ICMA Centre, Henley Business School

Programming for Finance assignment 2016/2017

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All code is available at:

https://github.com/Jorgencr/Assignment/blob/master/Submission.ipynb

Update
the file

Remaining work

Table of Contents

1   Initial statements

In this paper, I investigate the reaction of 'Brexit' for the main financial markets in the world. The relevant countries with the affiliated indices are presented in table 1. The purpose of the study is to assess whether there is a relationship between key events and the markets reactions, where I assume that the original source of the markets' reaction can be traced back to relevant information about the referendum.

Table 1: Indexes included in this study

Country	Index
United Kingdom	FTSE100
United States	S&P500
France	CAC
Germany	DAX
Japan	Nikkei225
Italy	FTMIB
Russia	MICEX
China	Hanseng

The remainder of this paper is organized as follows. Section 1 focuses on identified key events along with the rationale of my selection. Section 2 presents initial calculations for the markets' reactions on the key event dates, along with regression analysis to further allow the assessment of the relationship between the key event dates and the reactions. Section 4 provides an international perspective and we include international markets in my analysis.[1]

If news items were released during non-operating hours, I "attach" these news to the next price available (i.e. the first price of the next trading day).

2   Identified key events

For this study, I have identified **seven** key events which I have used to assess market reactions.[2] The section continues with a brief rationale as of why I have chosen to classify them as a key event, along with my interpretation of whether this event has a 'positive', 'neutral' or 'negative' on the 'Brexit' process. Here, a 'positive' impact has been defined as an event which is favourable for the 'Remain' side of the campaign. The identified key events are as follows:

- May 8th, 2015

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[1] All data are retrieved from Thomson Reuters Eikon, with the exception of data for Nikkei225 which is retrieved from Yahoo Finance

[2] Even though I am aware that there are potentially hundreds of events that can be characterized as a key event, I have only considered seven for this assignment. I am of the opinion that this assignment is about the coding rather than

The result after the General Election is clear, the Conservatives won a majority in the House of Commons and pledged to keep their promise to hold a referendum on the UK's membership of the EU by the end of 2017 (Parker, 2015; BBC, 2015b).

- February 19th, 2016

  Former Prime Minister David Cameron confirms that the referendum regarding Britain's membership of the EU will take place on 23, June - roughly four months later (Parker, 2016).

- June 16th, 2016

  The brutal murder of Labour MP Jo Cox, a advocate of Britain to remain in the EU, silenced the Brexit debate and the 'Leave' campaign feared that this could sway public opinion towards staying in the EU (Mance, 2016).

- June 24th, 2016

  The British people have voted to leave the EU, leaving large questions of what the consequences and repercussions will become after such an unprecedented decision (BBC, 2016; Morris, 2016; Wolf, 2016).

- October 3rd, 2016

  The first day of trading after Prime Minister Theresa May's speech on the Conservative Party conference, where she announced a timeline for the Brexit negotiation process to official begin and end (Kuenssberg, 2016).

- November 4th, 2016

  The English High Court ruled that the Government could not invoke 'Article 50' in the Lisbon Treaty without a vote in the Parliament, raising uncertainties whether the process will be blocked by MPs or re-negotiated to add further amendments (Croft, 2016; Bowcott and Elgot, 2016).

- January 17th, 2017

  After a period of silence from members of the government, Prime Minster Theresa May confirmed in a speech that she intended to her promise of taking Britain out the European Union. Along the confirmation, she provided more some clarification regarding what she hoped to gain from the forthcoming negotiations - being more explicit than before (Mance, 2017).[3]

