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The effect of the Brexit referendum on the financial integration of the EU and the UK

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The effect of the Brexit referendum on the financial integration of the EU and the UK

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Executive Summary

Britain's decision to leave the European Union (a process known as Brexit) had and will have a wide effect on many spheres. The effects were particularly visible on the financial markets in the short run. The process could lead to political, legal and economic disintegration, a process in which the United Kingdom would move further from the European Union.

We decided to analyze the change in financial integration that the referendum could have triggered. There are a large number of definitions, along with many measures for the concept of financial integration. We decided to follow a portfolio manager's point of view and to define the integration as the process leading to higher correlation between returns of companies from different countries. Our measures are therefore based on the correlations between the returns generated in the United Kingdom and those generated by European Union firms.

We use three measures: a comparison between pre-referendum and post-referendum correlations; a 6-month rolling-window correlation; a DCC-GARCH model. We show theoretically that the DCC-GARCH model has some advantages over the rolling-window correlation. We carry our analysis at the country and sector level. We also analyze the change in correlation of UK-centred and foreign-centred firms.

We find that the referendum led to a decreased of the correlations between all indices, at the country and sector level, often only temporarily. We found that most correlations regained their pre-referendum level at the end of the sample. The effects varied depending on the sector or on the geographic orientation of the firm. Our robustness checks (mean equation, order of the GARCH, dataset) confirm our results.

In a further step, we decided to estimate the relationship between conditional correlation and conditional volatility (the square root of the conditional variance) by running a regression. We show that for most sectors, there is a positive relationship between the conditional correlation and the conditional volatility. This is an undesirable feature for diversification purposes as it implies that the correlation between indices is higher when the volatility in one of the two economies is higher.

KEY-WORDS: Brexit- Financial Integration- Countries- Sectors- Internationalization- DCC-GARCH - Conditional Correlations- Conditional Volatility

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[1]When David Cameron suggested, on January 23rd 2013, that in case of reelection he would organize a vote on the belonging of the United Kingdom to the European Union, he was far from expecting that, on June 23rd 2016, after a harsh battle between "*economics and emotions*" [2,3], 52% of the voters would choose to leave the European Union. The next day Cameron left his position and on July 13th, Theresa May entered 10 Downing Street. May immediately stated that "*Brexit means Brexit*" and therefore seemed to adopt a hard position in the negotiations. On March 13th 2017, Brexit was validated by the British Parliament and Article 50 of the European Union Treaty was triggered on March 29th 2017. This article states that a two-year period opens for negotiation when a country has decided to leave the European Union. Formal Brexit should consequently intervene at last on March 29th 2019, although a transition period has been negotiated until end 2020[4]. The current period can hence be labelled as Post Referendum, Pre Brexit (Broadbent, 2017).

The European Union forces the adoption of a negotiation by steps: the conditions of the separation will be negotiated before the future relations between both parties can be considered. The first part of the negotiation encompasses the citizens' rights, some financial questions and the establishment of a border between Ireland and Northern Ireland. An agreement was found on December 8th 2017 and stated that the European citizens living in the United Kingdom would keep their rights, that the United Kingdom would give 50 billion euros to the European Union as a contribution to the European Union Budget and that no border would be established between Ireland and Northern Ireland.

The second phase of negotiation, concerned with the future relations between the United Kingdom and the European Union, opened in December 2017. Six main options[5] were on the table, three of them being much more likely to be chosen (Sampson, 2017): if the United Kingdom chooses the Norwegian model[6], it will be part of the European Economic Area (EEA) (and also of the single market) and its relation would not change much although the United Kingdom would loose its influence on the creation of EEA rules; if no agreement is reached, the relations will be based on World Trade Organization (WTO) regulations. This would substantially increase both border and behind-the-border tariffs, and carry indirect costs (higher markups, lower product variety, etc.); the third and more likely option is that the United Kingdom will ask for a customized relationship, as Mrs. May announced in June 2017. Her government recently presented a Brexit plan[7] shared by all government members, heading

[1] The total number of words of this thesis is 21 791. The theoretical and empirical parts count 9 842 and 11 794 words respectively.

[2] The Leave side's assessment of critical issues was doubtful: many effects were underestimated as their econometrics were "inconsistent with the most basic empirical evidence on how countries trade" (Breinlich Dhingra, Sampson & Van Reenen, 2016, p. 60), the benefits of the recovery of sovereignty were exaggerated (Sampson, 2017, Moloney 2017, Dhingra *et al.*, 2016a), etc. Moreover, the alternative to Remain was never really clear (Dhingra & Sampson, 2016). See also the blog of the London School of Economics: http://blogs.lse.ac.uk/brexit/2017/08/22/what-does-respecting-the-referendum-result-mean/ , last consulted on August 12th 2018.

[3] These are the words of former Prime Minister John Major (Conservative Party). See: The Financial Times: https://www.ft.com/content/52a2fc22-388f-11e6-9a05-82a9b15a8ee7 , last consulted on August 12th 2018.

[4] Source: European Council: http://www.consilium.europa.eu/en/press/press-releases/2018/01/29/brexit-council-article-50-adopts-negotiating-directives-on-the-transition-period/ , last consulted on August 12th 2018.

[5] See HM Government (2016) for more information.

[6] United Kingdom's Prime Minister is against this solution as "*it crosses many "red lines" drawn by Theresa May*". Source: The Economist : https://www.economist.com/britain/2018/02/22/norwegian-lessons-for-brexit-britain , last consulted on August 12th 2018.

[7] For more information, see the BBC: https://www.bbc.co.uk/news/uk-politics-44749993 , last consulted on August 12th 2018.

towards a soft version of Brexit and proposed to the European Union as a negotiation basis. This led to the resignation of Foreign Secretary Boris Johnson and of Brexit Minister David Davies.

All options exhibit a trade-off between sovereignty and economic integration. Although Theresa May initially argued for a hard[8] Brexit, the opposition argues for a soft version, to minimize the loss implied by Brexit. Anyway, a new trade deal is likely to take some time to be found. It could take more than 10 years to reach an agreement, according to Danish Foreign Minister Anders Samuelson[9]. However, the current transition period is expected to end on December 31st 2020.

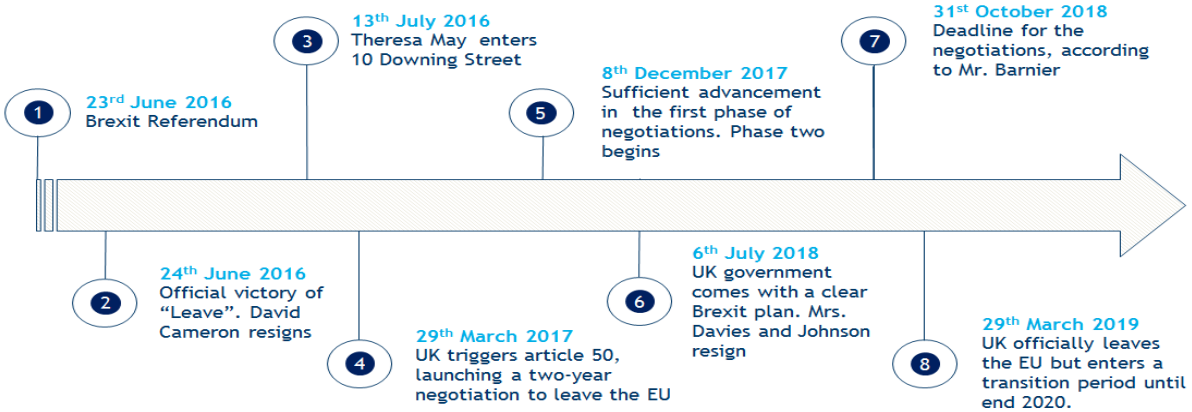

Figure 1: Key dates of the Brexit process

Brexit will have certain legal[10], political[11] and economic[12] effects on the United Kingdom and the European Union. Nevertheless, the impact of Brexit on financial markets is less obvious and raises questions for investors. In particular, returns of stocks between the EU and the UK could be increasingly influenced by different factors, creating a divergence that portfolio managers could exploit to decrease their risk exposure.

In the next chapters, the (expected) effects of Brexit will first be presented in details. Secondly the concept of financial integration, the costs and benefits of being financially integrated, the major indicators of financial integration as well as the potential benefits of international assets holdings will be developed. The third part develops our hypotheses on the impact of Brexit on European Union-United Kingdom financial integration. The methodology and data are presented in the fourth part. We present the results of our analysis and answer our research questions in the fifth and sixth parts, respectively for countries and sectors. The conclusion summarizes our findings and opens perspectives.

---

[8] A hard Brexit would mean the United Kingdom takes more distance with the EU (for instance by refusing to enter the EEA or EFTA and relying on WTO rules for bilateral trade), while a soft Brexit would mean that the relationship would remain about the same after the United Kingdom leaves the EU.

[9] Source: Bloomberg: https://www.bloomberg.com/news/articles/2017-03-09/britain-told-15-year-talks-on-eu-trade-deal-can-t-be-ruled-out , last consulted on August 12th 2018.

[10] Legally, the United Kingdom will have to adapt more than 12 000 EU regulations that were part of the European Laws. It will also modify its relation with the European Court of Justice. Source: BBC: http://www.bbc.com/news/uk-politics-39439554 , last consulted on August 12th 2018.

[11] Politically, Brexit led to a lack of agreement on whether to adopt a hard or soft view. It also wakened problems concerning United Kingdom-Gibraltar and England-Scotland relationships. Scotland's Prime Minister announced she would propose a second independence referendum, an idea she afterwards postponed. It also decreases the importance of the United Kingdom as part of the EU to influence European/World policies. Source: The Guardian: https://www.theguardian.com/politics/2017/jun/27/nicola-sturgeon-shelves-second-independence-referendum, last consulted on August 12th 2018.

[12] We will further develop these effects in the next part of this work.

The economic effects of Brexit

Short-term effects

The short-term effects of Brexit were overwhelmingly predicted as largely negative. Many forecasters (Kierzenkowski, Pain, Rusticelli & Zwart, 2016; Dhingra Ottaviano, Sampson & Van Reenen, 2016c, for instance) predicted strong short-term (before 2020) and long-term (after 2020) effects if the United Kingdom chose to leave the European Union. Also, directly after the vote, Moody's changed the outlook of debt rating from stable to negative[13] because of heightened uncertainty, low level of predictability and negative effects on GDP growth. As of today, the real economy resisted quite well[14].

The first effects to be seen were on the financial markets. From the end of December 2015, the Effective Exchange Rate[15] exhibited a downward trend. The day the results were published, it lost 6.8%. The fall even reached 16% on October 13th 2016 compared to its pre-referendum value (see graph below). This probably signals investors' view of Brexit as a negative event for the United Kingdom in the long run (Weale, 2016; OECD, 2017).

Figure 2: Pound Effective exchange rate between January 1st 2015 and July 2nd 2018[16]

This depreciation, along with strong global growth, led to higher exports and mitigated the negative effects of subdued consumption and investments on Gross Domestic Product (GDP) (Weale, 2016). However, as the country is a net importer of goods and as a weaker currency means more expensive imports, the depreciation of the Pound had a negative impact on the price of goods and inflation exceeded its 2% target since February 2017. This depreciation also affects the position of the United Kingdom in the global value chain (Kee & Nicita, 2017). Inflation even exceeded nominal wages growth rate for a period, leading to a decrease in real wages[17] (see appendices).

On the stock markets investors decreased their risk exposure, selling their (United Kingdom-focused) equities and buying bonds, leading to falling equity prices and bond yields

[13] Source : Moody's : https://www.moodys.com/research/Moodys-changes-outlook-on-UK-sovereign-rating-to-negative-from--PR_350566 , last consulted on August 12th 2018.
[14] For a first analysis of the reasons why forecasts failed, see Saunders (2017).
[15] The effective exchange rate is an average exchange rate, weighted by the importance of trade partners. Source: BoE : https://www.bankofengland.co.uk/statistics/details/further-details-about-effective-exchange-rates-data , last consulted on August 12th 2018.
[16] Source: BoE : https://www.bankofengland.co.uk/boeapps/database/fromshowcolumns.asp?Travel=NIxIRxSUx&FromSeries=1&ToSeries=50&DAT=RNG&FD=1&FM=Jan&FY=2015&TD=2&TM=Jul&TY=2018&FNY=&CSVF=TT&html.x=111&html.y=34&C=IIN&Filter=N , last consulted on August 12th 2018.
[17] Combined with the historically low unemployment rate, this seems inconsistent with the Phillips curve (Broadbent, 2017).

on June 24th [18]. In the following months, uncertainty remained high and United Kingdom markets were influenced by the debate between hard and soft Brexit, as well as by positive economic surprises (GDP growth was better than expected)[19]. The following graph, depicting the daily returns of London's main indices, FTSE 100 and FTSE 250, shows that both indices reacted heavily on the announcement of Brexit, although the effect on the FTSE 100 (-3.15%), comprising more multinational companies, was lower than the effect on the more United Kingdom-centred FTSE 250 (-7.19%). While multinational companies can be seen as inherently more diversified and consequently less dependent on local economic conditions, the effect of the depreciation of the Pound can also explain their better resilience, as a weaker pound increases the Pound-value of repatriated revenues. The shock induced by the results did not persist for a very long time: "*The short-run financial market outcome was much more benign than expected*" (Obstfeld, 2016, p. 361). However, there could be a longer-term effect on the volatility of the stock returns as the process of Brexit is highly uncertain.

Figure 3: Geometric returns of FTSE 100 and FTSE 250, March 23rd- September 23rd 2016[20]

The other main European and World indices also suffered from the decision, with Paris's CAC40 losing more than 8%, Berlin's DAX 30 6.8%, Tokyo's Nikkei 250 nearly 8% and New York's Dow Jones 2.5%[21]. The referendum also affected the volatility of the global stock exchanges[22].

Although the indices declined, the effects on the sectors were more contrasted. Ramiah, Pham and Moosa (2017) conducted an event study on the effects of the announcement of the referendum's results on different sectors to "*get a feel of the possible effects on various sectors of the British economy*" (p. 2508). They show that the short term effect of Brexit varies among their 24 industries.

