vector ε_t is white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = \Sigma$, $E(\varepsilon_t \varepsilon_t') = \sum$ where $\sum$ is a positive definite matrix. The system is stationary expressed as:

$$z_t = \phi(L)\varepsilon_t = \begin{pmatrix} \phi_{11}(L)\phi_{12}(L) \\ \phi_{21}(L)\phi_{22}(L) \end{pmatrix} \begin{pmatrix} \varepsilon_{12} \\ \varepsilon_{21} \end{pmatrix} \tag{3}$$

$$= \Psi(L)\upsilon_t = \begin{pmatrix} \psi_{11}(L)\psi_{12}(L) \\ \psi_{21}(L)\psi_{22}(L) \end{pmatrix} \begin{pmatrix} \eta_{12} \\ \eta_{21} \end{pmatrix}$$

Then, the spectral density can be derived from the previous matrix and denoted as:

$$f_x(w) = \frac{1}{2\pi} \left\{ \left| \psi_{11}(e^{-iw}) \right|^2 + \left| \psi_{12}(e^{-iw}) \right|^2 \right\} \tag{4}$$

Spectral analysis allows determining the cyclical properties of data. In this study, the Granger causality test-based frequency domain relies on a modified version of the coefficient of coherence. It is estimated in a nonparametric fashion enabling to derive the distributional properties of investigated time series. Let x_t and y_t be two stationary time series of length T representing the attention to Brexit and the central stock returns, respectively. The main goal of this study is to test whether x_t Granger cause y_t, at a given frequency λ, conditioning upon Z_t (additional control variables that will be mentioned below). Accordingly, Geweke (1982) proposed a measure of causality that can be expressed as follows:

$$M_{x \to y/Z}(w) = \log \left[1 + \frac{\left| \psi_{12}(e^{-iw}) \right|^2}{\left| \psi_{11}(e^{-iw}) \right|^2} \right] \tag{5}$$

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As $\left|\psi_{12}(e^{-iw})\right|^2$ seems "complex" nonlinear function of the VAR parameters, Breitung and Candelon (2006) and in order to resolve this drawback argue that the hypothesis $M_{x \to y/Z}(\omega) = 0$ correspond to a linear restriction on the VAR coefficients.

$$H_0 : R(\omega)\phi(L) = 0 \tag{6}$$

where $R(\omega) = \begin{bmatrix} \cos(\omega)\cos(2\omega)...\cos(p\omega) \\ \sin(\omega)\sin(2\omega)...\sin(p\omega) \end{bmatrix}$

Based on equation (6), we can adequately capture how signals evolve among different frequency bands involved. The significance of the causal relationship can be tested by a standard F-test or by comparing the causality measure for $\omega \in [0, \pi]$ with the critical value of a χ^2 distribution with 2 degrees of freedom, which is 5.99.

2.3. Data and hypotheses

In this article, the QR model and frequency domain causality test have been performed to analyze the reactions of UK and EU stock returns[3] conditioning upon global financial and economic factors. To this end, we use weekly data for over the period from January 2010 to July 2015[4] (with a total of 268 observations) for stock prices of UK (FTSE 100), Germany (DAX 30) and France (CAC 40).We prefer use weekly instead of daily or monthly data to avoid possible econometric pitfalls that may occur including the microstructure effects, the bid-ask bounce and the possible asymmetrical demeanor. The stock market prices data are collected from Datastream database. The search queries for keyword related to the British exit from EU (i.e., "Brexit") were collected via Google Trends (http://www.google.com/trends). Note that for twitter, we use the tweet backs related to the same keyword. Three global financial and risk factors that may have a wide role in explain the focal linkage have been considered. Generally, major global financial and economic factors could be channels through which fluctuations in the world's economic and financial conditions are transmitted to UK and EU equities. These factors include the US equity volatility index (*VIX*), the West Texas Intermediate (*WTI*) oil price and the world gold price. The *WTI* has been widely used in the

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[3] The stock return (*STR*) is calculated by considering the ratio stock price (in log) at time t and the lagged stock price (in log).

[4] The choice of sample selected for this analysis is dictated by the availability of reliable data.

literature as the benchmark price for global oil markets. The *WTI* crude oil is among the most traded oil on the world markets, and therefore is significantly affected by macro-financial variables. The gold is a precious metal that has been largely perceived as a hedge against sudden shocks and also a safe haven over extreme stock market fluctuations (Baur and Lucey 2010). Moreover, the literature in finance field has been frequently relied on proxies of uncertainty, most of which have the advantage of being directly observable. Such proxies include the implied volatility of stock returns (i.e., *VIX*). This index plays a powerful role in explaining asset allocation and portfolio strategies (Hood and Malik 2013 and Balcilar et al. 2014). It may help reaching further insights about how the stock markets responses to global market news. These time series data come from quandl website. All the investigated variables have been transformed by taking natural logarithms to correct for potential heteroskedasticity and dimensional differences among time series.

Bearing in mind the difficulty to quantify Brexit costs, we formulate some hypotheses to be tested: *Is the uncertainty about Britain leaving the Europe exerted a great influence on UK, German and French equities? If so, do the responses to possible Brexit appear different across these countries?* To answer these questions, we use a QR approach estimator which is robust to outlying observations on the dependent variable. The model to be estimated is given by:

$$\hat{r}_t^\tau = \hat{\omega}(\tau) + \hat{\alpha}(\tau)STR_{t-1} + \hat{\beta}(\tau)Brexit_t + \hat{\delta}_1(\tau)Oil_t + \hat{\delta}_2(\tau)VIX_t + \hat{\delta}_3(\tau)Gold_t \qquad (7)$$

where $\hat{r}_t^\tau$ is the estimated $\tau-$conditional quantile of UK, German and French stock returns (STR), and the estimated parameters $\hat{\alpha}(\tau)$, $\hat{\beta}(\tau)$ and $\hat{\delta}_k(\tau)$ for k=1, 2, 3 are function of τ; STR_{t-1}: the lagged stock return that may reflect the influence of some potential variables not included here due to the unavailability of weekly frequency data for some time-series.