Remember this

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[3]"The fact that the pound did not fall again on Mays confirmation that the UK government would not seek to remain in the single market suggests that this news is now mostly in the price," said Jane Foley, Rabobank forex strategist.
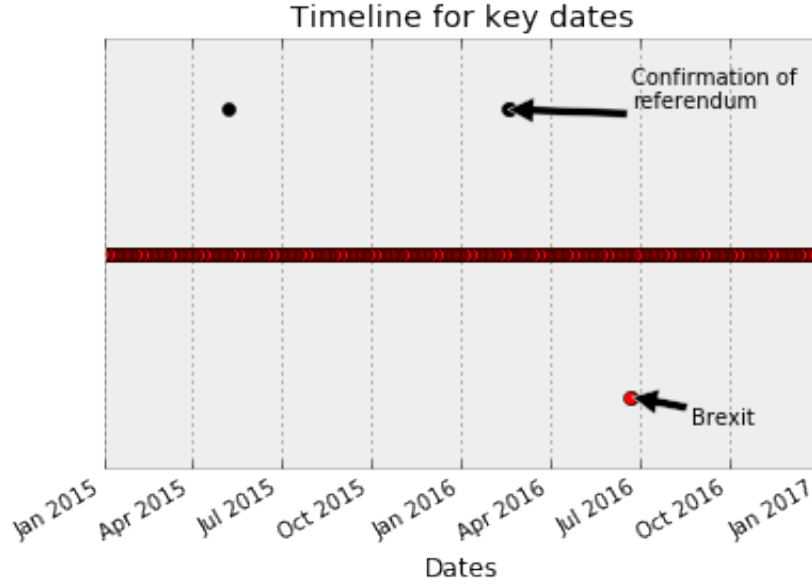
Figure 1: Timeline of key event before and after 'Brexit'

3 UK stock markets

For this assignment, I have chosen to study the broad FTSE100 index, along with gilts with different maturities.[4] I have also included GBP/EUR and GBP/USD. Table 2 presents calculated returns on key event dates for each of the selected instruments.

Table 2: Standard deviation, mean return and median for UK financial markets on key dates. (Figures are not annualized)

(All figures in percent)	.FTSE	GB 10Y GILT	GB 7Y GILT	GB 2Y GILT	GB 3M T-BILL	GBPEUR	GBPUSD
08/05/2015	2.29	-2.90	-2.90	-5.57	-0.21	1.82	1.37
19/02/2016	-0.36	-1.69	-2.28	-2.13	-4.06	-0.05	0.51
16/06/2016	-0.27	-0.18	0.00	3.39	-6.18	0.29	-0.01
24/06/2016	-3.20	-23.38	-30.73	-69.12	-14.12	-6.19	-8.41
03/10/2016	1.21	-3.78	-6.00	-30.11	9.66	-0.79	-1.04
04/11/2016	-1.44	-5.48	-8.02	-15.79	-2.56	0.13	0.46
17/01/2017	-1.47	-1.30	-1.37	10.82	-2.20	1.93	3.03
Standard deviation	1.82	8.06	10.68	27.13	7.11	2.74	3.67
Average return	-0.46	-5.53	-7.33	-15.50	-2.81	-0.41	-0.58
Median	-0.36	-2.90	-2.90	-5.57	-2.56	0.13	0.46

As one can see in table 2, the UK markets are on average adversely affected by information on

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[4] In general, the 10 year usually captures 80-90% of movements in sovereign bond yields. However, several maturities are included to give deeper insight in movements to key events

the selected key dates. We notice larger movements among the sovereign bond yields compared to FX and equities, a potential sign that investors seek safer investments during times of financial distress.[5] The largest impact of all identified key event dates occurs on June 24, the day when the result of the referendum was known and priced into the markets.

By constructing an indicator variable, I am able to derive the correlation between key event dates and the different instruments. From table 3, one can notice that all the identified key events seem to be negatively correlated with the indicator function - implying that markets interpreted news as 'negative' on general.

Table 3: Correlation matrix for UK financial markets, including dummy variables

	.FTSE	GB 10Y GILT	GB 7Y GILT	GB 2Y GILT	GB 3M T-BILL	GBPEUR	GBPUSD	Dummy Variables
.FTSE	1	0.270	0.261	0.145	0.003	0.078	0.016	-0.040
GB 10Y GILT	0.270	1	0.942	0.525	0.122	0.210	0.218	-0.130
GB 7Y GILT	0.261	0.942	1	0.618	0.115	0.207	0.224	-0.128
GB 2Y GILT	0.145	0.525	0.618	1	0.045	0.138	0.152	-0.080
GB 3M T-BILL	0.003	0.122	0.115	0.045	1	0.068	0.094	-0.067
GBPEUR	0.078	0.210	0.207	0.138	0.068	1	0.525	-0.056
GBPUSD	0.016	0.218	0.224	0.152	0.094	0.525	1	-0.074
Dummy Variables	*-0.040*	*-0.130*	*-0.128*	*-0.080*	*-0.067*	*-0.056*	*-0.074*	*1*