Another event study conducted by Oehler, Horn and Wendt (2017) showed that firms generating more sales abroad (their measure of diversification) have been less sensitive to the

[18] See for instance UBS (2016), which analyze the drivers of gold price for the first half of 2016.

[19] Source: Blog written by the staff of the Bank of England (BoE): https://bankunderground.co.uk/2017/04/19/the-impact-of-brexit-related-shocks-on-global-asset-prices/ , last consulted on August 12th 2018.

[20] Source: London Stock Exchange: https://www.londonstockexchange.com/statistics/ftse/ftse.htm , last consulted on August 12th 2018.

[21] Source: Les Échos: https://investir.lesechos.fr/marches/actualites/cac-40-brexit-petrole-axa-bnp-paribas-credit-agricole-societe-generale-total-la-seance-de-bourse-du-vendredi-24-juin-2016-1562043.php , last consulted on August 12th 2018.

[22] Source : Bank of England's staff blog : https://bankunderground.co.uk/2017/04/19/the-impact-of-brexit-related-shocks-on-global-asset-prices/ , last consulted on August 12th 2018.

Brexit-shock. We will therefore test if there has been a different change in integration depending on the company's diversification.

Turning to the real economy, the effects of the referendum were less severe than expected. GDP growth "*remained solid*" (Saunders, 2017, p.2) in the months following the vote, while the unemployment rate remained low[23]. However, the United Kingdom's growth rate decreased in 2017, as all components witnessed low growth. In May 2018, the OECD forecasted "*modest*"[24] growth for the coming months, because of persistent uncertainties. The Bank of England (BoE) estimates the current cost of Brexit at £900 per household[25]. This "*Brexit tax*" [26] is a pure deadweight loss: it would hit the United Kingdom's well-being while not being of interest to anybody, according to OECD secretary general Angel Gurría. He estimates the tax at 2200 Pounds per household by 2020, and between 3200 and 5000 pounds per household by 2030, although he emphasizes that this estimate is "*too cautious*"[27].

The post-referendum era is also marked by a higher degree of uncertainty, as we underlined in the introduction. This uncertainty is captured by the Economic Policy Uncertainty Index, which is based on the amount of press articles referring to economic uncertainty[28]. As the graph below shows, the index increased dramatically as from January 2016, peaked following the referendum and remained high and volatile since this date, compared to historical norms. Other indicators show that the uncertainty increased: the future value of the Pound fluctuated a lot in the previous weeks (see annexes); also, three prominent hedge funds of the United Kingdom froze $12 million of assets because of the large demand for redemption[29].

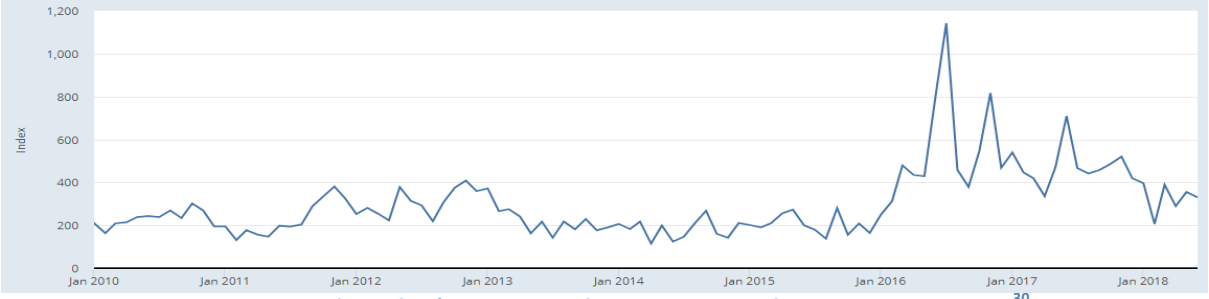

Figure 4: United Kingdom's Economic Policy Uncertainty Index, Jan 2010- June 2018[30]

The growth of investments[31] remained subdued by 3% to 4% given strong global growth and low interest rates, due to the uncertainty of the process and the lower potential

[23] This could be a problem in the future if the pool of available workers decreases, as growth would therefore necessitate higher productivity, while in the recent past it relied, among others, on higher labour supply. Sources : IMF: https://www.imf.org/en/News/Articles/2017/01/16/tr01162017-Press-Briefing-On-Update-Of-The-World-Economic-Outlook, last consulted on August 12th 2018; https://www.imf.org/en/News/Articles/2018/02/08/na021418-uk-economy-must-get-more-efficient, last consulted on August 12th 2018.

[24] Source : OECD : http://www.oecd.org/eco/outlook/united-kingdom-economic-forecast-summary.htm

[25] Source : The Guardian : https://www.theguardian.com/politics/2018/may/22/brexit-vote-cost-uk-mark-carney-bank-of-england , last consulted on August 12th 2018.

[26] Source : OECD : http://www.oecd.org/fr/economie/to-brexit-or-not-to-brexit-a-taxing-decision.htm , last consulted on August 12th 2018.

[27] *Ibid.*

[28] For more information on the methodology, see: http://www.policyuncertainty.com/uk_historical.html , last consulted on August 12th 2018.

[29] Source: Bloomberg: https://www.bloomberg.com/news/articles/2016-07-05/m-g-investments-suspends-trading-in-property-portfolio-fund , last consulted on August 12th 2018.

[30] Source : FED website : https://fred.stlouisfed.org/series/UKEPUINDXM, last consulted on August 12th 2018.

growth (OECD, 2018; Bank of England, 2018a). A study evaluated that companies abandoned 65.5 billion Pounds of investments due to Brexit[32]. By 2020, the level of investments could be 20% lower than what the Monetary Policy Comitee (MPC) forecasted before the vote. It should also be emphasized that investments in a given year might have been decided in another year. Turning to the investment intentions, studies show that they remain positive but "*reflected the investment needed to maintain business activity and improve efficiency*"[33].

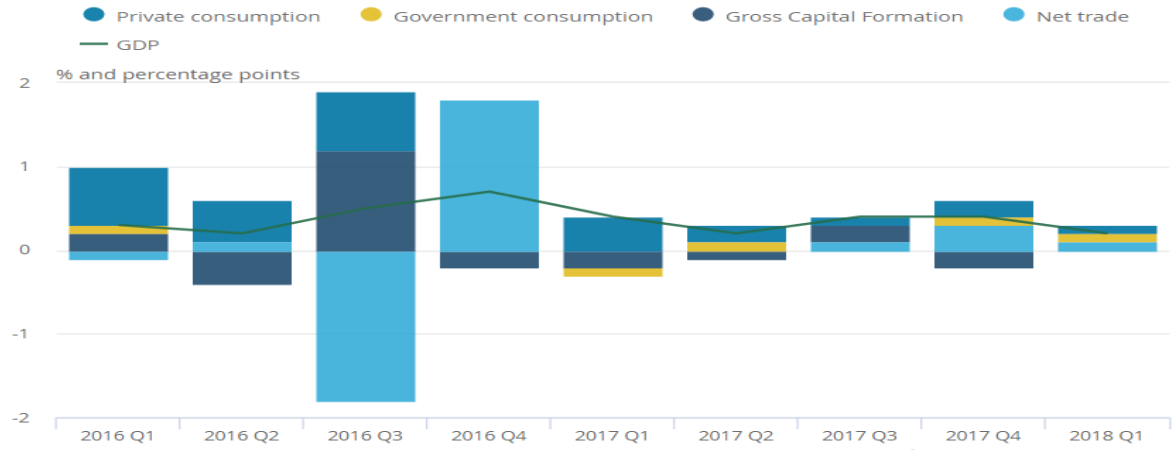

Figure 5: United Kingdom GDP decomposition, Q1 2016- Q1 2018[34]

Also, many (financial) companies, such as Goldman Sachs and Morgan Stanley[35] or BMW[36], and some European institutions[37] announced they would (partially) leave the United Kingdom for the European Union in the weeks following the vote, a process that is likely to continue according to the OECD[38]. Recently, EY reported that 75 (out of 222 surveyed) financial firms are considering or implementing staff relocation[39].

The relative resilience can in part be attributed to the measures the Monetary Policy Committee decided to take in the aftermath of the referendum (OECD, 2017). Because of the expected negative effects of Brexit on the economy, particularly those of business and consumer confidence on demand (Broadbent, 2017), the MPC decided to lower its main

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[31] Source : ONS : https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/npen , last consulted on August 12th 2018.

[32] Source : Hitachi Capital : https://www.hitachicapital.co.uk/news-media/businesses-abandon-655bn-of-investments/ , last consulted on August 12th 2018.

[33] Source : BoE : https://www.bankofengland.co.uk/-/media/boe/files/agents-summary/2018/february-2018 , last consulted on August 12th 2018.

[34] Source : the United Kingdom's Office for National Statistics (ONS) : https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/articles/monthlyeconomiccommentary/june2018 , last consulted on August 12th 2018.

[35] Source : Bloomberg : https://www.bloomberg.com/news/articles/2017-03-21/goldman-morgan-stanley-signal-london-job-moves-as-brexit-looms , last consulted on August 12th 2018.

[36] Source : Bloomberg : https://www.bloomberg.com/news/articles/2017-03-21/bmw-reviewing-u-k-plant-options-post-brexit-amid-trade-threats , last consulted on August 12th 2018.

[37] The European Medicines Agency moved to Amsterdam while the European Banking Authority joined Paris. See http://www.consilium.europa.eu/en/policies/relocation-london-agencies-brexit/ ,last consulted on August 12th 2018, for more information.

[38] Source: CNBC: https://www.cnbc.com/2017/11/28/brexit-will-see-more-firms-leave-uk-says-oecds-gurria.html , last consulted on August 12th 2018.

[39] Source : EY : https://www.ey.com/uk/en/newsroom/news-releases/18-06-25-ey-financial-services-brexit-tracker---firms-forge-ahead-with-contingency-plans-despite-transition-agreement , last consulted on August 12th 2018.

interest rate in August 2016, as well as to increase the importance of its Quantitative Easing[40]. These conventional and unconventional actions were conducted in order to support the economy by easing the granting of credits. In November 2017, the Bank decided to increase its main rate at 0.5%, in order to fight against the inflation, while it maintained its QE unchanged to support Britain's economy.

The outside world also suffers from Brexit. In addition to the stock market shock following the results, the IMF predicts that the output of the referendum could cost 0.2% to the world's economic growth (IMF, 2016b).

Long-term Effects

Three types of works estimate the long-term effects (Sampson, 2017): case studies of the consequence of joining the European Union; simulations using general equilibrium trade models; reduced-form evidence of the effect of European Union membership on trade. Most estimates conclude that, on the long term, Brexit will cost "*between 1 and 10% of United Kingdom per capita income*" (Sampson, 2017, p. 164). The Treasury (2016, cited in Dhingra *et al.*, 2016c) analysis forecasts falls of GDP ranging from 3.8% under the Norwegian option to 7.5% for the WTO option, although Dhingra and her co-authors (2016c) find their hypotheses too cautious. They rather find that "*the United Kingdom is likely to be considerably poorer than it would have been if it had remained in the European Union*" (Dhingra *et al.*, 2016c, p. 76). The OECD also assesses that each alternative is worse than remaining in the European Union[41]. The following table summarizes the results of some studies on the long-term impact of Brexit. A table developing the assumptions of some models can be found in appendix 1.

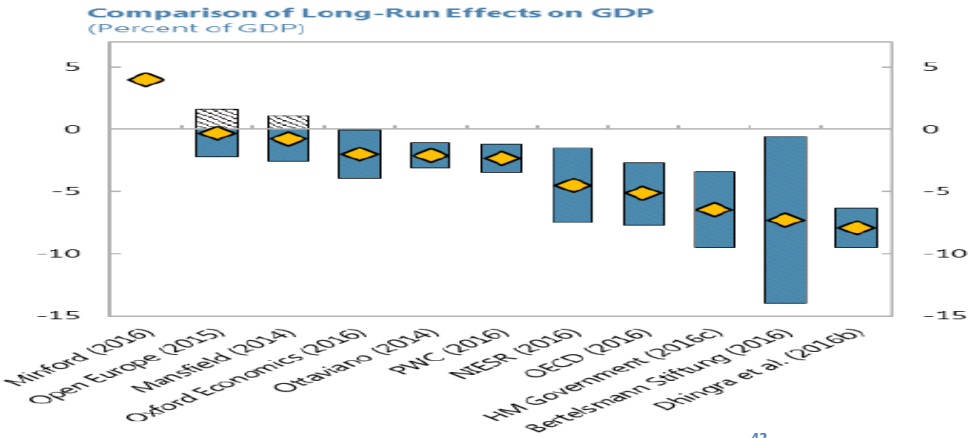


Figure 6: Comparison of long-run effects of Brexit on GDP[42]

The results of studies on the long run differed widely, mainly because they rely on different assumptions (effects on 5 500 companies which highly depend on passports[43], other

[40] Source: BoE: https://www.bankofengland.co.uk/monetary-policy-summary-and-minutes/2016/mpc-august-2016 , last consulted on August 12th 2018.

[41] Source : OECD : http://www.oecd.org/fr/economie/to-brexit-or-not-to-brexit-a-taxing-decision.htm , last consulted on August 12th 2018.

[42] Source : IMF, 2016a, p. 24

[43] If the United Kingdom leaves the EEA in order to regain sovereignty, tariff as well as non-tariff trade barriers will increase. It will loose its ability to grant passports to financial firms to operate in European Union countries, which means that a licence would be needed to open a subsidiary in an European Union country (Schoenmaker, 2016), although some alternatives (for instance the recognition of equivalency agreements) might be found. The United Kingdom's major role as a clearer of Euro-denominated trade would also come under pressure (*ibid.*), as a Financial Union could require this business to be performed in a European Union country (Moloney, 2017).

effects on the United Kingdom's integrated supply chains, such as customs or administrative burden[44], etc.) and are highly dependent on the future relationship between the European Union and the United Kingdom. They also differ by the channels they take into account (trade, FDI, (qualified) immigration, regulation, competition[45], etc.) and the models they use to forecast the effects of the channels[46].

One should also keep in mind that the European Union represents 44% of the United Kingdom's exports (and even 63% if we add exports to countries that have a trade agreement with the European Union) and 53% of its imports (Ramiah *et al.*, 2017). However, imports and exports are split differently across sectors, as can be seen in the following table. We can expect the sectors that have the closest relationship with the European Union to be more affected by the referendum.