In addition to the interdependence pattern, this research applies a frequency domain causality test to determine whether there is a time-varying causality between the growing interest to Brexit and the central stock market returns.

3. Main findings

3.1. QR results

We first employ OLS regression[5] to reach initial information about the reactions of UK and EU equities to Brexit. The idea here is to have a case of benchmarking to compare the OLS with QR in order to highlight the effectiveness of QR approach. The OLS results are reported in Table 1 indicate that the coefficient of Brexit proxied by Google Trends seem significant only for UK and France, which is non-credible given the large Germany's weight in Europe. The mean effect of the exogenous variable on the endogenous time series may be under or over estimate impacts or even fail to properly determine full possible influences (Cade and Noon 2003); hence the need to perform more elaborate methods.

Using QR technique, a clearer heterogeneity across UK and EU equities with respect the Brexit' impact was found. For UK, the attention to Brexit exerts a negative significant influence on stock return at low and middle quantiles (i.e., when investors are pessimistic or the market is moderately efficient); such relationship is weak, fluctuating between -0.083 and -0.013 (Table 1, Panel 1.1). Unlike UK, Germany would suffer markedly from possible Brexit. Precisely, the British exit from Europe lead to a decrease of stock return (the slope coefficient moves among -0.48 and -0.23). This result is also validated when the stock market is performing weakly, but also in upper quantile (i.e., τ =0.8). For France, the equity reaction to Brexit anxiety is negative at low quantiles and around middle quantile (i.e., when the stock market perform less than normal or around the average). Specifically, the Brexit coefficients vary between -0.12 and -0.005.

To avoid possible methodological pitfalls regarding omitted variable bias, a vector of additional explanatory variables (discussed above) is incorporated in the model. We include *WTI*, gold price and *VIX*. We clearly show that the implied volatility index affect statistically and negatively the performance of the UK and EU markets at different quantiles, indicating that the EU market returns decrease as the *VIX* increases. Unsurprisingly, the uncertainty is the thing that markets hate the most. The *VIX* has a moderate impact on UK and France stock markets and occurs in lower quantiles, while for Germany the effect appears more important and occurs in upper quantiles. Besides, gold has no influence for the considered countries

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[5] For comparison, we report the OLS and LAD (i.e., the 0.50 quantile) estimates in Table 1. The contrast between the conditional median (i.e., LAD) and the mean (i.e., OLS) estimates can be partially due to the asymmetry of the conditional density and to a strong effect exerted on the least squares fit by the possible outlier observations in the sample.

(except Germany at low quantiles or when pessimism mostly prevailed). This means that gold has not lost its great importance as a safe haven and a hedge in Germany. It seems important to recall that gold possesses no credit risk and cannot turn worthless even though uncertain event. With the financialization of the commodity markets, gold enables to provide great protection against losses when equities undergo large decreases. Then, including gold in portfolios allows investors preventing the downside risk in their investments (Mishra and Mishra 2010). We do not support this evidence for the investigated countries (except Germany in lower quantiles). *WTI* affects positively UK equity return at highest quantiles (i.e., when investors are optimistic) and middle quantiles, but this correlation seems weak since it is only significant at 10%. Nevertheless, *WTI* impacts negatively the German stock return around the middle quantile (i.e., τ =0.4 or 0.5). French equity does not seem sensitive to oil price fluctuations.

Table 1 (Panel 1.2) reports a formal test of the equality of the coefficient estimates for various τ-quantiles to evaluate whether the estimated QR relationships are conform to the location shift hypothesis which assumes the same slope parameters for all of the conditional quantile functions[6]. It shows that the coefficient estimates are statistically different from each other if the estimates for lower τ-quantiles are compared with estimates for the higher or intermediate τ-quantiles. These outcomes hold for the coefficient estimates of the variables *STR*$_{t-1}$ and Brexit. The null hypothesis of equal slope is generally rejected[7] at the conventional significance levels for UK (0.100 vs. 0.900, 0.300 vs. 0.700 and 0.400 vs. 0.600), Germany (0.100 vs. 0.900, 0.200 vs. 0.800 and 0.300 vs. 0.700) and France (0.100 vs. 0.900, 0.200 vs. 0.800, 0.300 vs. 0.700 and 0.400 vs. 0.600).

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[6] The Koenker and Xiao (2002) test computes that all the covariate effects satisfy the null hypothesis of equality of the slope coefficients across τ-quantiles. In particular, the difference between slope estimates at the τ and (1-τ) quantiles is examined. A rejection favors the QR.

[7] The rejection of the null hypothesis implies that the magnitude of the slope coefficient, estimated at the various parts of the return distribution, is different and that the difference is statistically significant.

