Business Management Dynamics
Vol.11, No.01, Jun 2021, pp.01-09

How Brexit affects the causal relationships between the UK and fourteen other developed countries in the European Union?

Kuo-Hao Lee[1] & Cheryl Howlett[2]

Abstract

The goal of this research is to investigate the causal relationships among the Small-Cap stock market behaviors of the UK and the other fourteen developed countries in the European Union before and after the UK European Union membership referendum. The Granger causality test is used in this study via a leveraged bootstrap test developed by Hacker and Hatemi-J to examine the causalities. The data results show that six causalities are found before the referendum and the number of the causalities decrease to only three after the referendum. It suggested that the UK Small-Cap market is less affected and has less influence on the movement of the other fourteen developed countries in the European Union. This finding provides another aspect of the UK European Union membership referendum for the investor to take into consideration while building an investment portfolio.

Keywords: Granger Causality, Bootstrap, MSCI, Small-Cap stocks

Available online
www.bmdynamics.com
ISSN: 2047-7031

INTRODUCTION

The UK European Union membership referendum was held on Thursday 23 June, 2016, to decide whether the UK should leave or remain a member of the EU. The result of the referendum, with more than 30 million people voting, was 51.9% in favor of leaving and 48.1% in favor of remaining as members. Many opinion leaders, including David Cameron and his Chancellor George Osborne, who wanted to stay in the EU, predicted if the UK voted to leave it would result in an immediate economic crisis and it is true that the pound collapsed the day after the referendum. But predictions of immediate doom were inaccurate, with the UK economy estimated to have grown 1.8% in 2016, second only to Germany's 1.9% among the world's G7 leading industrialized nations.

The stock market rose significantly since June 23, 2016, but on a company level there have been major outcomes. Internationally-focused companies'(?) earnings, such as those of Burberry, HSBC and Coca-Cola HBC, the soft-drink bottler, benefited from a weak pound. On the other hand, property investment companies which are the most obvious casualties of the Brexit (withdrawal of the UK from the EU) vote tended to take the biggest losses.

One year after the referendum, the FTSE 100 has returned 17.4%, in large part due to the pound's decline. The more domestically focused FTSE 250 index, which still has significant international exposure, has returned 13.4%. The most surprising result is that the FTSE Small Cap index, as the most domestically focused of the three, has returned the most at 22.3%. The data suggested the smaller companies are driven more by company specific developments, rather than large international and economic events and investors in smaller companies tend to be long term and have perhaps been more willing to ride out the ups and downs following the referendum.

As Britain anticipates one of the most unusual general elections, it is challenging for anyone who is apprehensive with the markets to look away from the UK. Europe was predicted to be in a position of uncertainty should Britain leave the EU, with the main effect on the euro since the referendum being that it has been worth considerably more against the pound. The euro regularly fetches around 0.88 one year after the referendum and has been as high as 0.90 at times. However, prices were closer to 0.76 to one euro before the referendum.

For both sides of the relationship, a weak pound against the euro causes some problems. For Britain, it means it becomes more expensive to import from Europe, and for Europe, it means that Britain will

[1] *Department of Finance, College of Business, Bloomsburg University of Pennsylvania, Bloomsburg, PA17815*
E-Mail: klee@bloomu.edu
[2] *Department of Finance, College of Business, Bloomsburg University of Pennsylvania, Bloomsburg, PA17815*

purchase less from eurozone countries. This could have a large impact in the longer term on businesses who trade a lot with Britain. But will it be a crisis for Small-Cap markets?

LITERATURE REVIEW

Recent research has found that there remain many mysteries of how Brexit will affect the economy and stock markets of the UK and the other European countries. Crafts (2016) states that the economic implications of Brexit are much less clear because there are many permutations of what it would entail. Future trade barriers rather than budgetary transfers are the main issue. Brexit could cost great if the UK left the single market and used its new policy space badly. Ironically, while Brexit clearly appeals to free traders, it could end up empowering protectionists. Samp (2016) stated a number of factors determine the relative impact on each sector. First, the heightened uncertainty will hit business confidence, causing firms to delay or reduce capital spending. Second, less favorable trade relations with the EU could see export-oriented sectors move production away from the UK. Lastly, restrictions on migration will cut down the size of the labor force. Thus, investment-oriented sectors such as construction and machinery have seen some of the largest downgrades. Moreover, transport equipment is mainly exported to Europe, so increased trade barriers could cause migration production out from the UK. Meanwhile, labor shortages could weaken growth of labor-dependent sectors. In addition, the vote has created uncertainties around the long-term viability of London as Europe's major financial center. The outlook for more consumer-focused sectors is less downbeat for now, although an uptick in inflation may erode household purchasing power in the near-term, and the multipliers from lower economic activity are likely to permanently reduce household incomes in the long term. Pain and Young (2004) draw on research that highlights the role of EU policies in the level of international trade and investment undertaken by Member States, and the implications of those international linkages for long-term productive potential. UK living standards would be adversely affected by withdrawal, largely due to a decline in the level of technical efficiency resulting from a lower future level of inward foreign direct investment.