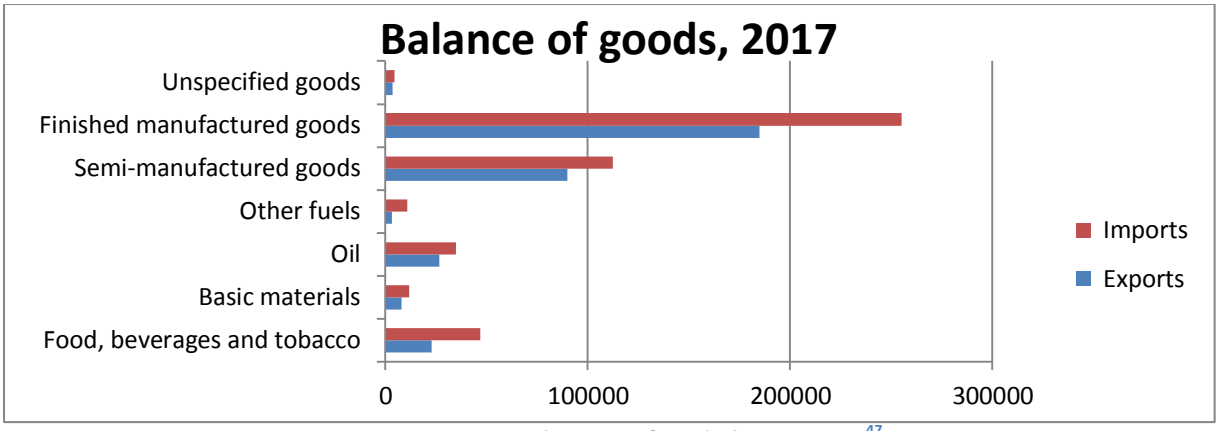


Figure 7: Imports and Exports of goods, by type, 2017[47]

Concerning goods, we can see that finished manufactured goods represent the biggest part of both imports and exports. Semi-manufactured goods arrive in second position.

Source : IMF : https://blogs.imf.org/2017/05/29/chart-of-the-week-brexit-and-the-city/ , last consulted on August 12th 2018.

[44] 63% of European and 40% of United Kingdom companies are searching for alternative suppliers, in the EU and the United Kingdom respectively. 8% of United Kingdom companies declared they had already lost contracts because of Brexit. Source: the United Kingdom's Chartered Institute of Procurement and Supply: https://www.cips.org/en/news/news/eu-businesses-say-goodbye-to-uk-suppliers-as-brexit-bites-into-key-relationships/ , last consulted on August 12th 2018.

[45] See Crafts (2016) for an assessment of how the increased competition of EU membership contributed to United Kingdom's GDP. The author also stresses that the withdrawal from the EU might not take away all gains.

[46] Sampson *et al.* (2016) criticize the use by the Economists for Brexit of a model relying on perfect competition, and rather favor a gravity model. Patrick Minford replied by explaining why, in his view, these models are "*seriously wrong*" (Economists for free trade, 2017, p. 75).

[47] Source: Office for National Statistics: https://www.ons.gov.uk/file?uri=/economy/nationalaccounts/uksectoraccounts/datasets/unitedkingdomeconomicaccountsbalanceofpaymentscurrentaccount/current/ukea2018q1reftable10currentandcapitalaccount.xls, last consulted on August 12th 2018.

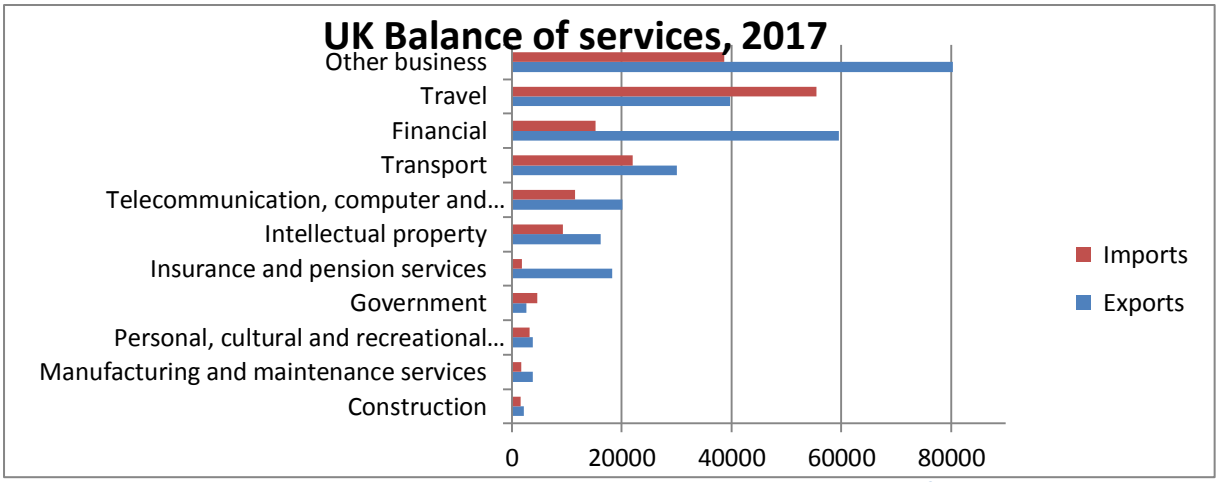


Figure 8: imports and exports of services for given sectors, 2017[48]

Turning to the balance of services, the travel and financial sectors are those that import and export the most. Some other sectors trade a bit less with foreigners, namely transports, telecommunication, intellectual property and insurances. If we adapt these industries using Standard and Poor's Global Industry Classification Standard (GICS), we can expect financials, consumer discretionary, telecommunication and industrials to suffer the most from Brexit as they have more economic linkages with the European Union.

The European Union is also affected, as it lost one of its biggest economies and contributors, although the effects of Brexit are expected to be much smaller, except for Ireland (Sampson, 2017).

Many scholars did not change their opinion after the relative resilience of the British economy in the first months after the vote[49], as the definitive effects could take years to materialize.

Leaving the European Union would also prevent the United Kingdom from entering the Capital Market Union, a project of the European Commission to be voted in 2019, aiming at creating a true, European capital market[50]. This project is seen as necessary as there are still many practical barriers preventing the free flow of capital between countries, their condition of financial integration[51].

Conclusion

The short-term effects of Brexit are less important than expected, at least for the moment. The depreciation of the Pound as well as the strong world demand enabled the United Kingdom economy to continue its growth. The equity markets also resisted quite well, partly because of the strong depreciation of the Pound. We should emphasize that most reports chose 2020 as the limit for the assessment of the short-term effects, leaving more than a year for them to materialize. However, the effects are likely to remain subdued.

[48] Source: Office for National Statistics: https://www.ons.gov.uk/file?uri=/economy/nationalaccounts/uksectoraccounts/datasets/unitedkingdomeconomicaccountsbalanceofpaymentscurrentaccount/current/ukea2018q1reftable10currentandcapitalaccount.xls

[49] Source : Financial Times : https://www.ft.com/content/c2b0359e-d0dc-11e6-b06b-680c49b4b4c0 , last consulted on August 12th 2018.

[50] For more information, see its description by the European Commission: https://ec.europa.eu/info/business-economy-euro/growth-and-investment/capital-markets-union/what-capital-markets-union_fr, last consulted on August 12th 2018.

[51] The European Commission (2011) recently published an assessment of these barriers.

We could see that the announcement of the results affected the FTSE100 less than the FTSE250. This could be explained by the fact that the FTSE100 generates more value abroad and is therefore less affected by the mere country-shock. Also, the pound devaluation makes incoming flows worth more in local currency.

One important point to keep in mind is the high uncertainty prevailing in the economy. We should also stress the weakness of business investments that could hamper growth in the longer run.

The longer term economic effects assessments are overwhelmingly negative, whatever the deal the United Kingdom could secure with the European Union. This could affect the stock market, as the intrinsic value of a stock is the sum of its discounted future cash flows, and these cash flows depend on the state of the economy.

In the introduction and this first chapter, it was shown that Brexit could (and likely will, at least partially) lead to the disintegration between the European Union and the United Kingdom. If the United Kingdom uses its regained sovereignty to implement different measures than the European Union will, this will have an impact on the trade and on the economic and legal frameworks of the United Kingdom. These movements could lead to a disintegration of the financial markets. If equities were to start behaving in a less similar manner (in other words, if the correlation between the returns generated in the European Union and the returns generated in the United Kingdom decreases), this could enable portfolio managers to better diversify their portfolios. The next section introduces the concept of financial integration, its benefits and risks for economies as well as for individual investors.

The concept of financial integration

Towards a definition of financial integration

The concept of financial integration is closely linked to that of globalization. Improvements in certain domains such as transports, technology, tariffs or politics enabled the trade of goods to develop and the Law of One Price[52] to be increasingly verified (O'Rourke, 2002)). International investments also deepened, as these advances also enabled close monitoring of foreign investments (Salvatore, 2013).

The process of financial integration also relies on the position adopted by the country in Mundell and Fleming's Trilemma, modelled by Obstfeld (1997)[53]. Countries willing to open their borders consequently have to choose between their monetary policy independence, to react more easily to economic shocks, and the peg of their currency, to facilitate trade. For instance, during the Bretton Woods era, countries pegged their currencies and wanted to retain their monetary policy autonomy. They hence accepted to sacrifice the international capital mobility, a choice that obviously hindered financial integration.

The concept of financial integration has several definitions, along with several measures. The European Central Bank (ECB) adopts a definition based on the laws and focuses on the attainment of three conditions: a uniform and coherent set of rules; an undifferentiated access to the whole array of financial instruments and services; fair and equal treatment on the market (Baele *et al.*, 2004). Perfect integration means that there are no entry barriers and that the two markets are hardly distinguished. Capital flows are allowed to move to other economies without restrictions. Financial integration is therefore, for the ECB, the creation of a single financial market.

Countries can take action to facilitate the process of integration. They could open their borders to international commodity trade, as this facilitates international asset trade (Adam, Jappelli, Menichini, Padula, & Pagano, 2002; Lane and Milesi-Feretti, 2003). They could also decrease the "*direct barriers*" (Baele, Ferrando,, Hördahl, Krylova, & Monnet, 2004, p. 3) to financial integration, such as double taxation[54] or legal differences (Pungulescu, 2013). This would reduce international transaction costs and therefore ease the international trade of assets, therefore decreasing the asymmetry of information (Lane & Milesi-Feretti, 2003). Countries can likewise decrease the "*informational barriers*" (Baele *et al.*, 2004, p. 3), such as reporting standards, languages and cultures. The launching of the process of financial

[52] O'Rourke *et al.* (2002) measure the integration of commodity markets as the verification of the Law of One Price. They state that "(…) *the only irrefutable evidence that globalisation is taking place is a decline in the international dispersion of commodity prices or what might be called commodity prices convergence*" (p. 26). In the context of financial markets, the prices are the interest rates of similar bonds or the return on similar equities, for instance. In this work, we will only focus on equities.

[53] The argument goes as follows: imagine two countries that allow free movement of capital, peg their currencies to avoid big shocks in trade and set their interest rates independently. If one of the countries decreases its interest rates (in order, for instance, to relaunch its economy), investors would take advantage of this arbitrage: they can invest in the other country for a better return (higher interest rate) without taking more risk (as the currencies are pegged). The demand for the currency of the latter country would increase, creating tensions in the foreign exchange market. One of the three pillars would have to be given up: either the countries would have to limit the flow of capital; or they would have to abandon the peg, which is no longer sustainable; or they would have to synchronise their monetary policies and agree on the level of their interest rates.

[54] Adam *et al.* (2002) argue that taxation purposes can explain part of the home equity bias. Lane and Milesi-Feretti (2003) rather argue that this bias is due to asymmetry of information. Chan *et al.* (2005) underline the role of capital controls.

integration hence depends on the attainment of certain thresholds on some variables (Prasad and Rajan, 2008).

De Nicolò and Juvenal (2010) distinguish between financial globalization and financial integration, the former being a quantity-based measure calculated as "*the growth rate of financial openness, defined as the ratio of the sum of external assets and liabilities* (…), *standardised by GDP*" (p. 4). By contrast, their definition of financial integration relies on the Law of One Price, and more particularly on the convergence of equity premia, as common factors should increasingly affect them.

Adam *et al.* (2002) also rely on the Law of One Price and state that "*assets generating identical cash flows command the same return, regardless the domicile of the issuer and of the asset holder*" (p. 4). This definition also presupposes the superiority of price-based indicators over quantity-based measures. The authors assess both the persistence (mean) and the dispersion (standard deviation) of price differentials in several markets. However, they also evaluate quantity-based measures, as international flows and stocks are likely to increase when integration improves. But, as the Law of One Price could hold even without cross-border financial flows and as high flows do not necessarily lead to higher integration, cross-border capital flows are neither a necessary nor a sufficient condition for integration (Adam *et al.*, 2002).

Adjaouté and Danthine (2002) measure stock market integration using correlations, as they argue that "*financial integration implies the convergence toward a single pricing kernel or discount factor. (...) financial integration should translate into portfolio of stocks representing an industry across the geographical area being priced closer together*" (p.24) and should therefore imply increased correlation in the stock returns of two countries and their sectors.

Pukthuanthong and Roll (2009) argue that the financial integration of developing and developed markets is high when the same global factors explain the whole variation of countries' indices. Perfect integration hence means that country-specific and regional factors do not account for any variation of stock-indices.

There are many different definitions of the concept of financial integration. Definitions are either based on the applicable laws (legal measures), financial flows between countries (quantity-based measures) or the equalization of the prices of their asset (price-based measures). This plurality induces a large array of methods that will be developed in this chapter, after the presentation of the costs and benefits of financial integration.