Table 1. QR estimates: The responses of UK and EU equities to the attention to Brexit (via Google Trends)

	Quantile	UK		GERMANY		FRANCE	
		Estimate	p-value	Estimate	p-value	Estimate	p-value
		1.1. Estimated results of quantile regression					
		Estimate	p-value	Estimate	p-value	Estimate	p-value
C	0.100	0.077304**	0.0035	-0.030905	0.7145	0.003532	0.8923
	0.200	0.064866**	0.0104	0.047791	0.5798	0.008104	0.8056
	0.300	0.052032**	0.0115	0.058089	0.4532	0.003573	0.9296
	0.400	0.052516***	0.0001	0.031063	0.6737	-0.008268	0.8279
	0.500	0.048883***	0.0000	0.013254	0.8520	0.001133	0.9787
	0.600	0.059693***	0.0000	0.014736	0.8295	0.023373	0.5863
	0.700	0.066684***	0.0000	-0.026926	0.6855	0.037889	0.3851
	0.800	0.066146***	0.0000	0.006986	0.9225	0.061789	0.1186
	0.900	0.088247***	0.0000	0.001472	0.9833	0.052007	0.1744
STR_{t-1}	0.100	0.185203	0.3450	0.259289*	0.0250	0.102956	0.4677
	0.200	0.355120*	0.0925	0.327413*	0.0332	0.275493	0.0814
	0.300	0.502901**	0.0028	0.388326*	0.0403	0.301966	0.1359
	0.400	0.515904***	0.0000	0.495999**	0.0028	0.326534*	0.0706
	0.500	0.521131***	0.0000	0.713286***	0.0001	0.335075*	0.0609
	0.600	0.433996***	0.0000	0.685595***	0.0003	0.409916**	0.0089
	0.700	0.391121	0.0005	0.773887***	0.0000	0.390235**	0.0051
	0.800	0.387219**	0.0012	0.674492***	0.0000	0.381744**	0.0037
	0.900	0.209733	0.1252	0.627506***	0.0001	0.383025**	0.0010
Brexit	0.100	-0.083993**	0.0033	-0.48154***	0.0243	-0.117189*	0.0983
	0.200	-0.014670*	0.0303	-0.236929**	0.0034	-0.122635	0.1096
	0.300	-0.01394***	0.0000	-0.233814**	0.0028	-0.120403*	0.0838
	0.400	-0.005084	0.9200	0.572133	0.4174	-0.050241*	0.0239
	0.500	-0.02680***	0.0004	0.670985	0.3099	-0.101040*	0.0567
	0.600	0.001541	0.9750	0.603817	0.3460	0.066139*	0.0309
	0.700	0.008991	0.8655	0.856050	0.1614	0.038380	0.8682
	0.800	0.026093	0.6357	-1.125378*	0.0580	0.019523	0.9429
	0.900	0.056692	0.3974	0.721225	0.3378	0.305296	0.3285
VIX	0.100	-0.04008***	0.0000	0.022716	0.9650	0.033893	0.8856
	0.200	-0.028987	0.2433	-0.006368	0.9914	-0.0663***	0.0000
	0.300	-0.030483	0.1807	0.059453	0.9250	-0.08361**	0.0010
	0.400	-0.023118*	0.0599	0.062712	0.9186	0.054198	0.8219
	0.500	-0.018411**	0.0013	0.044525	0.9435	0.137597	0.5803
	0.600	-0.000563	0.9705	-0.555275	0.4505	0.058270	0.8293
	0.700	-0.004913	0.7407	-0.151472	0.8663	0.264772	0.3052
	0.800	-0.011102	0.5554	-1.546686*	0.0708	0.308036	0.2623
	0.900	-0.016769	0.5354	-1.489976*	0.0400	0.678603	0.1324
GOLD	0.100	0.086380	0.5811	0.106887***	0.0000	-0.002877	0.9685
	0.200	0.031492	0.8237	0.229520***	0.0007	-0.021702	0.8094
	0.300	0.043922	0.7576	-1.027557	0.5093	-0.026687	0.8030
	0.400	-0.068214	0.5609	-1.232541	0.4644	0.091388	0.3440
	0.500	-0.105971	0.3466	-1.640870	0.3817	0.113711	0.2817
	0.600	-0.122657	0.2730	-0.354343	0.8666	0.116332	0.3097
	0.700	-0.144008	0.1873	-1.151907	0.5488	0.040614	0.7572
	0.800	-0.068177	0.5164	-2.494569	0.2734	0.071093	0.5507
	0.900	-0.193233	0.2877	-3.452253	0.1069	0.106502	0.4113
WTI	0.100	0.148765	0.1288	0.084605	0.9158	-0.026335	0.9450
	0.200	0.110016	0.1490	0.031912	0.9719	-0.077867	0.8707
	0.300	0.058996	0.4244	-0.525284**	0.0237	-0.017937	0.9736
	0.400	0.090488	0.2244	-0.592380*	0.0952	-0.220419	0.7307
	0.500	0.127165*	0.0888	-0.225534**	0.0012	-0.446058	0.5560
	0.600	0.125311	0.1191	0.286035	0.7348	-0.761129	0.2497
	0.700	0.109325	0.2327	1.097638	0.1972	-0.842381	0.2067

	0.800	0.170636*	0.0810	1.108329	0.2084	-0.357306	0.4675
	0.900	0.235583*	0.0734	1.398832	0.1727	-0.067096	0.8725
OLS (*Brexit*)		-0.026531**	0.0346	0.156782	0.3456	-0.05341**	0.0076
1.2. Statistic tests of the equality of slope estimates across various quantiles							
0.100 vs. 0.900		3.18*	0.0691	12.58**	0.0032	10.76**	0.0014
0.200 vs. 0.800		0.00	0.9208	15.26**	0.0011	6.22*	0.0108
0.300 vs. 0.700		5.03**	0.0085	4.83*	0.0439	23.15***	0.0000
0.400 vs. 0.600		6.77**	0.0083	1.75	0.1264	11.69**	0.0055

Notes: The right columns of this table present the F tests of the equality of slope parameters across various quantiles. ***, ** and * imply significance at the 1%, 5% and 10%, respectively;