3.1 Regression analysis

I employ a panel data regression analysis to study the effects of news on key dates on returns. For each regression, I use each of the instruments as dependent variables and the constructed indicator function as the independent variable. In order to avoid making the mistake of a 'dummy trap' I chose to include a constant in the regressions.[6] [7]

Dummy-trap?

Table 4: Summary of regression analysis, UK markets only

Independent variable	Indicator's effect		P-value	Significant
.FTSE	-0.0048	Negative	0.155	No
GB 10Y GILT	-0.0550	Negative	0.000	Yes**
GB 7Y GILT	-0.0731	Negative	0.000	Yes**
GB 2Y GILT	-0.1547	Negative	0.004	Yes**
GB 3M T-Bill	-0.0276	Negative	0.016	Yes*
GBPEUR	-0.0041	Negative	0.043	Yes*
GBPUSD	-0.0057	Negative	0.008	Yes**

* = 5% level, ** = 1% level

From table 4, the second column shows that all instruments are, on average, negatively affected

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[5] Sometimes referred to as 'flight to quality' (Vayanos, 2004)

[6] Need some explanations here!

[7] Only exhibits from regressions are presented in this section, see appendix **??** for full table

on key event dates. The indicator variable is significant for all sovereign bond yields except 3M T-Bill at 1% level, and all instruments except the FTSE100 index is significant at 5% level. This means that any information made publicly known on key dates had a negative impact on most financial markets. In terms of magnitude, the coefficient is highest for the 2 year sovereign yield - not surprising when taking into account that Britain has two years to successfully negotiate it's way out of the EU.

4 Rest of the world

Table 5: International market returns on key event dates

(*All figures in percent*)	.FTSE	.HSCI	.FTMIB	.MCX	.FCHI	.SPX	.GDAXI	.N225
17/01/2017	-1.47	0.70	0.25	-0.47	-0.46	0.00	-0.13	-1.49
04/11/2016	-1.44	-0.16	-0.62	-0.51	-0.78	-0.17	-0.65	0.00
03/10/2016	1.21	1.21	-0.78	0.44	0.12	-0.33	1.03	0.90
24/06/2016	-3.20	-2.75	-13.33	-1.83	-8.38	-3.66	-7.07	-8.25
16/06/2016	-0.27	-1.88	-0.99	-1.06	-0.45	0.31	-0.59	-3.10
19/02/2016	-0.36	-0.25	-1.19	-0.77	-0.40	0.00	-0.80	-1.43
08/05/2015	2.29	1.70	2.04	1.27	2.45	1.34	2.61	0.45
Standard deviation	1.82	1.62	5.08	1.01	3.38	1.55	3.02	3.14
Average return	-0.46	-0.20	-2.09	-0.42	-1.13	-0.36	-0.80	-1.84
Median	-0.36	-0.16	-0.78	-0.51	-0.45	0.00	-0.59	-1.43

Table 5 summarises returns on key event dates for international markets. Again, we notice that the biggest movements occur on June 24th and that markets react, on average, negatively on key dates.

I now use the same indicator function to construct the correlation matrix presented in table 6. Also in this case all, all variables seems to react negatively to events on my identified key dates.