In this work, we focus on the stock market integration and adopt the perspective of portfolio managers. We define financial integration as a process leading to ever closer correlation between the returns of geographic areas. This definition is similar to that of Fratzscher (2002), though we focus on regional integration and he focuses on the world integration. His definition is that "*Market i is more integrated the stronger domestic returns* $r_{i,t}$ *depend on contemporaneous world market shocks* $\varepsilon_{w,t}$ *with* $\gamma_{iw,t}$ *as the measure of the degree of integration of market I in the equation:*

$$r_{i,t} = \beta_{iw,t} E_{t-1}[r_{w,t}] + \gamma_{iw,t} \varepsilon_{w,t} + \beta_{i,t} E_{t-1}[r_{i,t}] + \varepsilon_{i,t}"$$

(Fratzscher, 2002, p.168).

Benefits and costs of financial integration

Financial integration affects both countries and investors. As its effects and measurement developed, a more nuanced view of the phenomenon settled, although its costs and benefits are still misunderstood and largely debated (Prasad & Rajan, 2008). In the next lines, there will be a first focus on its alleged and empirical advantages and disadvantages. Regarding the dichotomy of De Nicolò and Juvenal (1010), it should be stressed that the authors mobilized in the next section often amalgamate financial globalization and financial integration.

The first advantage of financial integration is that it enables a country to get funding abroad (Agénor, 2001), which enables growth as the level of investments stops being constrained by the level of savings. The empirical effects of capital inflows on growth are still largely debated. Agénor (2001) states that evidences suggest that financial integration has a positive effect on domestic investment and growth, though small developing economies are "*rationed out*" (p. 13) of the process. Pop (2008) refers to a study for the European Commission in which stock and bond integrations are evaluated to increase the European Union's GDP by 1.1% over 10 years. Prasad and Rajan (2008) argue that the main benefits of financial integration are indirect and cite studies concluding that foreign flows have no effect on growth, but also refer to some studies arguing the contrary. Also, when a market is more integrated, Dvořák and Podpiera (2006) argue that the beta of the firm should be calculated regarding the world market rather than the local market, thereby reducing its value and also the cost of capital.

Second, foreign flows of capital also contribute to welfare gains (Agénor, 2001). Foreign direct investors buy a significant share of a corporation and therefore favor the transmission of foreign managerial know-how to local companies, which increases the level of competition and decreases the prices. Salvatore (2013) argues that "*international capital flows increase the efficiency in the allocation of resources internationally and increase world output and welfare*" (2013, p. 376). However, Passari and Rey (2015) explain that the welfare effects are likely to be low as foreign capital only accelerates the reaching of the steady state, but subsequently decreases the consumption as the country has to repay the loan.

Third, by facilitating access to foreign capital, financial integration makes it possible to smooth consumption. Consequently, it has a counter-cyclical role as countries can lend money in good times and borrow funds in bad times (Agénor, 2001). For instance, the consumption growth rates of the Euro area countries are less correlated than their GDP growth rate (Adjaouté & Danthine, 2003). However, Kirabaeva *et al.* (2012) rather witness a pro-cyclical behaviour of flows. Among them, debt flows are the most volatile, as obtaining a foreign loan is far more difficult in bad times than in good times. Foreign flows therefore do not enable to smooth consumption and rather worsen crises (Agénor, 2001). According to Pungulescu (2013), financial integration enables both ex-ante (equity markets) and ex-post (bond-market, loans) adjustments of income sources.

A similar argument is that individual investors can decrease the risk of their portfolio by investing in foreign securities, as these securities are likely to be affected by different factors than the domestic securities[55]. By decreasing the correlation between the revenue streams of their assets, portfolio managers can decrease the risk (measured as the standard deviation of the revenues) of their portfolios (Reilly and Brown, 2002). Further, by having a

[55] Practically, Donadelli and Paradiso (2014) show that investors diversified their position during the subprime crisis period by investing in emerging markets.

wider range of securities to invest in, investors have access to a wider range of (adjusted) risk-return allocations, and can increase their risk-adjusted profits. This point will be developed in detail in the end of this chapter.

Finally, financial openness is also claimed to enhance and stimulate macroeconomic discipline (Agénor, 2001), as investors are only willing to invest in countries they believe are sound. The opening of borders could similarly signal the willingness to engage in sound policies. This also favours the development of a supervisory authority to reassure foreign investors. Foreign flows are also argued to have beneficial effects on the efficiency and stability of the domestic financial system, by increasing its competition, breadth and depth, and consequently enhance the allocation of funds and lower the costs of it. It hence enhances the quality and availability of financial services. By increasing the arrays of investments (for instance by permitting Foreign Portfolio Investments), it also enables foreign investors to move funds abroad in case of trouble, rather than assets, which means that the flows would likewise be able to come back sooner after the crisis. Foreign investors are less susceptible to experience governmental pressures to influence their investments.

Financial integration, however, has some drawbacks. First and foremost, it can imply a loss of macroeconomic stability by favoring monetary expansion, inflationary pressures, real exchange rate appreciation and widening of current accounts deficits. The incoming flows can lead to a loss of competitiveness if, for instance, the currency appreciates too much. This will also decrease the level of investments and negatively affect the long-term growth of the country (Prasad & Rajan, 2008).

The country is also exposed to sudden-stops, a phenomenon appearing when investors abruptly decide to stop their investments in the country (Prasad & Rajan, 2008). Probably because of the lack of information on foreign countries, investors are observed to herd, increasing the risk of volatility, or worse, of sudden stops. The country similarly looses part of its influence on its own economy (Salvatore, 2013).

Quinn, Schindler and Toyoda (2011) emphasizes that the effects of financial integration depend on the development of the country. Financial integration is described as more beneficial for countries with low capital-to-labor ratio, although this effect is only temporary. With a simple model, Salvatore (2013) also distinguishes the internal redistributional effects of international flows, depending on the role of the country (receiving or sending) and the source of revenue (labor or capital).

Measures

One possible explanation for the lack of consensus on the effects of financial integration is the lack of common measure for the concept (Volosovych, 2011). Therefore, according to Billio (2017) "*There is no general consensus on how to properly measure financial integration*" (p. 153). Many studies were led on the subject, all of them with their own measure of integration.

In a review of the main indicators of financial integration, Quinn *et al.* (2011) distinguish between *de jure* (based on legal differences and capital mobility restrictions) and *de facto* (based on observed capital flows) indicators and explain that the level and the change of financial integration differ widely depending on the indicator used (different methods and dimensions) and the set of conditioning information selected. The diverse measures "*capture different phenomena*" (p. 504). They divide *de facto* flows in three subsets: quantity-based

measures, based on flows or stocks of assets; price-based indicators, based on prices and returns; and hybrid indicators, mixing both categories[56].

Adam *et al.* (2002) distinguish four main categories of measures for financial integration, in a trial to clarify the diversity of measures and their relative advantages:

i) measures of credit and bond market integration
ii) indicators of stock market integration
iii) indicators based on the decisions of households and firms
iv) indicators of institutional differences (which provide explanation for market segmentation)

They also distinguish price-based and quantity-based indicators. The authors further evaluate the indicators based on four criteria: i) the availability of data needed; ii) the reliability of data; iii) the economic meaning of the indicator; iv) their ease of construction and adaptation. They conclude that price-based indicators should be favored since reliable data are easier to find and their interpretation is clearer: they often rely on the Law of One Price[57].

De Nicolò and Juvenal (2010) also make this distinction but, in their view, financial integration implies a certain convergence towards the Law of One Price and should solely be measured by price-based indicators. Quantity-based measures rather measure what they call "*financial globalization*" (p. 4). The authors argue that both concepts are expected to have diverging effects and should hence be distinguished. However, the distinction is barely made in the literature: many authors (Quinn *et al.* (2011), Obstfeld and Taylor (2004), Blancheton (2008), Lane and Milesi-Feretti (2003) among others) use them interchangeably.

The figure below synthesizes the analysis of Adam *et al.* (2002). It shows part of the array of measures that can be used to determine the financial integration of two countries or regions. Other markets can also be studied: Baele *et al.* (2004) study alternately the money market, the government bond market, the corporate bond market, the bank credit market and the equity market. In the present study, integration is measured with the purpose of drawing conclusions for portfolio managers, and more precisely for their management of stocks. This work will therefore focus on the stock market-based indicators[58]. The other methods will consequently be presented succinctly.

[56] We will not develop this type of measure in the next sections. An example is seminal work of Feldstein and Horioka (1980), who assume that in more financially integrated markets should enable domestic savings and investments to be less correlated. Drehen (2006, cited in Quinn *et al.* (2011)) creates a measure which mixes quantity-based indicators with *de jure* indicators.

[57] "The Law of One Price states that if assets have identical risks and returns, then they should be priced identically regardless of where they are transacted" (Baele *et al.*, 2004, p. 7). If such is not the case, there exist arbitrage opportunities.

[58] There is a higher consensus in the literature covering the integration of European Bonds Markets, as we did not encounter any study denying the decreasing deviation of nominal (sovereign) yields. See, for instance, Baele *et al.* (2004).

<table>
<tr><th>The indicator measures the effect of financial integration on:</th><th>Price-based indicators</th><th>Quantity-based indicators</th></tr>
<tr><td rowspan="3">Credit and bond markets</td><td rowspan="2">Interest rate differentials in the money market, bond market, mortgage market, and corporate loan market</td><td>Importance of foreign banks (asset shares and number)</td></tr>
<tr><td>Foreign assets and liabilities held by national banking sectors</td></tr>
<tr><td>Cross-border banking fees</td><td>International Diversification of Bond and Money Market Funds</td></tr>
<tr><td>Stock markets</td><td>Correlation of national stock market returns</td><td>International Diversification of Equity Funds, Pension Funds, and Insurance Companies</td></tr>
<tr><td rowspan="2">Household decisions</td><td colspan="2">Saving-investment correlations</td></tr>
<tr><td colspan="2">Consumption correlation across countries</td></tr>
<tr><td>Corporate decisions</td><td colspan="2">Cross-border M&A activity</td></tr>
<tr><td>Legal Institutions</td><td colspan="2">Dispute Resolution Index, Dispute Duration Index</td></tr>
</table>

Figure 9: Typologies of financial integration measures (Adam *et al.*, 2002, p. 61)

De jure and quantity-based indictors

De jure indicators take an in-depth look at the legal framework surrounding international capital flows. For instance, the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) of the IMF (2016) *"provides a yearly description of the foreign exchange arrangements, exchange and trade systems, and capital controls of all IMF member countries"* (p. 1). More particularly, the report contains a table describing the openness of countries regarding different indicators (free float, availability of a capital market, etc.), which has been transformed by scholars in either binary (see Epstein and Shor, 1992, cited by Quinn *et al.*, 2011) or discrete variables (Brune & Guisinger, 2006, cited by Quinn *et al.*, 2011). Other measures, not based on AREAER, exist as well. For instance, Bekaert, Harvey, Lundblad and Siegel (2005, cited by Quinn *et al.*, 2011) suggest the creation of a binary variable that takes the value 1 after a country's equity market was liberalized and 0 otherwise.

We consider that these measures emphasize a necessary but not sufficient condition for financial integration. They highlight the possibility for residents of a country to invest in another country but do not say anything about the accomplished investments. As we previously saw, there seem to be more factors at hand for stockholders and bondholders to decide to invest in a country. Moreover, there are some possibilities to invest in a country although it is formally closed, for instance by under-invoicing (Prasad & Rajan, 2008; Kose *et al.*, 2009).

Quantity-based indicators hence focus on the amount of a country's money invested abroad. Although we join De Nicolò and Juvenal (2010) in thinking that quantity-based indicators measure financial globalization rather than financial integration, a large part of authors base their assessment of financial integration on such quantity-based measures. These authors define financial integration as the increase in reciprocal financial flows. While we should keep in mind that, based on the definition of integration as defined by the verification

of the Law of One Price, two countries can be perfectly integrated without any reciprocal financial transaction (Quinn *et al.*, 2011) or can have massive reciprocal flows without being integrated, this literature enables the understanding of the drivers of international assets allocations. Obstfeld and Taylor (2004) offer such an assessment for the period between 1860 and 2000 (see figure below), and show that the level of integration varied widely in this period. Other quantity-based indicators can be found in the figure above.

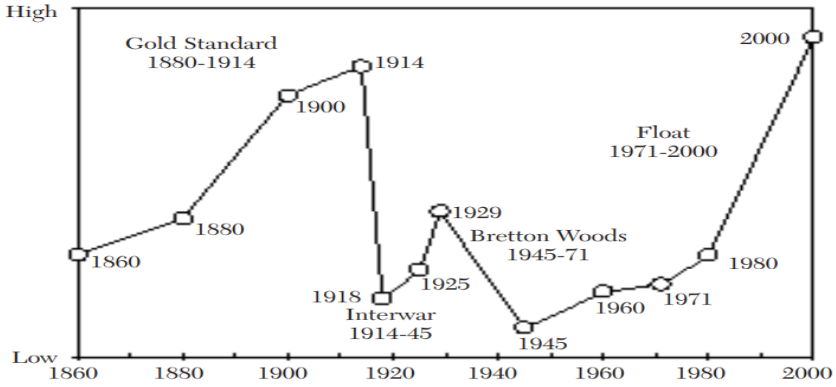


Figure 10: Obstfeld and Taylor's quantity-based international financial integration 1860-2000[59]

Price-based indicators

We will present price-based measures in more details, as we use that type of measures in this work. These indicators rely on the assessment of arbitrage opportunities.

A) Correlations

Adam *et al.* (2002) only present one price-based metric for this category: correlation of stock market returns. However, they recommend not to conclude on this measure as it is both unstable and hard to interpret (as it is based on ex-post returns rather than ex-ante returns, and hence subject to common shocks). For the stock markets assessment, the authors recommend to favor quantity-based measures as they are easier to compute and to update.

These authors are, however, far from being exhaustive. In a recent study, Billio *et al.* (2017) evaluate and rank eight existing dynamic measures based on equity prices convergence, ranging from simple correlations to DCC-GARCH, which enables to account for time varying volatility. In order to account for several flaws in the existing indicators (common shocks artificially increase the measured integration, presence of heteroscedasticity, etc.), they present three new measures of financial integration. They conclude that the simplest indicator, statistical correlation, provides results similar to more complex measures, both for capturing the dynamics of integration and for explaining *de facto* integration. For these authors, the integration pattern is well captured by studying the dynamic of unconditional correlation.