These results do not appear highly sensitive to the Brexit attention proxies used. By considering the number of tweet backs as quantitative measure, the findings change slightly (Table 2, Panel 2.1). First of all, a systematic pattern exists for the quantile-varying estimates of the Brexit coefficient among the investigated countries, that the classical methods unknown. It is often revealed that UK and EU equities respond dissimilarly to the anxiety over Brexit. For all the concerned countries, a negative and significant relationship between the central variables occurs when the stock return is at low quantiles (i.e., when stock market perform badly). However, the severity of the effect of uncertainty surrounding Brexit was not uniform across UK and EU markets. In particular, Germany suffered the most, while France and UK (in this order) experienced a moderate influence. More accurately, we show that the Brexit' impact on UK stock return moves within -0.04 (10th) and -0.02 (20th and 30th). In France, the interest to the Britain being outside EU exert more important influence on investors' confidence, as its effect on equity return fluctuates among -0.11 (10th) and -0.17 (20th). For Germany, the situation appears more serious, since this turbulent and uncertain time affects strongly stock returns (-0.25 (20th) and -0.46 (50th)). In sum, the reactions of UK and EU stock markets to Brexit looms is asymmetric; When concentrating on the additional control variables, the results appear quite interesting. We note usually that the uncertainty index displays higher coefficient for Germany followed by UK (but in lower quantiles). The VIX' impact on French equities is weaker, occurring at higher quantiles. Oil price affects significantly the three investigated markets around the average; such effect seems stronger for UK and with less extent for Germany. French equity is moderately influenced by *WTI* changes. Over the current uncertainty surrounding possible British exit from EU, gold plays as a hedge for Germany, while its influence on UK and French equities seems negligible. The same result has been found in Table. A further investigation consists on re-applying the same exercice using Koenker and Xiao (2002) test. The results change slightly compared to

Table1[8]. In sum, these findings fortify the usefulness to consider the distribution heterogeneity when examining an unsettled context where standard methods are unbefitting.

Table 2. QR estimates: The responses of UK and EU equities to the attention to Brexit (via Twitter)

		UK		GERMANY		FRANCE	
		2.1. Estimated results of quantile regression					
	Quantile	Estimate	p-value	Estimate	p-value	Estimate	p-value
C	0.100	0.052985*	0.0323	-0.019697	0.3092	0.003988	0.5794
	0.200	0.034371**	0.0013	0.009315	0.6460	0.009455	0.2382
	0.300	0.035970***	0.0003	0.011011	0.6618	0.013079	0.1481
	0.400	0.043796***	0.0000	0.007925	0.7835	0.01549*	0.0959
	0.500	0.048029***	0.0000	0.032688	0.2759	0.02024*	0.0414
	0.600	0.054015***	0.0000	0.026345	0.3780	0.03266**	0.0038
	0.700	0.053331***	0.0000	0.030519	0.2014	0.0651***	0.0000
	0.800	0.067277***	0.0000	0.057537*	0.0117	0.0830***	0.0000
	0.900	0.079079***	0.0000	0.061460**	0.0059	0.0872***	0.0000
STR_{t-1}	0.100	0.414711*	0.0803	0.265216**	0.0051	0.118053	0.4018
	0.200	0.627097***	0.0000	0.226769*	0.0471	0.28048*	0.0705
	0.300	0.637144***	0.0000	0.330034*	0.0757	0.31648*	0.0883
	0.400	0.561870***	0.0000	0.527488***	0.0009	0.41446*	0.0243
	0.500	0.542995***	0.0000	0.659070**	0.0017	0.5877***	0.0002
	0.600	0.504320***	0.0000	0.677864**	0.0013	0.590***	0.0001
	0.700	0.514409***	0.0000	0.784196***	0.0000	0.4479**	0.0062
	0.800	0.411687***	0.0000	0.810639***	0.0000	0.4817**	0.0091
	0.900	0.305533*	0.0130	0.811372***	0.0000	0.701656	0.0020
Brexit	0.100	-0.04473***	0.0002	-0.431865*	0.0769	-0.11007*	0.0902
	0.200	-0.02281***	0.0000	-0.257121*	0.0112	-0.1727**	0.0054
	0.300	-0.02676***	0.0000	-0.424442*	0.0055	-0.133***	0.0000
	0.400	0.038677	0.3349	-0.464107**	0.0049	-0.144***	0.0000
	0.500	0.004696	0.9027	-0.11167***	0.0000	-0.017095	0.8572
	0.600	-0.012201	0.7557	0.630502	0.3294	-0.09423*	0.0451
	0.700	-0.002318	0.9509	0.730724	0.2099	-0.102749	0.3342
	0.800	-0.031175	0.4114	0.403495	0.4862	-0.059095	0.5865
	0.900	0.049920	0.4650	1.080137	0.1915	-0.124581	0.2811
VIX	0.100	-0.177211**	0.0064	-0.165043	0.8277	-0.162700	0.6216
	0.200	-0.114345*	0.0158	-0.484926*	0.0735	-0.136848	0.9522
	0.300	0.456242	0.9232	-0.447242*	0.0461	-0.756460	0.8743
	0.400	1.315345	0.9792	-0.152919	0.7812	-0.059562	0.7952
	0.500	1.289688	0.6562	0.125419	0.6577	-0.788413	0.2279
	0.600	0.024949	0.7197	-0.415203	0.2446	-1.502949	0.8221
	0.700	0.401490	0.3006	-0.009345	0.1209	-0.0090**	0.0045
	0.800	0.490723	0.1696	0.278196	0.9613	-0.03446*	0.0294
	0.900	-1.938552	0.1626	-0.613779	0.9274	-0.0432**	0.0010
GOLD	0.100	0.086380	0.5811	0.106887***	0.0000	-0.002877	0.9685
	0.200	0.031492	0.8237	0.229520***	0.0007	-0.021702	0.8094
	0.300	0.043922	0.7576	-1.027557	0.5093	-0.026687	0.8030

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[8] Specifically, we note that the slope coefficient of the attention to Brexit via Twitter differs at 30th against 70th and 40th against 60th quantiles for UK and Germany, and at 10th against 90th and 20th against 80th for the case of France.