Table 6: Correlation matrix for international markets, including dummy variables

	.FTSE	.HSCI	.FTMIB	.MCX	.FCHI	.SPX	.GDAXI	.N225	Dummy Variables
.FTSE	1	0.414	0.708	0.436	0.831	0.571	0.785	0.267	-0.040
.HSCI	0.414	1	0.303	0.328	0.376	0.239	0.366	0.421	-0.015
.FTMIB	0.708	0.303	1	0.402	0.862	0.538	0.815	0.239	-0.097
.MCX	0.436	0.328	0.402	1	0.441	0.315	0.460	0.205	-0.027
.FCHI	0.831	0.376	0.862	0.441	1	0.600	0.920	0.272	-0.071
.SPX	0.571	0.239	0.538	0.315	0.600	1	0.572	0.170	-0.037
.GDAXI	0.785	0.366	0.815	0.460	0.920	0.572	1	0.273	-0.053
.N225	0.267	0.421	0.239	0.205	0.272	0.170	0.273	1	-0.096
Dummy Variables	*-0.040*	*-0.015*	*-0.097*	*-0.027*	*-0.071*	*-0.037*	*-0.053*	*-0.096*	*1*

Similar to before, I employ regression analysis on each of the markets return on an indicator variable to establish the nature of the relationship and whether it is significant or not.

Table 7: Summary of regression analysis, international markets

Independent variable	Indicator's effect		P-value	Significant
.HSCI	-0.0021	Negative	0.595	No
.FTMIB	-0.0211	Negative	0.000	Yes**
.MCX	-0.0044	Negative	0.323	No
.FCHI	-0.0116	Negative	0.011	Yes*
.SPX	-0.0040	Negative	0.182	No
.GDAXI	-0.0084	Negative	0.059	No

* = 5% level, ** = 1% level

Table 7 presents exhibits from the regression analysis where we notice fewer significant coefficients compared to the previous analysis. However, also here all coefficients are negative which means that markets reacts generally reacted negatively on key dates.

Do international markets follow UK market's reaction?
Numerous studies have indicated that major stock markets are correlated, and that the correlation changes over time (Bennett et al., 1988; Makridakis and Wheelwright, 1974). According to Koch and Koch (1991), correlation across major stock markets have increased during recent years, while King and Wadhwani (1990) and Bertero and Mayer (1990) argues that correlation increases during times of financial distress.

In this perspective, it is not unexpected to see that indices included in this analysis are positively correlated - some more than others - and that major movements in the UK stock market are reflected in other stock markets. From table 6 and table 7, we see that the UK stock market is most correlated and synchronised with the European stock indices (FCHI, GDAXI and FTMIB). These are countries involved in the EU, and it is therefore expected that these countries are influenced by the same events and/or information regarding 'Brexit' negotiations.

5 Question 4

In this section, I calculate the cumulative returns for different time-ranges to in an attempt to assess whether market sentiment changes as time passes by.[8] Due to space restrictions, I have chosen to present four events in which patterns seem to be more pronounced.

> Make sure to comment on both international markets AND UK markets

Figure 2 to 6 presents four key events where the cumulative returns have been calculated from T-5 (for all events) up to one, three and five days after the key event occurred. Figure 2 clearly demonstrates how UK markets drop prior to the key date, 2016-11-04, especially seen by the significant fall in the two-year sovereign bond yield. On the key date, much uncertainty was accrued due to the High Court ruling, but it is evident that markets already took this into account before

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[8]All graphs for all key events are available in appendix XX

the ruling was presented. The next trading day[9], UK markets seemed to be recovering followed by a rally the next two to four days.

(a) [T-5, T+1] [T-5, T+3] [T-5, T+5]