Forbes and Rigobon (2002) theoretically show the upwards bias of this measure in periods of high volatility. They prove that an increase in the American market volatility will lead to a mechanical increase in the correlation coefficient with the Mexican market, although the underlying relationship between the Mexican and the American stock returns remains the same. Simple correlation consequently increases when common volatility is high, as correlations are not robust to outliers (Volosovych, 2011). Pukthuanthong and Roll (2009) argue that this effect is not a problem if it reflects the true volatility of markets, as they will

[59] Source: Obstfeld and Taylor, 2004, p. 28.

tend to move together if they are affected by the same shock. However, if there are sampling errors, the estimated R-squared might differ from the real R-squared.

This measure has however been criticized by Pukthuanthong and Roll (2009). These authors prove that country stock-market indexes correlations can be low even when they are perfectly integrated, as, for instance, different countries may (and often will) have different weighting for each sector, which can react differently to a certain shock (e.g. an oil price shock). The authors also argue that simple correlations of indices should not be used as indicators of potential diversification benefits, as they do not reflect the whole array of risk-return present in the country.

Adjaouté and Danthine (2002) insist on the fact that change in sector composition could lead to changes in the correlation of the returns.

B) Principal Components Analysis

Focusing on a weaker notion than the Law of One Price, Volosovych (2011) developed the use of Principal Component Analysis (PCA) to evaluate the degree of integration of several markets, stating that integrated markets should see higher comovements in their returns. He argues that his method solves some of the flaws of correlations, as PCA is robust to outliers and conditional heteroskedasiticy.

Pukthuanthong and Roll (2009) showed the flaws of correlations and consequently turned to a linked measure: rather than looking at the correlation between countries' returns, they look at the (adjusted) R-squared of a regression of a country's returns on the main Principal Components of each index. Their logic is that if two countries are integrated, they should entirely and solely be driven by the same global factors, and not at all by country-specific factors, so the R-squared of the regression should be 1. By focusing on the R-squared, they do not focus on varying Betas[60] but rather on the variation they explain as a whole.

Donadelli and Paradiso (2014) also use PCA to evaluate the extent to which the first West-European PCA can explain the returns in three financially less-developed regions, at the national and sectoral levels.

However, as these authors only use one principal component, whose effects might differ across countries, their measure of integration could have the same flaws as simple correlation, as the principal component could explain nearly nothing of the variation and their equation would consequently be limited to a simple correlation (Pukthuanthong & Roll, 2009). Testing this hypothesis, Pukthuanthong and Roll (2009) conclude that "*a single global market factor such as the first principal component is not able to fully capture the extent of market integration*" (p. 230).

C) Variance ratios

These models evaluate the role of orthogonalised external shocks. They are based on the assumption that if a market is more integrated, its returns should move along with external markets. For instance, Yi and Tan (2009) use the framework developed by Akdogan (1996) to evaluate the integration of Singapore and Malaysia with the world and regional markets.

The variance of the model

$$R_{UK} = \alpha_{UK} + \beta_W * R_W + \beta_\theta * \theta_{EU} + \varepsilon_{UK} ,$$

[60] The authors even argue that the betas can even be of opposite sign, if one country is an oil exporter, and the other an importer.

which states that at each time t the returns of the United Kingdom (R_{UK}) is a function of the returns of the world (R_W)and the European Union returns orthogonal to the world returns (θ_{EU}), can be decomposed as

$$Var_{R(UK)} = \beta_W^2 * Var_{R(W)} + \beta_\theta^2 * Var_{\theta_{(EU)}} + 2 * \beta_W * \beta_\theta * Cov_{R(W);\theta_{(EU)}} + Var_{\varepsilon(i)},$$

Or, because R_W and θ_{EU} are orthogonal

$$Var_{R(UK)} = \beta_W^2 * Var_{R(W)} + \beta_\theta^2 * Var_{\theta_{(EU)}} + Var_{\varepsilon(i)}.$$

By dividing both sides of the equation by $Var_{R(UK)}$, we find

$$1 = \beta_W^2 * \frac{Var_{R(W)}}{Var_{R(UK)}} + \beta_\theta^2 * \frac{Var_{\theta_{(EU)}}}{Var_{R(UK)}} + \frac{Var_{\varepsilon(i)}}{Var_{R(UK)}}.$$

If we rename the variables, we get

$$1 = a + b + c$$

with

a= $\beta_W^2 * \frac{Var_{R(W)}}{Var_{R(UK)}}$, which is a multiple of the ratio between the world and country variances. This ratio should rise if the country is more integrated with the world market.

b= $\beta_\theta^2 * \frac{Var_{\theta_{(EU)}}}{Var_{R(UK)}}$, which is a multiple of the ratio between the regional European and country variances. This ratio should rise if the country is more integrated with the European market. It can therefore be seen as an indicator for European market integration.

c= $\frac{Var_{\varepsilon(i)}}{Var_{R(UK)}}$, which is the risk specific to the country. It is a measure of "*country's unsystematic risk*" (Birg and Lucey, 2006, p.397).

This measure is hence country-specific, as it enables measuring the integration of a country in an area. It also enables to test which of regional or world indices best explain country indices variation.

D) Other Models

Bekaert *et al.* (2013) argue that company valuations (or earning yields) should converge in integrated markets, as their expected growth opportunities as well as the discount rate should harmonize. Their measure therefore mixes economic (growth prospects) and financial (discount rate) integration.

Baele *et al.* (2004) evaluate the effect of the propagation of news on the unexpected return. Therefore, local news should have decreasing importance as integration increases, while global news should explain more of a well-diversified return of the portfolio. The authors show that, as time goes by, a larger proportion of local variance is explained by European or global shocks and conclude to higher integration.

Some authors assess the degree of financial integration using an asset pricing model (see for instance Guesmi, Teulon & Muzaffar, 2014). However, doing so, their results account for the evaluation of the integration as well as of their model (Baele *et al.*., 2004). Therefore, facing the same data, different models would likely return different levels of integration.

Levy Yeyati, Schmukler and Van Horen (2009) test the possibility for arbitrage by computing the price differential between a share quoted in its local market and its depositary

receipts[61] in another market[62]. Their measure, based on the price differentials of the same instrument on two different markets, enables to directly test the Law of One Price on two strictly identical assets, which is not the case of other measures as indices encompass assets with different liquidity and active in different sectors.

De Nicolò and Juvenal (2010) measure the evolution of financial integration by computing the dispersion of equity excess returns[63] across countries, a measure that should decrease as integration increases. They can thereafter calculate the integration of a single country in a subset of countries by computing the distance between its premia and the average premia of its area. This model also enables to test if there is a structural break after an event, by regressing the measure obtained on time and some chosen time-dummies.

There are many other measures. See Nardo, Ndacyayisenga, Papanagiotou, Rossi and Ossola (2016) for a literature review of the different models used to test the extent of financial integration in Europe.

The effect of the European Union on capital market integration

There have been numerous studies on the impact of joining the European Union on the stock market integration as well as on the dynamics of stock market integration in the European Union. Others have focused on the impact of the EMU, and compared it to that of the enlargement of the European Union.

Pukthuanthong and Roll (2009) analyze the stock market integration of 81 countries around the world between 1976 and 2003 using PCA and find that the European Community facilitated financial integration as these countries exhibit the largest increase in their measure of integration.

Baltzer, Cappiello, De Santis and Manganelli (2008) assess the integration of new member states countries after they join the European Union using two methods. They first use a Hodrick-Prescott filter on the time series of the returns and show that these returns converge. They also use an asymmetric GARCH method to calculate the time-varying variance ratio and show that the part of the variance explained by European shocks increases after the countries joined the EU.

Using a DCC-GARCH model, Büttner and Hayo (2011) estimate that joining the European Union has a positive effect on the stock market integration of new member states as the correlation of their returns with old member states increases. The effect is even higher if the country joins the euro area and when its relative and absolute listed market capitalization is larger.

Beckers, Connor and Curds (1996) found that the EU as a whole is more integrated than the rest of the world, as the world and country factors are becoming more important than

[61] These « are shares of non-US corporations traded in the US » (Levy Yeyati *et al.*, 2009, p. 436).

[62] However, the existence of such double-trading is *per se* a sign that markets are not perfectly integrated, as it is supposed that a single quotation limits the number of potential investors. Recently, Eurocommercial properties IPOed in Brussels while it was already traded in Amsterdam, in order to be more visible and directly available for Belgian investors. Source: Eurocommercial properties : https://www.eurocommercialproperties.com/download/index/YTo0OntzOjc6InJlZmVyZXIiO2I6MDtzOjI6ImlkIjtiOjA7czo0OiJ0eXBlIjtiOjA7czo0OiJmaWxlIjtzOjc4OiJodHRwczovL3d3dy5ldXJvY29tbWVyY2lhbHByb3BlcnRpZXMuY29tL2Fzc2V0cy91cGxvYWRzL2ZpbGVzL1BSMjAxODA2MjdVSy5wZGYiO30, last consulted on August 12th 2018.

[63] The authors' definition is based on ex-ante equity premia but, because of practical issues in assessing equity premia, they use ex-post equity excess returns, after assuming that their time-average is equal.

the country-specific factors. They also found that the EU had a clear trend towards integration, while the trend of the rest of the world is not significant.

Gjika and Horváth (2013) similarly showed that the correlation between old and new member states increases following their accession to the European Union. They further show that the correlation between new member states increased.

Christiansen and Ranaldo (2009) study the integration of new member states by analyzing the coexceedance[64] between old and new member states and show that new member states have increased their integration by joining the European Union, as their coexceedances increased. They have both increased their integration with old European Union members as well as with Euro-Area members. They also found that new member states are "*more exposed to adverse comovements, volatility as well as persistence after their adhesion*" (p.1056), signaling that financial integration with the European Union could be a risky process.

Bekaert *et al.*. (2013) prove that joining the European Union significantly reduces earning yield differentials with older member states, their measure of both financial and economic integration. They further found that the adoption of the Euro had no effect.

Applying beta and sigma convergence tests to study the return convergence of new member states, Dunis *et al.*. (2013) find that the process of financial integration accelerated after the countries joined the European Union. On the contrary, and similar to Bekaert at al. (2013, they do not find the same positive impact after the countries joined the EMU.

Fratzscher (2002) uses a GARCH(1,1) to document the dynamic correlation among European equity markets and finds that they have become highly integrated since 1996. Contrarily to Bekaert *et al.*. (2013) and Dunis *et al.*. (2013), they find that the EMU, which led to the elimination of exchange rate volatility and the convergence of monetary policy, explained a large part of the process of increased integration.

Using a DCC-MiDaS specification, Virk and Javed (2017) demonstrate that correlations between European countries (therefore also countries outside the EMU) increased following the introduction of the Euro, though the pattern was stronger in larger markets. In particular, they find that the introduction of the Euro also boosted the integration between the United Kingdom and European countries. The process of increased correlation continued in the following years, though there were periods of divergence in 2008 and 2010.

Using a modified version of Engle's (2002) DCC-GARCH model, Cappiello, Engle and Sheppard (2006) also show that the introduction of the Euro lead to higher dynamic correlations between the United Kingdom (which remained out of the EMU) and a set of EMU countries (France, Germany, Italy).

Using a Conditional Asset Pricing Model enabling the study of the time-varying degree of integration, Hardouvelis, Malliaropulos and Priestley (2006) find that the degree of integration in the European Union varied substantially through the period under study (1992-1998). However, the process leading to the EMU harmonized the markets, whose expected returns became increasingly determined by European Union-wide market risk and less by local risk. The stock markets consequently converged toward full integration in the second half of the 1990s. On the contrary, the United Kingdom market, which is not part of the EMU, showed no signs of increased integration with the European Union stock market following the

[64] The authors define coexceedance as « the joint occurrences of extreme returns in different countries" (Christiansen & Ranaldo, 2009, p.1049).

EMU process. Their results therefore contradicts those of Cappiello, Engle and Sheppard (2006) and Virk and Javed (2017).

Yang, Min and Li (2003) find that the introduction of the EMU did not affect the integration between the EMU countries and the United Kingdom. On the contrary, they find that the impact of the United Kingdom on the European stock markets is reduced after the introduction of the EMU.

The European Union helped to integrate the markets of its countries. It is largely unknown, however, if leaving the European Union will have reverse effects.

Portfolio management implications

According to Reilly and Brown (2002), there are three main reasons for investors to consider investing abroad. First, it broadens their investment opportunities and hence their risk-return choices. This result is similar to Levy and Sarnat (1970) who compare the diversification benefits of (hedged) portfolios with growing geographic diversification and show the "*continuous reduction of the portfolio variance (at all levels of return) as the opportunity set is broadened*" (p. 673). Second, the returns of some foreign equities have often exceeded that of US equities, even when adjusted for risk. Third, the low correlation between equities from different countries enables investors to diversify a bigger share of the risk. In the following lines, we will focus on the role of correlations.

The portfolio selection model built by Harry Markowitz and James Tobin made the case for asset diversification as a tool to diminish the risk of investments, measured by the standard deviation of securities' portfolio (daily) returns. As the standard deviation of a sum is lower than the sum of the standard deviations if the correlation between the assets is lower than 1, asset managers should seek assets with the lowest possible correlation, while also accounting for their returns. Doing so, they can decrease or annihilate idiosyncratic risk until a certain point.

The following figure shows how lower correlation can affect the risk of a 2-security portfolio. When assets X and Y are given different weights in the portfolio, the standard deviation of the portfolio is the weighted average of assets standard deviation if the correlation is 1 (case A), lower than this weighted average if the correlation is, for instance, 0.5 (case B) or 0 (case C), and can even be annihilated if the assets have a perfect negative correlation (case D).