The outcome of the UK's referendum on membership of the EU will shape the future of the UK's relationship with its largest trade partner-the EU. Brexit is not only affect the UK markets but also the countries in the EU. Membership of the EU has reduced trade costs between the UK and the rest of Europe. Multinational firms have complex supply chains and many co-ordination costs between their headquarters and local branches and the uncertainty over the shape of the future trade arrangements between the UK and the EU would also tend to dampen international European investment.

After Brexit, the UK would become an independent player, free to seek its own trade deals with the rest of the world. Dhingra, Ottaviano, Sampson and Reenen (2016) found data shows that trade with such non EU countries does indeed rise after Brexit. But the magnitude of these increases is not enough to offset the decline in trade with the EU. Being part of the EU does not restrict UK companies' ability to trade with the rest of the world, but as our nearest neighbor and the world's largest market, the EU is the UK's natural trade partner.

According to the study by Brooks and Del Negro (2006), an increase in the international component of a firm's sales will increase the exposure of the firm to global events. The benefit of diversification of international portfolios with Large-Cap stocks cannot be manifest since the returns of those companies are primarily affected by common global factors. This finding can be applied for the influence of the Brexit, such that Large-Cap stocks might not be able to independent from the impact of the referendum.

Petrella, G. (2005) revealed that Europe Mid-Cap and Small-Cap stocks behave differently from euro area Large-Cap stocks. This result implies that it could be useful to expressly consider smaller size-ranked portfolios while building a European long-term asset allocation portfolio. Gjika, D. and R. Horváth (2013) studied time-varying stock market comovements in Central Europe employing the asymmetric dynamic conditional correlation multivariate GARCH model and noted that the correlations among stock markets in Central Europe and between Central Europe vis-à-vis the euro area are strong which suggesting that the diversification benefits decrease disproportionally during volatile periods.

Departing from previous studies, we will investigate the causality between the behaviors of Small-Cap markets of the UK and the other fourteen countries in the EU, to determine if the performance of the Small Cap markets can be the benefits for diversity or could be used as predictor after the UK European Union membership referendum.

DATA AND METHODOLOGY

Our research applies the daily MSCI Small-Cap index of the UK and the other fourteen countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Ireland, Netherland, Norway, Portugal, Spain, Sweden and Switzerland), for the period of June 23, 2015 to June 22, 2017, one year before and one year after the UK European Union membership referendum.

First, we calculate the daily return of the MSCI Small-Cap index of fifteen countries by the following formula:

$$x_t = \frac{(p_{t+1} - p_t)}{p_t}$$

The descriptive statistics of the daily return are shown in Table 1.

After computing the daily return, we investigated Granger causality using Hacker and Hatemi-J's leveraged bootstrap test (2006). This applies the vector autoregressive model of order p, VAR (p):

$$x_t = \upsilon + A_1 x_{t-1} + \cdots + A_p x_{t-p} + e_t$$

The x represents a two-dimensional vector of volatility of two-country pairings. The lag order p performs well when the goal of the VAR model is to conduct ex ante inference (Hacker & Hatemi-J, 2006, 2009, & 2011). The information criterion is written as:

$HJC = \ln\left(det\widehat{\Omega}_j\right) + j\left(\frac{n^2 lnT + 2n^2 \ln(lnT)}{2T}\right), j = 0, \ldots, p.$

The $det\widehat{\Omega}_j$ is the estimated maximum likelihood variance-covariance matrix of the residuals in the VAR(j) model and n represents the number of variables. T is the sample size. The null hypothesis is the kth element of σ_t does not Granger-cause the dth element of x_t. It is defined as:

H_0: the row d, column k element in $A_r$equals 0 for $r = 1, \ldots, p$.

The null hypothesis of non-Granger causality is

$$H_0: C\beta = 0$$

The hypothesis is tested via a Wald test, which requires reformulating the VAR(p) model as:

$$Y = DZ + \varepsilon$$

and testing the null using the following Wald test statistics:

$$Wald = (C\beta)'[C((Z'Z)^{-1} \otimes S_U)C']^{-1}(C\beta) \sim \chi_p^2$$

where $\beta = vec(D)$ and vec is the column-stacking operator. The $\otimes$ notation is the Kronecker product and C is an indicator matrix. S_U represents the variance-covariance matrix of the unrestricted VAR model. That is, $S_U = (\hat{\varepsilon}'_U \hat{\varepsilon}_U)/(T - c)$, where c is the amount of estimated parameters.