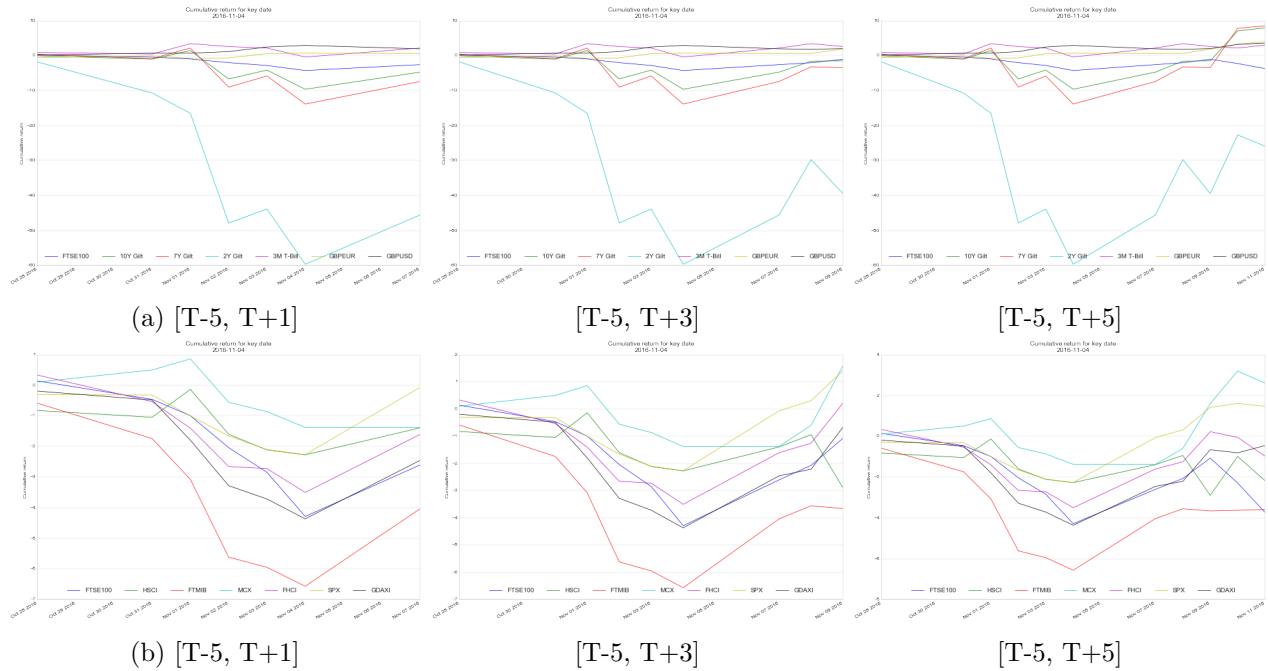(b) [T-5, T+1] [T-5, T+3] [T-5, T+5]

Figure 2: Cumulative returns for key date: 2016-11-04

The next key date of interest is June 24th, 2016. Compared to the previous key event, markets' reactions, as one can see in figure 4, appear to be characterised by an element of surprise. Prior to the referendum, prices and yields are steadily increasing, but plunge after the result of were ready - an indication that markets were caught completely off-guard. The following days are characterized by high volatility in both directions as uncertainty manifests itself in the form of political uncertainty, leadership questions and financial destabilisation.

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[9] Since the key event date is on a Friday, the next trading day is the following Monday

(a) [T-5, T+1]   [T-5, T+3]   [T-5, T+5]