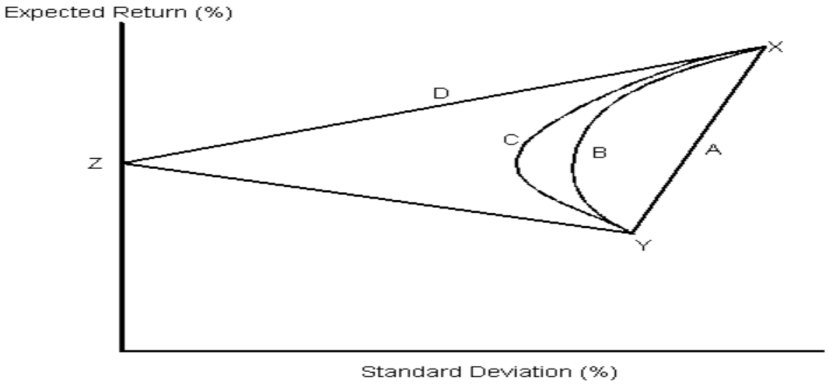


Figure 11: Risk-return relationship as a function of assets' correlation[65]

[65] Source : Own calculations

The risk of a portfolio can accordingly decrease until a certain level if a growing number of imperfectly correlated shares are incorporated, as can be seen in the figure below. Lessard (1973) and Reilly and Brown (2002) study the covariance of US and international stocks and call for international diversification. Solnik (1995) evaluated that an internationally well-diversified portfolio can be half as risky as an American only well-diversified portfolio. Instead of increasing the size of a portfolio to further reduce the risk, the author argues that international diversification is useful as "*a substantial reduction can still be achieved for an international portfolio of the same size*" (Solnik, 1995, p. 91).

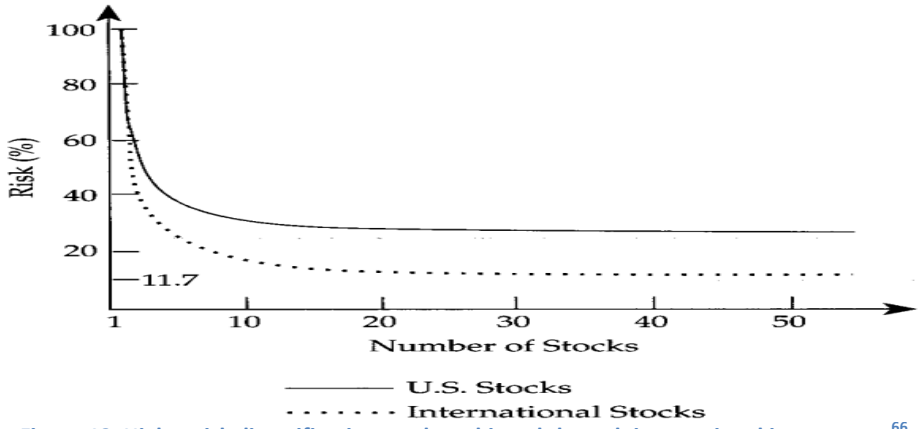


Figure 12: Higher risk diversification can be achieved through international investments[66]

Levy and Sarnat (1970) argue that "*The addition of even relatively low return foreign stocks might materially reduce the variance of the overall portfolio*" (p. 670). Securities of the same country are likely to be influenced by the same factors (e.g. GDP growth or monetary policy) (Sharpe, 1972) and therefore affected by the same shocks. Domestic diversification should therefore be weaker than international diversification, as different countries are subject to different macroeconomic factors. International diversification accordingly enables to possess assets driven by different (national) factors, which exhibit lower correlations, and hence diminish the risk of the portfolio.

Foreign assets therefore have "*stabilizing portfolio effects*" (Levy & Sarnat, 1970, p. 674) as they can reduce the overall variance of the portfolio. By diversifying internationally, an investor can move the attainable efficiency frontier to the left.

Focusing on the Euro Area, Beine, Cosma and Vermeulen (2010) explain that financial integration has both a bright and a dark side for investors. The bright side is that it enlarges the opportunities to invest. The dark side is that integrated stock markets tend to have increased comovements during crashes so that diversification is less effective in a period when it is most needed[67]. Integration therefore seems to have two linked effects: it first increases the pool of assets and hence the opportunities to diversify, but as time goes by, these assets are increasingly responsive to the same shocks and there are fewer benefits from diversification (Büttner & Hayo, 2011; Adjaouté and Danthine, 2002).

Longin and Solnik (1995) show that the correlation between equity markets increases between 1960 and 1990. Quinn and Voth (2008) also report increased in stock return correlations between 1893 and 2005. Beine *et al.*. (2010) also show that the introduction of

[66] Source: Solnik, 1995, p. 92.
[67] However, Vermeulen (2013) shows that there is still room for effective diversification during the crisis as all markets are not equally impacted by the subprime crisis.

the Euro Area has increased the comovements of returns and accordingly reduced the benefits of portfolio diversification.

Coeurdacier and Guibaud (2011) explain how perfect integration should lead to a higher correlation between stock prices, as a positive shock in the local asset (implying an increase in price as well as in volatility) should motivate portfolio managers to rebalance their portfolio towards the foreign asset which remained unaffected by the shock (and whose volatility did consequently not increase), driving up its price. This simple model, with two countries and two assets, shows how equity market integration implies increased comovements in asset prices. Portfolio investors should consequently increasingly turn to developing markets (Goetzmann, Li & Rouwenhorst, 2005).

Studying portfolios positions during the global financial crisis, Vermeulen (2013) shows that, despite increasing correlation in stock returns, equity holders reaped benefits from internationally diversifying their portfolios in less correlated markets. In his study, the author mobilizes the I-CAPM framework, suggesting that the optimal portfolio is composed of assets for a value equal to the relative value of the foreign market. In practice, home bias prevents investors to hold enough foreign assets. Studying the financial crisis, he witnesses a portfolio reallocation towards assets of less correlated markets.

Dvořák and Podpiera (2006) argue that the beta of a firm operating in a financially integrated market should be calculated using the world market rather than the local market, as the firms operate on the world market.

Baca, Garbe and Weiss (2000) confirm the growing importance of sector effects over country effects in determining equity returns, a finding that goes in line with further integration. Adjaouté and Danthine (2003) evaluate the respective cross-sectional dispersion of country and sector returns, a measure that is negatively related to the correlation. They find that the potential for industry diversification has increased in the late-1990s, exceeding the potential for country diversification. These results support increased integration, as countries are seen as becoming more uniform than sectors. Other studies support this result (Bley, 2009; Baele et al., 2004) and should lead investors to see industry diversification as more important than country diversification.

Eun and Lee (2010) emphasize that most of the literature focuses on the correlation between markets but does not examine the risk-return evolution, which is a distinctive phenomenon. They studied 17 developed markets and found that both their mean and variance converged during the period 1974-2007. The Euclidian distance of their risk-return also decreased. They also show that these convergences, associated with increased market integration, decrease the efficiency of international portfolio diversification.

Conclusion

There are many different existing definitions of financial integration, each of them necessitating a different measure. We should also stress the fact that many authors, while referring to financial integration, rather study financial openness (De Nicolò & Juvenal, 2010). This could explain the lack of agreement on the effects of financial integration.

It is clear, however, that financial integration has several benefits. In particular, regarding the equity market, it should enable to decrease the cost of capital, as some country-specific risk is eliminated and in turn increase the set of productive investments and favor growth. Households should be able to better diversify the risks and to smooth their

consumption following macroeconomic shocks. International financing would enlarge the pool of funds available for companies.

In this thesis, we adopt the view of a portfolio manager, whom correlations remain a widely used measure, as we showed that, all else equal, lower correlations could decrease the total risk of a portfolio. We focus on price-based measures. Inside the category of price-based indicators, there are different measures. It was shown that measures based on correlations are biased during crises and far from a perfect measure of market integration as they could change because of alterations in the composition of sectors (though this should be less of a problem in a short-term sample such as ours). Subsequently, two measures will be taken into account in the following chapters: simple unconditional correlations, because of their simplicity and their extensive usage; (dynamic) conditional correlations by applying the DCC-GARCH model, as it is widely used in the literature, particularly for the study of shocks.

The effect of Brexit on financial integration: hypotheses

In the empirical part of this thesis, different hypotheses directly resulting from the theoretical part will be tested.

First hypothesis: Brexit has a negative impact on the financial integration of the European Union and the United Kingdom at a 'country' level

We saw in the first part of this work that market reacted heavily to the referendum-shock, affecting the FTSE as well as foreign markets. This shows that markets are at least partly integrated, as foreign markets reacted to news from the United Kingdom. However, to the best of our knowledge, no empirical studies have been conducted so far on the change of integration that Brexit triggered. We believe that the results of the Brexit referendum have negatively affected the integration of the United Kingdom and European Union stock markets. We believe that the correlation of the returns of both markets has decreased, leaving more diversification benefits for portfolio managers, *ceteris paribus*.

Second hypothesis: The impact of the referendum on the financial integration differs among sectors

Event studies show that sectors have not reacted in the same way as the country index but have been affected in different fashions following the vote. Focusing on the exports and imports, we also showed that these sectors have different dependencies towards the European Union. Some, such as the financial sector, are heavily dependent on the European Union, while others, such as construction, rather depend on internal factors. Their assessed level of integration could accordingly exhibit heterogeneities.

Third hypothesis: The impact of the referendum on the financial integration differed depending on the internationalization of the firms

Following Oehler *et al.* (2017), it was decided to evaluate the impact of firm internationalization on the change of integration. The starting point will be the statement that companies generating more money out of the United Kingdom (our proxy for the level of internationalization of a firm) have been less affected by the referendum than companies generating a greater share of their turnover in the United Kingdom. This can be due to the fact that more internationalized companies show some diversification in their revenues streams and higher possibilities to reorganize their value chains.

Data, methodology and limitations

Data

The composition and descriptive statistics of our indices are available in the appendix.

Portfolios creation

Following our hypotheses, we needed to have indicators for two geographies: the United Kingdom and the European Union without the United Kingdom (European Union27).

We also paid attention to the currencies. The literature is divided on whether to calculate the returns in local or common currencies. The latter argue that using a common currency enables to adopt the perspective of an international investor (Donadelli & Paradiso, 2014). However, exchange rates fluctuations can (dramatically) increase or decrease the Euro or Dollars returns of the foreign securities, and bias our estimation of integration upwards or downwards. We saw previously that the Pound depreciated a lot following the announcement of the results. We therefore follow Beine *et al.* (2010) and Longin and Solnik (1995), among others, and decide to use data in local currency while emphasizing that investors could, in practice, hedge this risk by using currency derivatives.

If there are different indicators of United Kingdom in local currencies, Bloomberg only offers European Union27 portfolios in dollars, while S&P provides such an European Union27 portfolio but has strict restriction for the inclusion of equities, which prevents some countries to enter the portfolio. We could not find any pan-European local currency indicator. We consequently decided to create our own European portfolio.

European portfolio

As explained above, we did not need to create a United Kingdom portfolio as they already existed. We retrieved FTSE 100, FTSE 250 and FTSE 350 from S&P Capital IQ.

To create our pan-European local currency indicator, we took all the equities listed on the main index of each country (a list of the pair country-index can be found in the appendix 2). For each of these companies, we retrieved the dividend-adjusted share price (in local currency) as well as the company valuation (in dollars, as we needed a common currency for comparison purposes) from S&P Capital IQ for each business day between January 2nd 2012 and July 9th 2018. We were able to compute log-returns for each company and also had daily dollar market capitalization for each company.

In order to create a portfolio, we multiplied each log-return by the relative dollar valuation of the company in the index. At each time t, we calculated:

$$r_{Pf} = \sum_{i=1}^{n} \left(r_i * \frac{Market\ Capitalization_i}{Market\ Capitalization_{Pf}} \right),$$

where r_{Pf} is the return of the European portfolio; r_i is the log-return of company i; $\frac{Market\ Capitalization_i}{Market\ Capitalization_{Pf}}$ is the relative market capitalization of company i in the European portfolio, the weight we applied on the log-returns.

We consequently did not use country-weighting in this exercise and considered all companies as European. The drawback to this is that certain countries struggle to have reliable companies on the exchange while others, like France and Germany, also have smaller indices (CAC Mid and Small or SDAX, for instance), where some companies are worth more than those in the main index of some countries.

We needed to further treat our data to avoid false zero returns. For instance, May 1st is closed in Europe but not in the United Kingdom. The value of the indices is therefore the same for April 30th and May 1st in the European Union, leading systematically to artificial "zero" returns on May 1st. As the probability to have exactly zero return in a trading day for all equities is quasi-zero (Pukthuanthong & Roll, 2009), in order to avoid returns determined by a convention and not by the market and in order to have the same time unit between returns, we decided to mark leave a blank for the 1st May returns in the European Union. Only the dates on which all markets were simultaneously closed (e.g. weekends, December 25th or January 1st) were deleted from our sample.

We could hence create a European portfolio by summing the dollar-value of each company, and leaving a blank for the disruptions (e.g. introduction of a new company in the index).

Sectoral portfolios

The procedure to create sectoral portfolios is largely the same. We needed to create sectoral portfolios for the United Kingdom and the European Union.

We relied on the level 1 classification of S&P's Global Industry Classification Standard (GICS) methodology, provided by Capital IQ, which assigns a sector to a company on the basis of its principal activity in terms of revenues, earnings and market perception[68]. Determining a single sector might sometimes be a problem for our analysis, as some companies are more diversified and could consequently be affected differently by a shock than other companies in the same sector.

Once again, we computed the value-weighted returns of the indices following the same method.

Inward- vs. Outward-looking portfolios

In order to compare the effect of Brexit depending on the focus of the company, we created two portfolios: one for the companies whose revenue stream depends the most on foreign sales and one for companies whose revenues are mostly composed of their United Kingdom sales. We retrieve the information on the geographic segment from Capital IQ.

We decided to focus only on United Kingdom based-companies listed on the FTSE 100 and FTSE 250 and consequently deleted foreign-based companies. We also deleted companies for which we did not have enough information. In order to avoid companies which we believed made transfer pricing (e.g. Domino's pizza generate 84% of its revenues in United Kingdom and Ireland), we deleted companies that did not distinguish United Kingdom and Ireland for the creation of revenues.

We decided to use the 1st and 3rd quartiles as reference: in extent, companies generating less than 14.11% of their sales in the United Kingdom were compiled in a foreign-focused index, while companies generating 100% of their sales in the United Kingdom were compiled in another, United Kingdom-focuses index.

Methodology

In order to answer each research question, we will apply several methods, which we will now develop. The different methods we used are similar to those of Evans and McMillan

[68] For more information on the method for assigning a sector, see Standard and Poor's (2006).

(2009). They use successively simple period correlations, rolling window correlations and GARCH. All our computations are made using Stata, an econometric software.