Financial data in emerging markets typically have time-varying volatilities and exhibit non-normality. Thus, the accuracy of the Wald test based on asymptotic critical values would be questionable. To compensate, we used the causality method developed by Hacker and Hatemi-J (2006), a technique robust to both non-normality and time-varying volatility. The Hacker and Hatemi-J method consists of the following steps:

1. Estimate the VAR model using the selected lag order, p, and obtain the estimated residuals $(\hat{e}_t)$.
2. Generate simulated data using 10,000 iterations, denoted by x_t^*:
$$x_t^* = \hat{A}_0 + \hat{A}_1 x_{t-1} + \cdots + \hat{A}_p x_{t-p} + \hat{e}_t^*$$
where the circumflex are the estimated values. The residuals are adjusted in each independent draw to generate an expected mean value of zero and modified using leverages to exhibit constant variance (Hacker & Hatemi-J, 2006).
3. Calculate the W test statistic for each iteration, generate an approximate distribution for the bootstrapped W test statistic, and find the α-level of significance "bootstrap critical value" (c_α^*).

4. Compare the calculated W statistic of the original data, not the data generated by bootstrap simulation, to the bootstrap critical values. If the calculated W statistic is higher than the bootstrap critical value c_α^*, reject the null hypothesis at the α-level of significance. A rejection indicates the existence of Granger causality.

EMPIRICAL RESULTS

As previously stated, we apply a bootstrap simulation to determine one unique critical number based on the empirical distribution of the specific data set that doesn't require normality. Before the referendum, the causality result of Small-Cap markets of the other fourteen developed countries in the EU on the UK Small-Cap market is shown in Table 2-A and the causality of the UK market on the other fourteen countries is shown in Table 2-B. In Table 2-A, the calculated W statistic for the causal effect of the daily return of Italy and Norway Small-Cap markets on the daily return of the UK Small-Cap market are 2.884 and 2.865, which are higher than the estimated critical value 10% levels, 2.808 and 2.781. This result implied that, the UK Small-Cap market is affected by the performance of the Italy and Norway Small-Cap markets before the referendum. Further, in Table 2-B, the calculated W statistic for the causal effect of daily return of the UK market on the Austria market is 7.087 which is higher than all three estimated critical values. The data also reveal that the UK market has influence on Finland and Switzerland at 5% levels and on Norway at 10%. In total, six causal relationships exist among the UK and the other fourteen developed countries before the referendum.

Next, we examine the causality after the referendum. The data results are shown in Table 3-A and Table 3-B. In Table 3-A, we noticed that after the referendum the UK Small-Cap market is only affected by Norway with calculated W statistics (2.742) higher than the 10% critical value (2.711.) As for the reverse direction of the causality, the UK market has impact on both the Norway and Sweden markets with the calculated W statistics (4.110 and 3.553) higher than the 5% critical value (3.856) of Norway and 10% critical value (2.766) of Sweden.

To summarize the data result, we have found that before the referendum, the UK Small-Cap market is driven by the Italy and Norway markets. After the referendum, Italy loses its effect on the UK market. On the other hand, the UK has influence on four countries before the referendum which are Austria, Finland, Norway and Switzerland. But after the referendum, just two countries, Norway and Sweden, are driven by the UK market.

CONCLUSIONS

The result of the UK's referendum on membership of the EU will change the future of the UK's relationship with its largest trade partner-the EU. How do the European investors apply this new revolution into their decision making process? This question becomes more and more popular. Causality between the Small-Cap markets of UK and the other developed countries in the EU is one of the crucial factors in the process of forming an investment portfolio. A Granger causality test is applied in this study which is a leveraged bootstrap test developed by Hacker and Hatemi-J (2006) that is robust to non-normality and ARCH to examine the causality of the UK and fourteen developed countries in the EU during the period from June 23, 2015 to June 22, 2017, one year before and one year after the UK European Union membership referendum.

According to the causality test results: before the referendum, the performance of the UK Small-Cap market is affected by both Italy and Norway and the UK market has influence on four countries (Austria, Finland, Norway and Switzerland). The causal relationship between the UK and Norway is bi-direction. Further, the data result shows evidence that the amount of the causal relationships decreases from six down to three after the referendum. The UK market is driven by only the Norway market and the UK market has impact on only the Norway and Sweden markets. This finding indicates the result of the referendum decreased the co-movement between the UK and the other developed countries in the European Union, except Norway, while the causal relationship between the UK and the Norway Small-Cap markets remains bi-directional regardless of the result of the referendum.