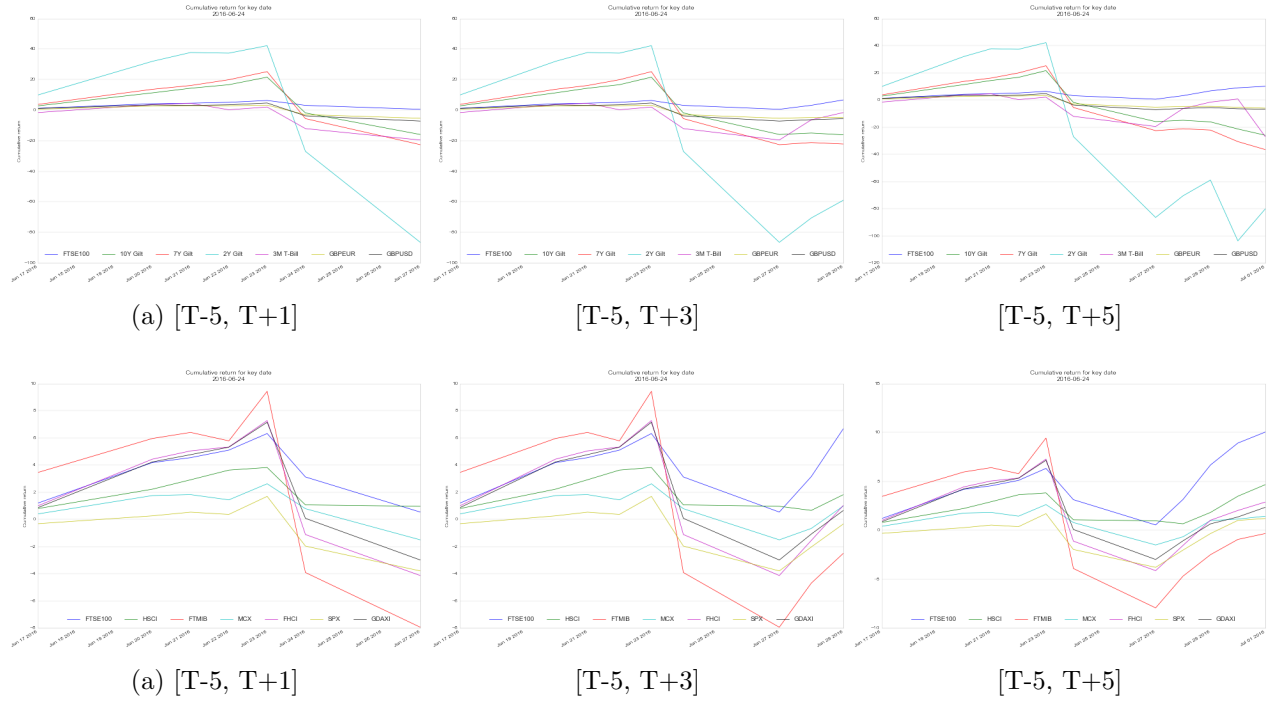(a) [T-5, T+1]   [T-5, T+3]   [T-5, T+5]

Figure 4: Cumulative returns for key date: 2016-06-24

Labour MP Jo Cox's death on June 16th, 2016, seemed to represent a shift in the EU 'Brexit' battle between the two campaigns. Prior to the tragic killing, markets moved in both directions, but dropped significantly after the announcement of her death. Some advocated that this incident could sway public opinion towards a more 'Remain'-friendly tone, and the increasing markets seemed supportive to this argument - especially the two year yield which rallied in the aftermath.

(a) [T-5, T+1]   [T-5, T+3]   [T-5, T+5]
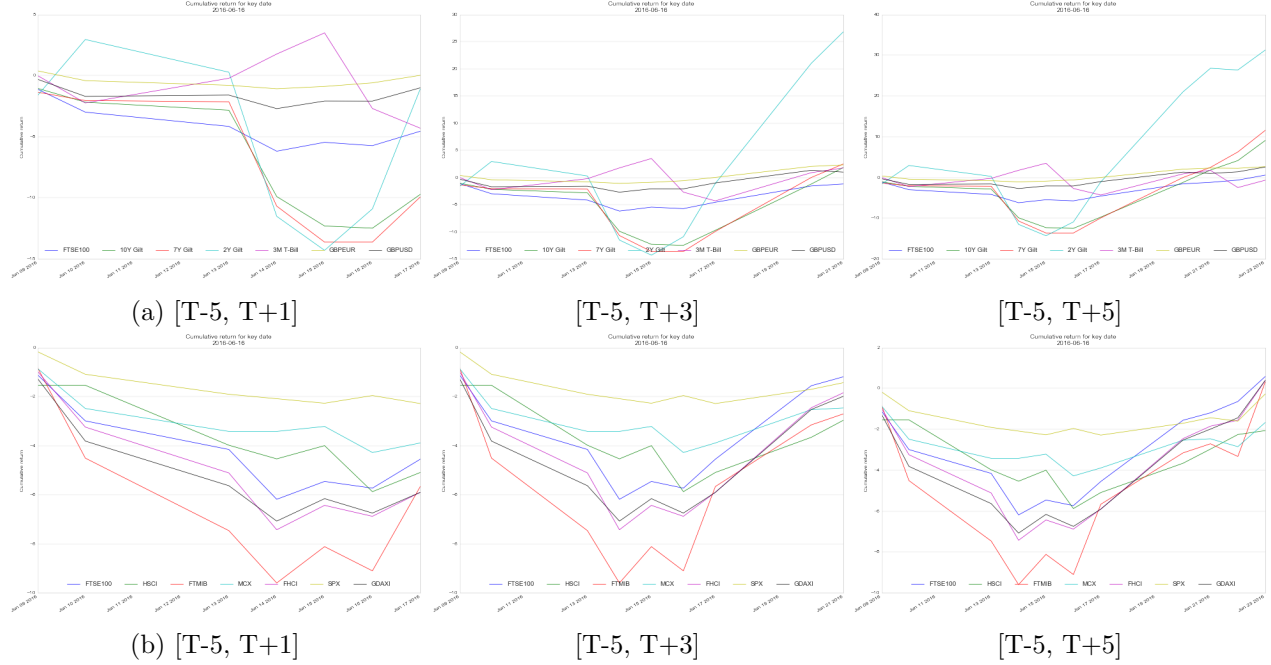
(b) [T-5, T+1]   [T-5, T+3]   [T-5, T+5]