Augmented Dickey-Fuller test of stationarity

Stock prices are expected to be non-stationary, as one of the conditions for weak stationarity, constant mean, is unlikely to be met. Therefore, we decided to work with log-returns, which have several advantages that we already mentioned. In order to avoid any spurious regression due to the possible non-stationarity of our data (trend, random walk with or without drift), we perform the Augmented Dickey-Fuller test. This enables to test the stationarity of a time series. The null hypothesis of the ***dfuller*** test in Stata is that the series contains a unit root and is non-stationary. If we reject the null hypothesis (at a confidence level of 95% equivalent to a p-value of 0.05), we are confident that the data we use are stationary. We therefore perform the test, and observe that all our series are stationary, as all p-values were 0.0000, well below 5%. We hence reject H_0 and consider the data are stationary (they are integrated with order zero: I(0)).

Simple rolling-window unconditional correlations

As a first estimate, we decided to compare the correlation before the referendum with the correlation after the results were announced. However, in order to have a dynamic measure of correlations, we also applied simple rolling-window correlations. We computed the traditional measure of time-series correlation using a rolling window of 120 days (around 6 months). However, Solnik and Roulet (2000) criticize the use of rolling windows for the analysis of correlation, as long term trends take time to appear and short term changes are hardly noticed because equally weighting the data implies that each innovation only represents a small part of the sample. Though, we decided to apply it as it is widely used in the literature (see Engle, 2002), easy to compute and it could carry some information. However, due to its many drawbacks, we consider it as a less interesting indicator than the dynamic conditional correlation.

DCC-GARCH

Our return variables are likely to be heteroskedastic. In particular, we observed a cluster of increased volatility around the referendum date.

We suspected heteroskedasticity in the simple regression

$$r_{UK,t} = \alpha_0 + \sum_{i=1}^{5} \alpha_i * r_{UK,t-i} + \sum_{j=1}^{5} \beta_j * r_{EU,t-j} + u_t.$$

If such is the case, we need to specify it in our model, either by adapting it (using heteroskedasticity robust standard errors in the case of an OLS) or by using a model which accounts for heteroskedasticity (sur as the family of ARCH models). To know if there is heteroskedasticity, the table below gives the p-values of the White tests for the country and sector regressions. The White test is a more general heteroscedasticity test that the simple Breusch-Pagan test, as White test checks for the presence of unrestricted forms of heteroscedasticity (Wooldridge, 2016). Its null hypothesis is that data are homoskedastic. We use the usual threshold of 5% to reject the null hypothesis.

Index	p-value	Conclusion
Countries	0.0000	Heteroskedasticity
Consumer discretionary	0.0000	Heteroskedasticity
Consumer staples	0.0000	Heteroskedasticity
Energy	0.0000	Heteroskedasticity
Real Estate	0.0000	Heteroskedasticity
Financials	0.0000	Heteroskedasticity
Health Care	0.0000	Heteroskedasticity
Industrials	0.0000	Heteroskedasticity
Information Technologies	0.0000	Heteroskedasticity
Materials	0.0000	Heteroskedasticity
Telecommunication Services	0.0001	Heteroskedasticity
Utilities	0.0000	Heteroskedasticity

Figure 13: Stata's p-values from simple regressions and test for Homoskedasticity

Based on this test, we are confident that there is heteroskedasticity. As this study focuses on the correlation between the returns in the European Union and the United Kingdom, we decided to use a DCC GARCH model. This model belongs to the family of (G)ARCH models, which account for the changing variance in the data. These models have 2 main advantages over OLS regressions with heteroscedasticity-robust standard errors: their estimators are asymptotically more efficient than those of OLS; ARCH models enable the study of the dynamics of the conditional variance (Wooldridge, 2016). The next lines will describe the inception of the ARCH model, its generalization into GARCH model and its adaptation to the study of dynamic conditional correlations, leading to the DCC GARCH model.

In a study on inflation rates, Engel (1982) developed a framework for the analysis of variables exhibiting heteroscedasticity, based on the fact that some variables have successive clusters of high and low variance. This model is called AutoRegressive Conditional Heteroskedasticity of order q (ARCH(q)), as the variance equation incorporates the lagged values of the residuals. It is composed of two main equations (the mean and variance equations) and can, following Brooks (2008), be described as:

$$y_t = \mu + \varepsilon_t,$$

$$\varepsilon_t = \sigma_t * v_t,$$

$$\sigma_t^2 = w + \sum_{i=1}^{q}(\alpha_i * \varepsilon_{t-i}^2),$$

where y_t, the return at time t is estimated as the sum of a constant mean μ and residual ε_t. These residuals are characterized as the product of the returns' time-varying standard error σ_t and an i.i.d. white noise (v_t) with 0 mean and variance equal to 1. The variance of the residuals is described as the sum of a constant w and the lagged values of the squared residuals, with w≥0 and α_i≥0 to avoid a negative variance.

Bollerslev (1986) modified the framework by adding the lags of the variance in the variance equation. For example, a GARCH(q,p) can be written as :

$$y_t - \mu = \varepsilon_t = \sigma_t * v_t$$

$$\sigma_t^2 = w + \sum_{i=1}^{q}(\alpha_i * \varepsilon_{t-i}^2) + \sum_{j=1}^{p}(\beta_j * \sigma_{t-i}^2),$$

with w≥0, $\alpha_i \geq 0$ ∀i and $\beta_j \geq 0$ $\forall j$, so that conditional variance remains positive.

There are many alternative specification based on GARCH model. The focus of this study being to look at the correlations between markets, we decided to use Engle's (2002) Dynamic Conditional Correlation-Generalized AutoRegressive Conditional Heteroscedasticity model (DCC-GARCH). It has been developed by Engle and Sheppard (2001). This model works in two steps: it estimates a GARCH model on the assets by maximum likelihood estimation and then uses these results to estimate the dynamic conditional correlations. The estimated conditional correlations are "*based on information known the previous period*" (Engle, 2002, p.340). The equations of this model rely on two main elements (Cappiello, Engle & Sheppard, 2006).

First, the conditional returns are expected to be normal with mean zero and covariance matrix H:

$$r_t | I_{t-1} \sim N(0, H_t)$$

where I_{t-1} is the Information set at time t-1.

Second, the decomposition of H_t yields:

$$H_t = D_t R_t \, D_t$$

with R_t the time-dependent (un)varying correlation matrix and D_t which stems from a GARCH model and is the k × k diagonal matrix of time-varying standard deviations. The element on the i[th] diagonal is $\sqrt{h_{i,t}}$.

Using this model, the estimation of the conditional covariance matrix is made in two stages: the first stage estimates of $h_{i,t}$ by fitting univariate volatility models; the second stage consists in estimating the conditional correlation using the standard deviations estimated at the first stage to generate standardized residuals (Sriananthakumar & Narayan, 2015).

In our application, we decided not to follow the vast majority of authors (see for instance Kearney & Potì, 2006) who regress the returns on no exogenous variables, nor Baltzer *et al.* (2008) or Syllignakis and Kouretas (2011), who regress the returns on their one period lag while Fratzscher (2002) also add the current returns of the market under comparison. Rather, our mean equation defines the returns in the United Kingdom and the European Union as a function of the five-period lagged values of both areas returns:

$$r_{UK,t} = \alpha_0 + \sum_{i=1}^{5} \alpha_i * r_{UK,t-i} + \sum_{j=1}^{5} \beta_j * r_{EU,t-j} + u_t$$

$$r_{EU,t} = \gamma_0 + \sum_{i=1}^{5} \gamma_i * r_{UK,t-i} + \sum_{j=1}^{5} \delta_j * r_{EU,t-j} + v_t,$$

Our robustness checks will highlight how our results differ if we use a simple mean equation composed of a constant and an error term.

We decided to test for the presence of an ARCH(1) using Stata's ***estat archlm*** command. This test relies on Engle's Lagrange Multiplier test. The null hypothesis is that there is no autoregressive conditional heteroskedasticity. The p-values and interpretation of each test are given in the next table:

Index	p-value	Presence of ARCH(1)?
Countries	0.0000	Yes
Consumer discretionary	0.0000	Yes
Consumer staples	0.0000	Yes
Energy	0.0000	Yes
Real Estate	0.0000	Yes
Financials	0.0000	Yes
Health Care	0.4148	No
Industrials	0.0000	Yes
Information Technologies	0.0000	Yes
Materials	0.0421	Yes
Telecommunication Services	0.0030	Yes
Utilities	0.0000	Yes

Figure 14: Stata's p-values of Engle's test for the presence of ARCH(1) in our mean equation

We can see that ARCH effects can be expected for all sectors, except the Health Care sector. Nevertheless, we decided to treat this sector the same way we treated the others. We decided to apply the DCC MGARCH(1,1) process to the conditional covariance of the error terms, as GARCH(1,1) are "*typically*" (Bollerslev, Chou & Kroner, 1992, p. 22) adopted in finance and perform well for modelling the conditional variance of daily returns (Herwartz, 2017).

Once we fit the model, Stata will give us some outputs: the estimation of the coefficients in the mean and variance equation, for instance. It will also give us estimates of lambdas, which are the adjustment coefficients estimating the dynamic of the conditional variance. We then test for the significance of both lambdas in order to test for the presence of a dynamic pattern in the conditional correlations. The null hypothesis is that the conditional correlations are time-invariant, while the alternative is that these conditional correlations are time-varying. When both lambdas are not significant, the process reduces to a Constant Conditional Correlation GARCH, and there is no dynamics in the conditional correlations.

Stata also gives estimates for the conditional covariance and conditional variances. We have to compute the correlation manually, using the well-known formula:

$$correlation\ (a,b) = \frac{covariance\ (a,b)}{\sqrt{variance\ (a) * variance(b)}}$$

We get an estimation of time-variant correlation between the European Union and the United Kingdom. The time series obtained vary constantly. All first correlations are very low (below 0.4), for all time-series, so we decided to clean the data and remove these outliers (we deleted the first 50 estimates in order to generalize the process), as they could affect our analysis.

We then estimate a dynamic Markov-Switching Model, with abrupt changes between states. This enables us to differentiate between several regimes. This tool enables to endogenously determine the transition between the states based on the time series of our correlation, contrarily to binary variables which are often imposed arbitrarily and ex-ante. To keep things simple, we only estimated two regimes, based on the mean correlations: high and low. This will give us the probability of being either in state 1 (high correlations) or in state 2 (low correlations). The outliers we deleted in the former step could have influenced the determination of the States of the MSM.

A screenshot of our **dofile**, containing the code we implemented to apply the DCC-GARCH model in Stata is available on request.

The following table summarizes the steps we implemented in our analysis as well as the aim of each process:

	#	Step	Objective
Preparation	1	Creation of market valuation-weighted portfolios	Have a European Union27 indicator, sector indicators and United Kingdom inward versus outward indicators. All indicators are in local currency, and their market value is in US Dollars.
	2	Computation of returns	Compare the returns in the European Union27 and the United Kingdom
	3	ADF test	Test for the stationarity of the time series
Analysis	4	Pre and post referendum correlation	See if the correlations changed in the period post-referendum compared to the period pre-referendum
	5	Simple rolling-window unconditional correlations	See how the correlations changed through time, but with major drawbacks
	6	DCC-GARCH	Account for the heteroskedasticity in the error terms and Study the behavior of the conditional correlations of the United Kingdom and European Union returns.

Figure 15: Main steps in our methodology

Limitations

There are several limitations to this work.

First and foremost, the literature was unable to distinguish a unique measure for financial integration. Many authors relied on different indicators, with different aims. Furthermore, we could not find any peer-reviewed text treating our question research, be it with another method. While this means that our work contributes to the literature, this also leads to a lack of comparability of our results.

Second, while we used valuation weights for our returns, we did not use country weights. As always, different indicators would have led to different results and effects. However, the robustness checks we applied give us more certainty that our results hold when we use a different sample, composed of different companies and built differently. We should stress that different portfolios could give different results. If we had focused on a broader or smaller range of companies, our analysis could have changed. This can be seen in the Inward vs. Outward United Kingdom portfolios: we created two subsets in the single United Kingdom350 portfolio. If the results are different in these two subsets, we can infer that the chosen portfolio has some importance in the results.

Third, even with the same portfolio, we could have used dollar returns. This would have incorporated currency risk in our analysis: *ceteris paribus,* fluctuations of the local currency's exchange rate *vis à vis* the dollar would have created fluctuations in the returns of local equities. In order to answer this limitation, we will apply our DCC GARCH model to dollar denominated portfolios.

Robustness checks

The results of this work could depend heavily on the method used. We therefore decided to check the robustness of our results by modifying alternately the mean and the variance equation.

Results also are likely to heavily depend on the sample used. Hence, we decided to check the robustness of our results by applying our methodology on two other sets of data for each 'country': we used S&P Europe Ex-UK Broad Market Index and S&P United Kingdom Broad Market Index, both at the country and sector levels. These indices where either both labelled in local currencies or in US Dollars.

The mean equation

For our first robustness check, we changed the mean equation. In our baseline case, we decided not to follow the crowd, and rather to use a mean including the first five lags of each variable in the mean equations. To test the robustness of our results, we decided to test if our results would be affected by a different and more common specification, leaving the rest of the procedure unchanged: we hence estimated the correlations with a DCC-GARCH (1,1) model. In extent, instead of writing them as

$$r_{UK,t} = \alpha_0 + \sum_{i=1}^{5} \alpha_i * r_{UK,t-i} + \sum_{j=1}^{5} \beta_j * r_{EU,t-j} + u_t$$

$$r_{EU,t} = \gamma_0 + \sum_{i=1}^{5} \gamma_i * r_{UK,t-i} + \sum_{j=1}^{5} \delta_j * r_{EU,t-j} + v_t,$$

we decided to include no variable. The mean equations are consequently seen as a constant and an error term:

$$r_{UK,t} = \alpha_0 + u_t$$

$$r_{EU,t} = \beta_0 + \varepsilon_t \ .$$

Thus, all the effect that we captured in the slope of the mean equations are now rejected in the error terms. This could have an effect on the estimate of the error term and affect the way the GARCH model works.

Unfortunately, Stata was not able to give estimates for the Financials and the Real Estate Sectors using these mean equations, so we could not have 14 correlations (1 for the country index, 11 for the sector indices and 2 for the 'focus' indices) but only 12 correlations that were compared to our first estimates. The results are displayed in the Robustness Check sections of the assessment of each hypothesis, while the time-series graph of the difference between the series is available upon request.