	0.400	-0.068214	0.5609	-1.232541	0.4644	0.091388	0.3440
	0.500	-0.105971	0.3466	-1.640870	0.3817	0.113711	0.2817
	0.600	-0.122657	0.2730	-0.354343	0.8666	0.116332	0.3097
	0.700	-0.144008	0.1873	-1.151907	0.5488	0.040614	0.7572
	0.800	-0.068177	0.5164	-2.494569	0.2734	0.071093	0.5507
	0.900	-0.193233	0.2877	-3.452253	0.1069	0.106502	0.4113
	0.100	1.473951	0.5682	0.739456	0.5748	-1.104859	0.7221
	0.200	1.082668	0.8870	0.481473	0.9521	-0.869632	0.3580
	0.300	0.005958	0.9906	-0.416135*	0.0554	-0.2040**	0.0064
	0.400	0.665325*	0.0243	-0.473920*	0.7343	-0.23534*	0.0810
WTI	0.500	0.519166*	0.0614	-0.120784	0.6110	0.013033	0.8013
	0.600	-0.583889	0.2492	-0.348164	0.2592	-0.055399	0.2579
	0.700	-0.528580	0.1811	-3.708769	0.4411	-0.518038	0.2699
	0.800	-0.654508	0.1544	-4.119389	0.1509	-0.559562	0.9060
	0.900	-0.987736	0.1202	-4.470263	0.2170	-0.834317	0.9498
OLS (*Brexit*)		0.034564	0.3568	-0.104***	0.0003	0.009672	0.4512
2.2. Statistic tests of the equality of slope estimates across various quantiles							
0.100 vs. 0.900		0.76	0.2154	0.13	0.8965	3.56**	0.0011
0.200 vs. 0.800		1.97*	0.0404	0.22	0.8123	10.14***	0.0000
0.300 vs. 0.700		2.12**	0.0091	3.07*	0.0297	1.89*	0.0412
0.400 vs. 0.600		7.65***	0.0000	5.62**	0.0038	0.21	0.3781

Notes: The right columns of this table present the F tests of the equality of slope parameters across various quantiles. ***, ** and * imply significance at the 1%, 5% and 10%, respectively.

3.2. Frequency domain causality findings

As mentioned above, the focus of the use of frequency domain causality test is on detecting cycles in the intensity of Brexit' impact on UK and European stock markets. Figure 1 depicts the evolution of the linkage between the interest to Brexit (measured via Google Trends) and UK and EU equities conditioning upon gold price, uncertainty (or VIX) index, and WTI. The figure contains the test statistics with their 5 percent critical values for the different frequency bands involved (solid line) over the interval $[0, \pi]$. The frequency (ω) on the horizontal axis can be translated into a cycle or periodicity of T weeks by $T = (2\pi / \omega)$ where T is the period. The results of Granger coefficient for causality running from the attention to Brexit to equities show that searching the keyword "Brexit" via Google Trends Granger-cause UK and EU equities (Figure 1) at level of frequencies reflecting short-run business cycle (or high frequencies). The cycle appears lengthy for Germany (when $\omega \in [1.73\pi - 3.03\pi]$, corresponding to a cycle within four weeks) compared to France (when $\omega \in [1.84\pi - 3.03\pi]$, corresponding to a cycle length of 3.4 weeks) and UK (when $\omega \in [2.27\pi - 2.49\pi] \cup [2.60\pi - 3.03\pi]$, corresponding to a cycle between 2.4 and 2.7 weeks). The reverse causality is not supported at any case.