This finding provides a different approach to analyzing the event of the UK European Union membership referendum and gives investors who are interested in the European markets a new prospective of less sensitivity of the UK to other countries and vice versa after the referendum.

Table 1-A: Descriptive Statistics of the Small Cap index daily return before the UK European Union membership referendum

Descriptive Statistics	Average	Standard Deviation	Skewness	Kurtosis
AUSTRIA	-0.00012	0.01152	-0.28468	1.70161
BELGIUM	0.00008	0.01131	-0.22467	2.55107
DENMARK	0.00027	0.01264	-0.42738	3.44907
FINLAND	0.00022	0.01315	-0.18843	0.85318
FRANCE	0.00012	0.01148	-0.15640	1.69128
GERMANY	0.00020	0.01247	-0.16651	1.18728
IRELAND	0.00056	0.01161	-0.10656	1.47191
ITALY	-0.00036	0.01461	-0.33315	1.40774
NETHERLANDS	-0.00016	0.01225	-0.02212	0.90079
NORWAY	-0.00001	0.01794	-0.21757	1.14869
PORTUGAL	-0.00107	0.01515	-0.18365	1.92834
SPAIN	-0.00053	0.01254	-0.06817	1.19145
SWEDEN	0.00053	0.01298	-0.33203	1.36957
SWITZERLAND	0.00011	0.00913	-0.07722	0.84917
UK	-0.00022	0.01272	0.41939	3.37726

Table 1-B: Descriptive Statistics of the Small Cap index daily return after the UK European Union membership referendum

Descriptive Statistics	Average	Standard Deviation	Skewness	Kurtosis
AUSTRIA	0.00087	0.01060	-1.97458	14.77591
BELGIUM	0.00046	0.00925	-1.32143	8.32370
DENMARK	0.00112	0.01017	-1.63361	10.44933
FINLAND	0.00078	0.01095	-2.14086	19.57538
FRANCE	0.00114	0.01040	-1.36693	14.13089
GERMANY	0.00085	0.00950	-1.17077	7.87684
IRELAND	0.00035	0.01371	-3.17207	26.63016
ITALY	0.00073	0.01387	-2.51751	21.37845
NETHERLANDS	0.00081	0.01042	-2.42629	16.54232
NORWAY	0.00024	0.01325	-0.48876	3.82514
PORTUGAL	0.00042	0.01389	-1.67664	14.44191
SPAIN	0.00055	0.01088	-2.64704	24.43009
SWEDEN	0.00049	0.01056	-1.63294	12.49340
SWITZERLAND	0.00101	0.00883	-1.39229	8.41572
UK	0.00002	0.01542	-5.01244	48.01555

Table 2-A: The results of causality test of the 14 developed countries on the UK before the UK European Union membership referendum.

Null hypothesis	Calculated W-statistics	bootstrap critical value		
		1%	5%	10%
AUSTRIA	0.235	7.119	3.944	2.805
BELGIUM	0.024	6.931	3.936	2.739

DENMARK	0.270	7.046	3.915	2.750
FINLAND	1.338	7.272	4.049	2.827
FRANCE	0.113	6.785	4.083	2.838
GERMANY	0.172	7.133	3.997	2.785
IRELAND	0.000	6.731	3.772	2.675
ITALY	2.884	6.954	3.902	2.808
NETHERLANDS	0.019	6.865	4.037	2.778
NORWAY	2.865	7.183	3.932	2.781
PORTUGAL	1.556	7.156	3.978	2.765
SPAIN	1.478	6.890	3.985	2.752
SWEDEN	0.028	7.299	3.998	2.795
SWITZERLAND	0.244	6.956	3.827	2.756

Notes: Underline values indicated that the null hypothesis is rejected at 1%.

Table 2-B: The results of causality test of the UK on 14 developed countries before the UK European Union membership referendum.