Figure 5: Cumulative returns for key date: 2016-06-16

The last event I would like to highlight is the UK General Election, where the Conservatives won majority in the House of Commons and promised that they would hold a referendum on the UK's membership of the EU. In the run-up to the election, markets exhibit a positive trend (with the exception of bod yields) until the results of the election were ready. At first, the markets seems to respond positively to the results, but then fell sharply in the last days of the interval. A possible explanation for this behaviour could be affiliated with the fact that the Conservative party won an 'unexpected' outright majority at the expense of the Liberal Democrats - their coalition partner from the previous General Election (Parker, 2015). The Lib Dems pledged to keep Britain in the EU in their manifesto, but with a Conservative parliament majority the promise of a referendum suddenly seemed realistic - putting a downwards pressure on yields and prices (BBC, 2015a).

10

[T-5, T+1]　　　　[T-5, T+3]　　　　[T-5, T+5]

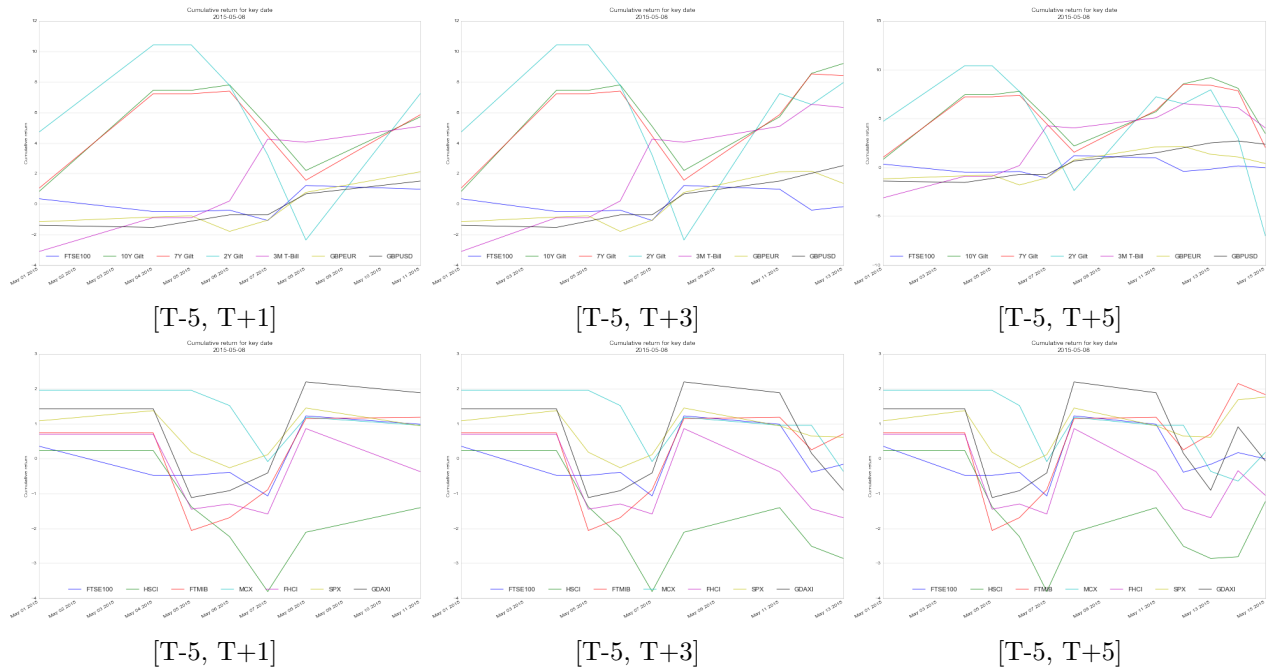[T-5, T+1]　　　　[T-5, T+3]　　　　[T-5, T+5]