Figure 1. The frequency domain causality between the attention to Brexit (via Google Trends) and UK and EU equities
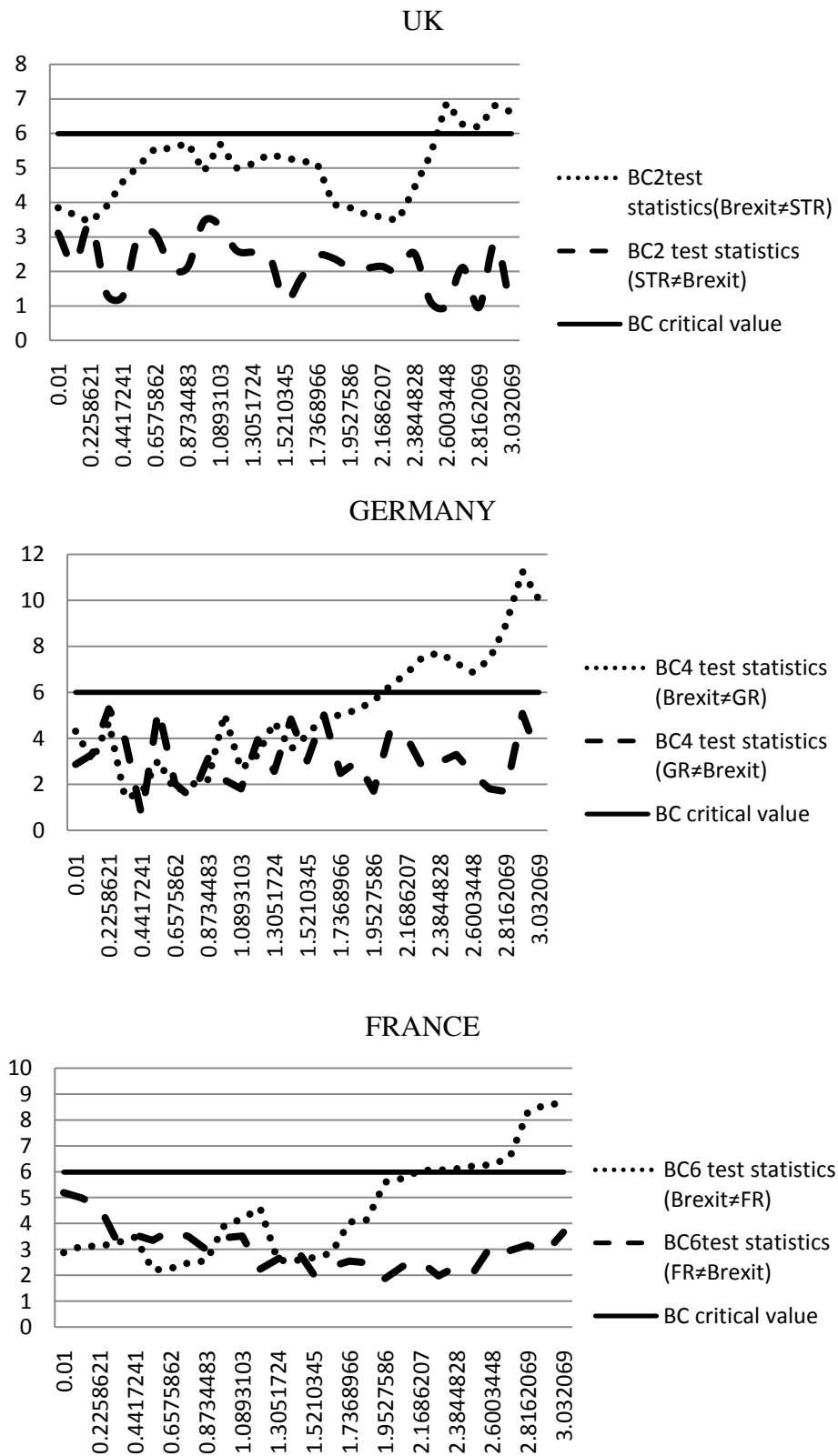
UK

GERMANY

FRANCE
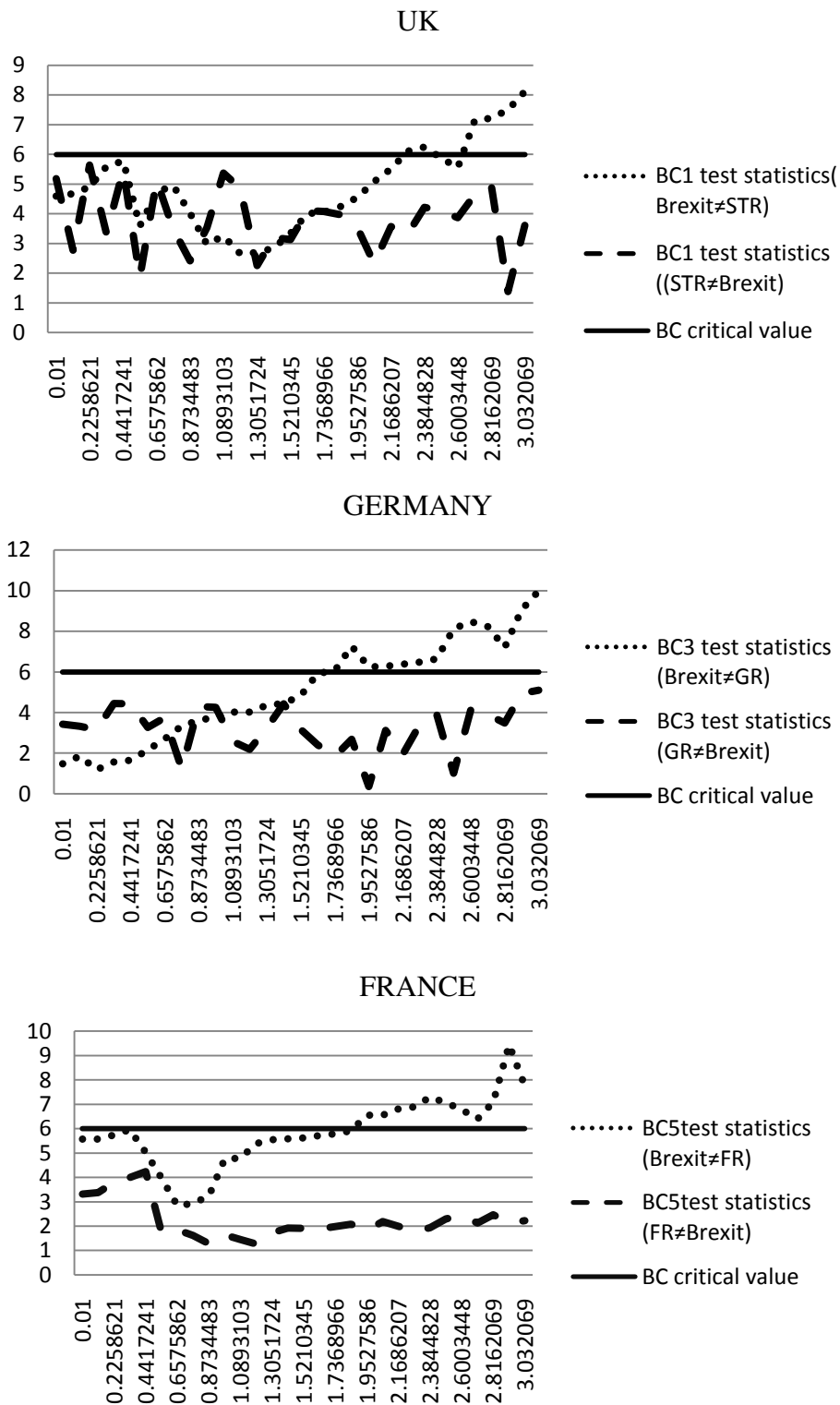
Note: The horizontal line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency *w*.