Null hypothesis	**Calculated W-statistics**	**bootstrap critical value**		
		1%	5%	10%
AUSTRIA	**7.087**	7.042	3.995	2.813
BELGIUM	0.909	7.234	4.052	2.832
DENMARK	2.665	7.238	4.051	2.767
FINLAND	*4.358*	6.969	3.954	2.787
FRANCE	1.636	7.201	3.935	2.757
GERMANY	1.108	7.256	4.012	2.844
IRELAND	1.523	7.045	3.996	2.823
ITALY	0.046	6.900	3.931	2.771
NETHERLANDS	0.219	6.823	4.048	2.817
NORWAY	2.856	6.878	4.055	2.757
PORTUGAL	0.009	7.035	3.840	2.725
SPAIN	0.354	7.389	3.984	2.834
SWEDEN	2.258	7.152	3.998	2.750
SWITZERLAND	*4.063*	6.892	4.018	2.780

Notes: Bold values indicated that the null hypothesis is rejected at 1%, italic values for 5% and underline values for 10%.

Table 3-A: The results of causality test of the 14 developed countries on the UK after the UK European Union membership referendum.

Null hypothesis	**Calculated W-statistics**	**bootstrap critical value**		
		1%	5%	10%
AUSTRIA	0.745	7.169	3.858	2.676
BELGIUM	0.248	7.014	3.840	2.692
DENMARK	1.414	6.953	3.978	2.718
FINLAND	0.664	6.906	3.945	2.698
FRANCE	0.679	6.916	3.937	2.724
GERMANY	0.424	6.865	3.947	2.731

IRELAND	0.024	6.747	3.824	2.746
ITALY	1.289	6.672	3.863	2.694
NETHERLANDS	0.517	6.929	3.905	2.684
NORWAY	2.742	7.146	3.886	2.711
PORTUGAL	1.108	7.077	3.946	2.685
SPAIN	0.559	6.897	3.754	2.683
SWEDEN	0.815	6.945	3.832	2.622
SWITZERLAND	1.387	6.954	3.927	2.681

Notes: Underline values indicated that the null hypothesis is rejected at 1%.

Table 3-B: The results of causality test of the UK on the 14 developed countries after the UK European Union membership referendum.

Null hypothesis	**Calculated W-statistics**	**bootstrap critical value**		
		1%	5%	10%
AUSTRIA	1.253	6.694	3.835	2.666
BELGIUM	0.203	6.887	3.868	2.742
DENMARK	0.934	6.918	3.945	2.746
FINLAND	2.506	6.810	3.890	2.716
FRANCE	0.003	6.757	3.884	2.669
GERMANY	0.375	6.837	3.836	2.675
IRELAND	0.538	6.740	3.880	2.675
ITALY	0.000	6.952	3.979	2.765
NETHERLANDS	0.518	6.928	3.997	2.720
NORWAY	*4.110*	6.814	3.856	2.709
PORTUGAL	0.158	6.495	3.793	2.633
SPAIN	0.207	7.039	4.003	2.705
SWEDEN	3.553	6.581	3.848	2.766
SWITZERLAND	1.259	6.755	3.770	2.687

Notes: Italic values indicated that the null hypothesis is rejected at 5% and underline values for 10%.

REFERENCES

Brooks, R., & Del Negro, M. (2006). Firm-level evidence on international stock market comovement. Review of Finance, 10(1), 69-98.

Crafts, N. (2016). The Impact of EU Membership on UK Economic Performance. [Article]. Political Quarterly, 87(2), 262-268.

Dhingra, Swati and Ottaviano, Gianmarco I. P. and Sampson, Thomas and Reenen, John Van (2016) The consequences of Brexit for UK trade and living standards. CEP BREXIT Analysis No.2, CEPBREXIT02. London School of Economics and Political Science, CEP, London, UK.

Gjika, D., & Horváth, R. (2013). Stock market comovements in Central Europe: Evidence from the asymmetric DCC model. Economic Modelling, 33, 55-64.

Hacker, R. S., & Hatemi-J, A. (2006). Tests for causality between integrated variables using asymptotic and bootstrap distributions: theory and application. Applied Economics, 38(13), 1489-1500.

Hatemi-J, A., & Irandoust, M. (2011). The dynamic interaction between volatility and returns in the US stock market using leveraged bootstrap simulations. Research in International Business and Finance, 25(3), 329-334.

Hatemi-J, A., & S. Hacker, R. (2009). Can the LR test be helpful in choosing the optimal lag order in the VAR model when information criteria suggest different lag orders? Applied Economics, 41(9), 1121-1125.

Samp, A. (2016). Impact of EU exit on our UK industry forecasts. Economic Outlook, 40(3), 10-12.
Pain, N., & Young, G. (2004). The macroeconomic impact of UK withdrawal from the EU. Economic Modelling, 21(3), 387-408.
Petrella, G. (2005). Are Euro Area Small Cap Stocks an Asset Class? Evidence from Mean-Variance Spanning Tests. [Article]. European Financial Management, 11(2), 229-253.