Figure 6: Cumulative returns for key date: 2015-05-08

Plot prices?

6 Question 5

In the following part, identified key events have been classified as either positive, negative or neutral with respect to the impact on the 'Brexit' negotiations. The following classification was made:

Is this classification mentioned or coherent with previous questions?

Table 8: Table of classification of dates

Dates	Classified as
2015-05-08	Negative
2016-02-19	Neutral
2016-06-16	Positive
2016-06-24	Negative
2016-10-03	Negative
2016-11-04	Positive
2017-01-17	Negative

To get a better picture of how market returns were on the different days, I grouped the different dates together and calculated the mean of the returns. The results are presented in table 9.

Table 9: Mean returns for categories, question 5 (figures not annualized)

Indicator	.FTSE	.HSCI	.FTMIB	.MCX	.FCHI	.SPX	.GDAXI	GBPEUR	GBPUSD	GB 10Y GILT	GB 7Y GILT	GB 2Y GILT	GB 3M T-BILL	.N225
N.A	0.02	0.01	0.02	0.02	0.03	0.04	0.05	0.00	-0.02	-0.02	-0.02	-0.03	-0.05	0.06
Negative	-0.29	0.22	-2.95	-0.15	-1.57	-0.66	-0.89	-0.81	-1.26	-7.84	-10.25	-23.49	-1.72	-2.10
Neutral	-0.36	-0.25	-1.19	-0.77	-0.40	0.00	-0.80	-0.05	0.51	-1.69	-2.28	-2.13	-4.06	-1.43
Positive	-0.86	-1.02	-0.80	-0.79	-0.61	0.07	-0.62	0.21	0.22	-2.83	-4.01	-6.20	-4.37	-1.55

In spite of the fact that means for the three categories are calculated on a scarce basis, one can see that markets' movements are larger in general on key event dates compared to the rest of the year. The positive key events seem to entail more positive (or less negative) returns compared to negative events, albeit there are some exceptions.

Table 10: Calculated mean returns for key events in range [T-5,T+5]

Indicator	.FTSE	.HSCI	.FTMIB	.MCX	.FCHI	.SPX	.GDAXI	GBPEUR	GBPUSD	GB 10Y GILT	GB 7Y GILT	GB 2Y GILT	GB 3M T-BILL	.N225
Negative	0.26	0.12	0.07	-0.01	0.02	0.08	0.06	-0.19	-0.15	0.36	0.51	-0.36	-0.39	0.04
Neutral	0.75	0.20	0.74	0.48	0.79	0.59	0.58	-0.08	-0.33	0.60	0.64	-0.81	-0.17	0.69
Positive	-0.14	-0.19	-0.15	0.04	-0.03	0.05	0.00	0.30	0.28	0.77	0.91	0.24	0.10	-0.15

Table 10 presents the calculated mean returns for

Table 11: Result from regression analysis, Q5

Date	Characterized as	Coefficient	P-value	Significant?
17/01/2017	Bad	0.0017	0.0080	Yes**
04/11/2016	Good	0.0012	0.2910	No
03/10/2016	Bad	-0.0012	0.2540	No
24/06/2016	Bad	0.0050	0.0340	Yes*
16/06/2016	Good	0.0004	0.8350	No
19/02/2016	Bad	0.0014	0.5210	No
08/05/2015	Bad	-0.0028	0.0020	Yes**

* = 5% level, ** = 1% level

Remove?

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