In further step, the same testing procedure (conditioning upon the same control variables) is implemented to the Twitter data related to "Brexit" (Figure 2). The results remain fairly solid and, while the cycles vanish for all the considered countries. The strength of causality is often more pronounced for Germany where we show that there is a significant causality from Brexit to stock returns when $\omega \in [2.06\pi - 3.03\pi]$, corresponding to a cycle of three weeks, whereas the causal cycles are less lengthy for France (when $\omega \in [2.16\pi - 3.03\pi]$, corresponding to a wave length inferior to 2.9 weeks) and UK (when $\omega \in [2.38\pi - 3.03\pi]$, corresponding to a cycle less than 2.6 weeks).

Notably, the followed interpolation procedure has affected sharply the strength of Granger-causality (the cycles vanish when using the number of tweets as measure of the interest to Brexit), not the direction of causality and our hypothesis that the uncertainty and anxiety over Brexit Granger-cause UK, Germany and France equities varies depending on frequency-to-frequency variation. The aforementioned findings prove slight differentiability among Googlers and Twitters. Even though Twitter has become a popular way of highly directing followers to news (in particular, blogs), the social media discussion (especially, Twitter) stand out from users as more likely to be high earners and college-educated.

Despite their computational differences, QR and frequency domain causality test are likely to be complementary rather than substitute with respect the reactions of UK and EU stock returns to the attention towards Brexit. Indeed, whatever the internet proxy used (Google Trends or Twitter), both methods employed show the same hierarchy (Germany followed by France and UK) regarding the effect of Brexit on the equity returns of the three investigated countries. The results are fairly robust, all suggesting the need to account for asymmetry and nonlinearity when assessing the equities responses over an uncertain framework.

Figure 2. The frequency domain causality between the attention to Brexit (via Twitter) and UK and EU equities

UK

GERMANY

FRANCE

Note: The horizontal line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency *w*.

3.3. Interpretation of results

We must start by advancing that our primary focus in this study is to test whether investors' fears over possible British exit from EU affect equities of major European countries. These markets participants' moods to Brexit were extracted via Google Trends and Twitter. This strategy is rather subjective and cannot reflect the real effect (economic, political, social, etc...) of Britain exit. Nevertheless, the results seem quite intuitive. The uncertainty surrounding the possible Brexit affects significantly German, French and UK equities (and with great extent, Germany). This significant anxiety's influence on European equities is expected because UK's trade is geared greatly towards the EU. More than 50 percent of its exports are to the EU, and also more than 50 percent of imports come from European States. Also, the fact that the investors' fears have greater influence on the German market seems logical due to the strong power or the dominant role of Germany in the European Union. Compared to France, Germany enjoyed deeper trade and investment relations with the UK. Based on UNCTAD statistics, in 2013, Germany represents the second export destination after USA with approximately 11 percent of overall exports, followed by the Netherlands (8.7 percent) and then France (6.6 percent). Similarly, with respect imports structure, Germany is positioned as the number one trade partner with 13.3 percent, then China (8.7 percent), the Netherlands (7.5 percent), the USA (6.9 percent) and France (5.9 percent). Moreover, the EU and UK are becoming growingly inter-connected via investment relationships. Arguably, the Netherlands (227.3 USD millions), Germany (123.7 USD millions) and France (102.8 USD millions) are the biggest investor nations, representing together around 60 percent of FDI from the EU (Figure A.1, Appendix).

Besides, the fact that UK stock market exhibits moderate Brexit' influence may reflect the difficulty to properly predict whether Britain should stay or leave the EU and thus hesitation surrounding UK market participants decisions. According to YouGov[9] polling data, the UK is divided into 41 percent asserting they would vote to leave and 41 percent saying that they would vote to still in the European Union. But if negotiations between the UK and other EU states lead to important outcomes around some issues, the percentage of supporters to stay in EU increases to 50 percent, compared to 23 percent voting to be outside the Europe. It's true that some asserted that Britain should attempt to loser trading relationships with EU by forming economic and political partnerships with countries outside Europe; but others

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[9] YouGov is a global market research and data company built on the idea that the more people participate in the decisions made by the institutions will be, better will be the decisions-making. For more details about this company, please refer to this link: https://yougov.co.uk/find-solutions/

proposed achieving formal linkages with European countries by ensuring a European Free Trade Association. Likewise, Regardless of the referendum result, the British exit from EU[10] will have serious geopolitical and economic outcomes and will threaten the prospects for European integration.

4. Conclusion

The question of UK membership is evidently a big issue for Europe and especially for the two most powerful nations on the European continent (i.e., Germany and France). If the UK votes to be outside the EU, gloomy outcomes are expected for Britain and EU. In this context, the German Finance Minister, Wolfgang Schäuble, asserted that "Brexit would make the whole of Europe less stable and more volatile, […] and Britain would be shut out of the single market if it left the EU". Also, analysts and market participants over the Europe seem very anxious about the costs of Brexit. The possible British exit from the EU could pose risks for Britain and EU ranging from falling trade flows and capital outflows. These considerations make a basis of the given research. Aware by the difficulty to effectively quantify the losses from Brexit, the purpose of this article is to test how plays media' stance towards the Brexit (by introducing the concept of Internet concern as a quantitative measure) in exacerbating uncertainty among investors in UK, Germany and France.

To the extent that global investors increasingly use portfolio diversification as appropriate strategy to lighten risks, a rigorous examination of the equities' responses to the disquiet over Brexit may be useful for the investor's optimal asset allocation decisions. To address this issue, the paper employs a QR approach and frequency domain test (relying on signal theory). The main advantages of these techniques lie in their ability to model the link between the attention to Brexit and stock market returns more effectively than is possible with standard methods including the OLS and the standard Granger causality test. While OLS regression is only able to estimate the impact of Brexit on the conditional mean of UK, German and French equities. QR goes further by disentangling this influence on the conditional mean into different effects on the conditional quantile (accounting for asymmetry), offering thus the most information possible about the central relationship.

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[10] We should mention that the UK has an important position with respect the global decision making. It is a prominent member of the United Nation's Security Council, G7 (one of four EU member states), G20 (one of four EU member states), the International Monetary Fund and World Bank (almost 4.2 percent of the voting power) and the Financial Stability Board (one of six EU member states).

Beyond the correlation investigation, this study gauges the frequency domain causality, allowing to test whether the causality between the focal time-series moves among different frequency components (accounting for nonlinearity) which the standard Granger causality test[11] is unsuitable to accommodate.

We have initially considered the OLS and LAD regression techniques for estimating the effect of anxiety over Brexit on the focal equities. Nevertheless, we observe an insignificant dependence in the case of Germany, underscoring the inability of these two methods to draw firm evidence regarding this issue. By applying then QR and frequency domain causality test, quite interesting findings have been emphasized. First, the reactions of UK and EU equities to the disquiet over Brexit are sharply heterogeneous among tail distributions, highlighting the occurrence of asymmetry. Indeed, the stock market of Germany suffered more than UK and France. Second, the causal cycle is likely to be longer for Germany rather than France and UK.

These obtained findings have far-fetching policy implications. They may be used for portfolio construction and diversification, as variant sensitivities to Brexit event have been discovered across UK and European equities. The fact that the responses of the investigated equities change remarkably from lower to upper quantiles and from shortest to longest frequencies may have profound consequences for portfolios that trade with various rebalancing horizons. Holding diversified portfolio could palliate risk management. But this is not usually true, especially if we focus on an uncertain context. Beyond these outcomes, it should be pointed out that Brexit could change the fate of European integration by leading to an unparalleled political disunity and instability in the world.

In a nutshell, this article points out the functionality of QR approach in analyzing "complex" phenomena in an unsettled framework. Similarly, the frequency domain causality test has demonstrated its efficacy in this exercise. Additionally, this paper has proved the usefulness of search query data (Google Trends and the number of tweets) in determining how respond UK and EU stock markets to Brexit. Search volume may be perceived as a very practical way to compute the traders' investments attention that can help in identifying some Brexit costs. Before ending, we should mention that these findings remain preliminary and several extensions appear warranted. It is recommended to conduct further research by

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[11] Using standard Granger causality test, insignificant causal relationship is found for Germany, highlighting the inefficacy of this technique to find solid insights into this convoluted subject. The results of this test are available for readers upon request.

employing other measures of attention to Brexit with other Internet-based data in the Big Data Era to confirm our findings and to reach better paths.

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Appendix

Figure A.1. Countries of origin for EU FDI stock in UK (in USD millions)
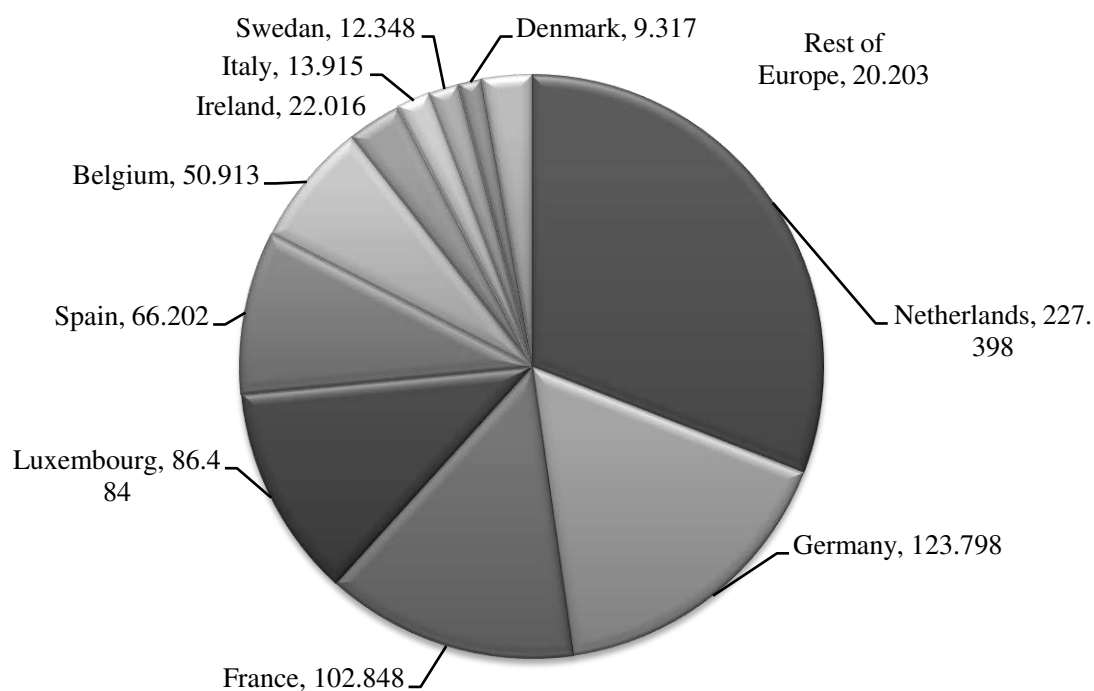
Source: UNCTAD Bilateral FDI Statistics.