The variance equation

Second, we could also have specified the variance equation differently. In the baseline case, we followed the crowd and applied a GARCH (1,1) model. But we could also have used different orders of lags. Three alternative models are estimated: GARCH (1,2), GARCH (2,1) or GARCH (2,2). We will check if our results change dramatically by marginally changing the lag structure of our variance term. The graphs are available in each section, while the time-series graph of the difference between the series is available upon request.

Unfortunately, Stata was unable to achieve estimates for some models: it could not find an equilibrium for the GARCH(1,2) of the materials sector; the GARCH(1,2) of the utilities sector; the GARCH(2,1) and GARCH(1,2) of the financial sector; none of the alternative GARCH for the Real Estate sector.

Alternative dataset

Third, the results of this work are dependent on the dataset used. So far, we have used a self-made value-weighted home-currency European portfolio. In order to focus on real-life

indices, we decided to use S&P indices. The two indices encompass different companies, and could therefore lead to different results.

To perform this test, we rely on Standard and Poor's (S&P) "Europe Ex-UK Broad Market Indices" available at the European as well as sectoral level. For the United Kingdom, we relied on S&P's "United Kingdom Broad Market Index", also at the country and sectoral level. These indices are computed by weighting the return of a company by its market capitalization[69]. Once again, we took the Total Gross Return indices in local currency.

Unfortunately, S&P only computes its Real Estate indices since September 2016, so we will not be able to test the robustness of our results on the full sample size. Also, we should stress that we only apply the DCC-GARCH method as we believe it is the best indicator we developed.

Internationalization

In order to have alternative indices for the United Kingdom- or Foreign-centred companies, we decided to use S&P Small Cap BMI and S&P MidLarge Cap BMI, for both the European Union and the United Kingdom. We should stress that these are only proxies. However, based on the composition of our UK-centred and Foreign-centred indices and to the mean market cap of each, we believe that larger companies are more likely to be internationalized than smaller firms.

[69] For more information on the methodology, see: S&P Dow Jones Indices: https://eu.spindices.com/documents/methodologies/methodology-sp-global-bmi-sp-ifci-indices.pdf?force_download=true , last consulted on August 12th 2018.

Assessment of the first hypothesis

We will now turn to the empirical assessment of our hypotheses. We will first assess our first hypothesis that the referendum led to a statistically significant decrease of the level of financial integration between the United Kingdom and the European Union.

Unconditional correlations

The unconditional correlations for the country indices fell from 0.877 before the vote to 0.815 after it. Therefore, there seems to have been a decrease in the level of correlation, but this says nothing of the dynamics of the correlation, and the result date has been chosen subjectively. A second, more dynamic, option is to look at the six-month rolling-window correlation. It is represented in the figure below. The split into FTSE 100 and FTSE 250 can be found in appendix 3.

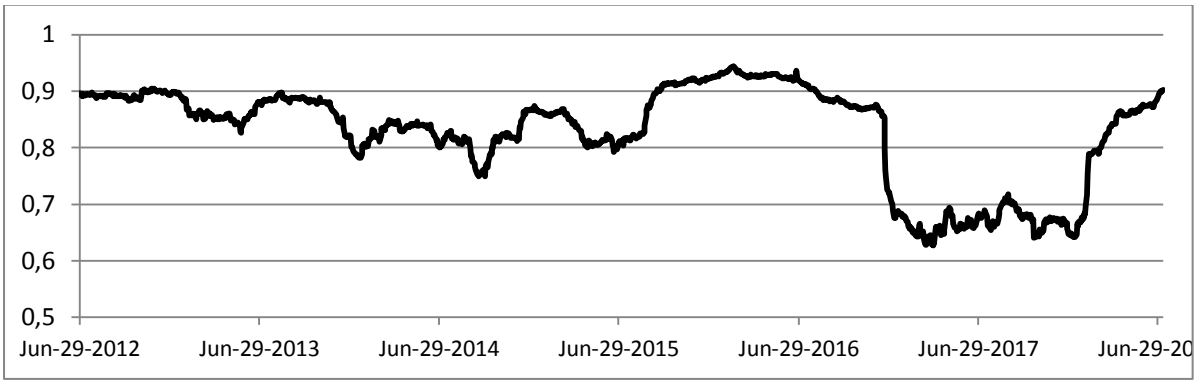


Figure 16: Countries: 6-month rolling-window correlations. Source: own calculations.

As we can see on this graph, the correlation is high and between 0.8 and 0.9 for the pre-Brexit period. It then rose to above 0.9 just before the vote. Following the results, it fell with a shock on the December 21st [70], to a low of around 0.628 on March 29th 2017. The decrease in correlation is temporary: correlation exceeds 0.8 since March 5th 2018 and grows back to its pre-referendum level. We can see that the last data points are between 0.8 and 0.9, as were the first. Because of the flaws of this form of correlations (the marginal effect of an additional point is hardly measured), we now turn to the assessment of the Dynamic Conditional Correlations.

Dynamic conditional correlations

In a third step, we applied a DCC-GARCH to our country data. Screenshots from Stata's regression output can be found in Appendix 3. All our GARCH coefficients (respectively ARCH(1) and GARCH(1)) are significant with p-values of 0.0000, so Stata has clear proofs of GARCH-type series in the countries returns between the European Union and the United Kingdom. We should also stress that our test for the joint-significance of lambdas has a chi-squared value of 2248.61 and a p-value of 0.0000, so we are confident that our correlation are not constant over the period. The daily evolution of Dynamic Conditional Correlations is given in the figure below:

[70] Because of the rolling window method, we should stress that this point estimate encompasses data between 24th June 2016 and December 21st 2016. It is therefore the first estimate composed exclusively of post referendum returns.

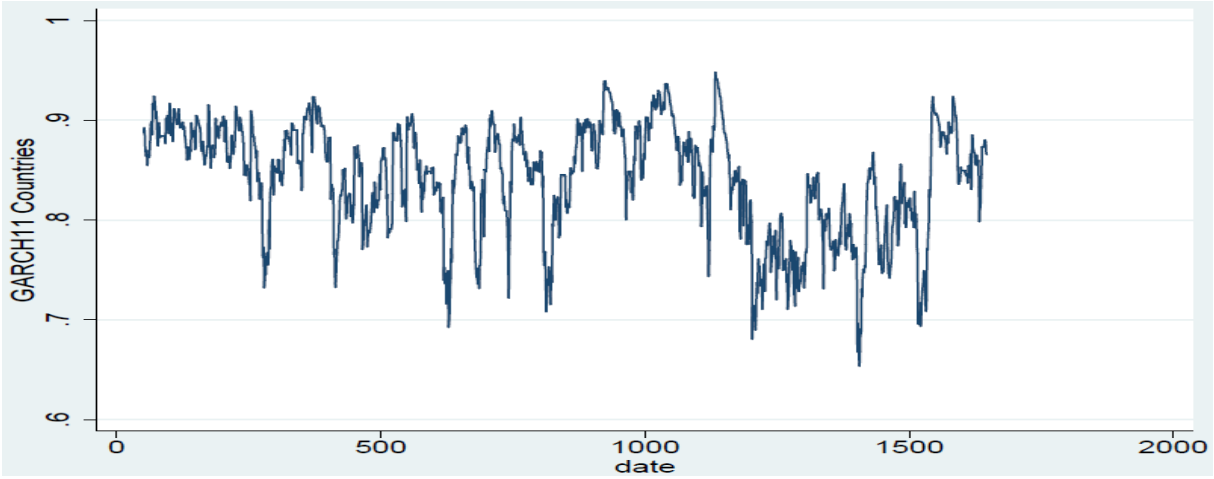


Figure 17: States' Dynamic Conditional Correlations. Source: own calculations.

It obviously varies much more than the 6-month rolling-window unconditional correlations we saw in the previous section. We can see that there seems to be three periods: one before 20th September 2016 (point estimate 1214) where the correlation is high at around 0.85 but has some short-run falls. It then constantly falls between 20th September 2016 (point 1214) and 6th February 2018 (point 1568) to a mean of below 0.8. In the end of the sample, it increases back to its old mean of around 0.85.

In order to get more certainty on the existence of these two states, we decided to apply a two-state Markov Switching Model (MSM) on the time-series of Dynamic Conditional Correlation. In essence, it reveals the existence of two states in the time series, with different means: State 1 has a low mean equal to 0.792 and State 2 has a high mean equal to 0.873. The test of the equality of the means gives a chi-squared of $8{,}1*10^5$ with a p-value of 0.0000. We then have two clearly different states. The graph fitted with the MSM is available below:

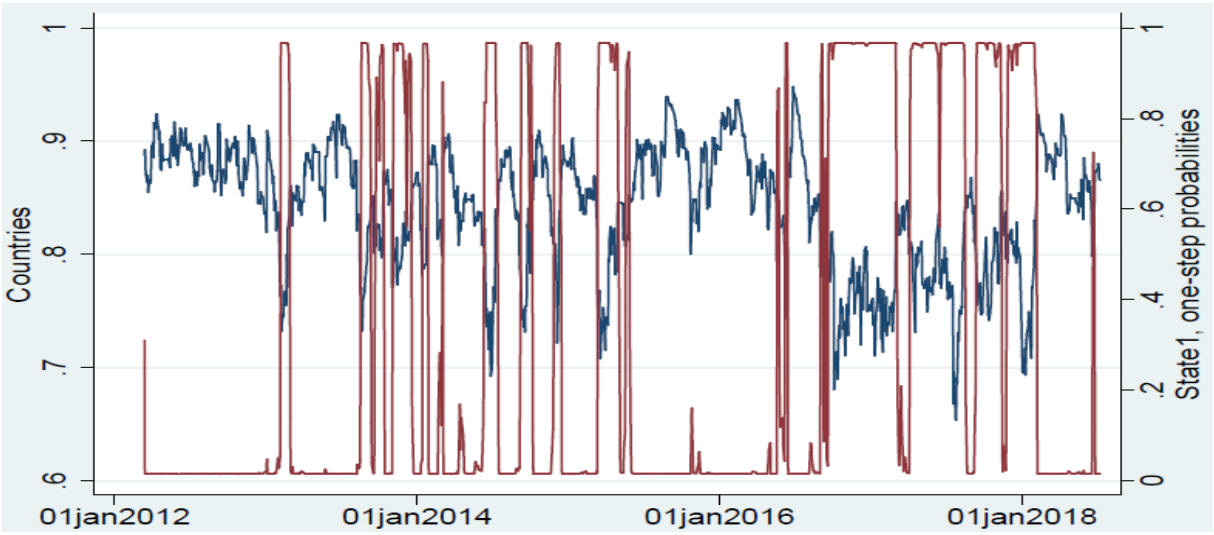


Figure 18: Country DCC with MSM. Source: own calculations.

The three periods we introduced previously appear rather clearly on this graph. We can see that the probability of being in state 1 is almost zero for most of the points until September 20th 2016, though there are short-lived decreases in conditional correlations. Then, this probability remains at about 1 for nearly all points until February 6th 2018. The latest estimates show the likely recovery of the old mean.

Our results show a decrease in the correlations among the returns at the country level, but this decrease seems to have been temporary. Currently, the correlations are likely to be in the high State, meaning less diversification possibilities than a few months ago.

Robustness checks

We will now apply the three robustness checks we discussed in our methodology section: we will check for the robustness of our results by changing the mean equations, the variance equation and the sample.

Using the simpler version of the mean equation, consisting in a constant term plus an error term, does not widely change the estimates. There are differences, but these are rather small and temporary. We could have expected this result as most of the estimates of our more complete mean equations are not statistically significant at 5% (only the fifth lag of the European Union's return is significant in the mean equation of the European Union; see appendix 3 for the screenshots of the output of the model). Our results are therefore robust to the specified mean equation. The following figure plots both time-series of conditional correlations, while the time series of the difference is available upon request.

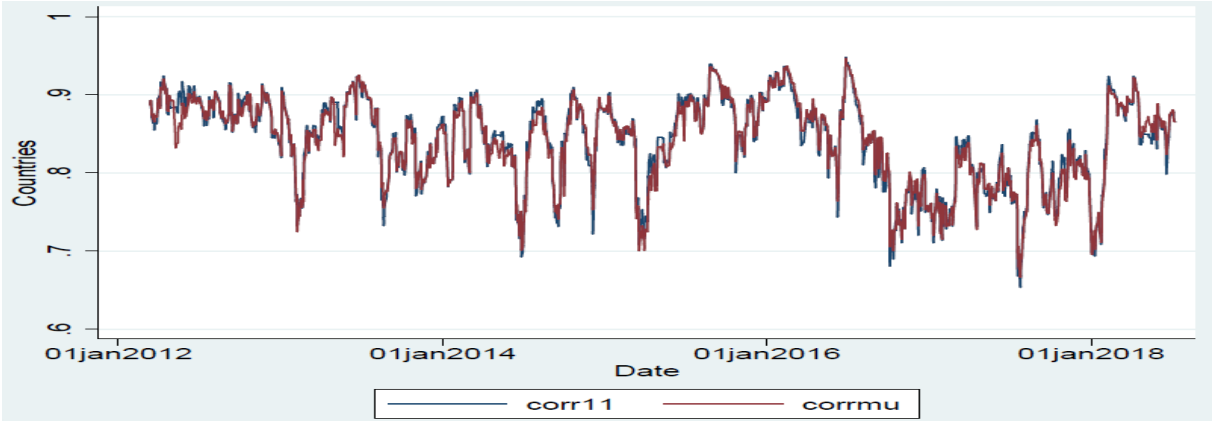


Figure 19: Countries: Robustness Check: the mean equation. Source: own calculations.

Our second robustness check was to change the order of the GARCH model, by using successively GARCH(2,1), GARCH(1,2) and GARCH(2,2) instead of GARCH(1,1). The plot of the four time-series of conditional correlations is represented in the next figure. We clearly see that the four lines are nearly undistinguishable. We do not believe that more differences would appear if we used models with higher orders, and rather think that the GARCH(1,1) model suffices for our data. We can therefore conclude that our results are robust to the model chosen.

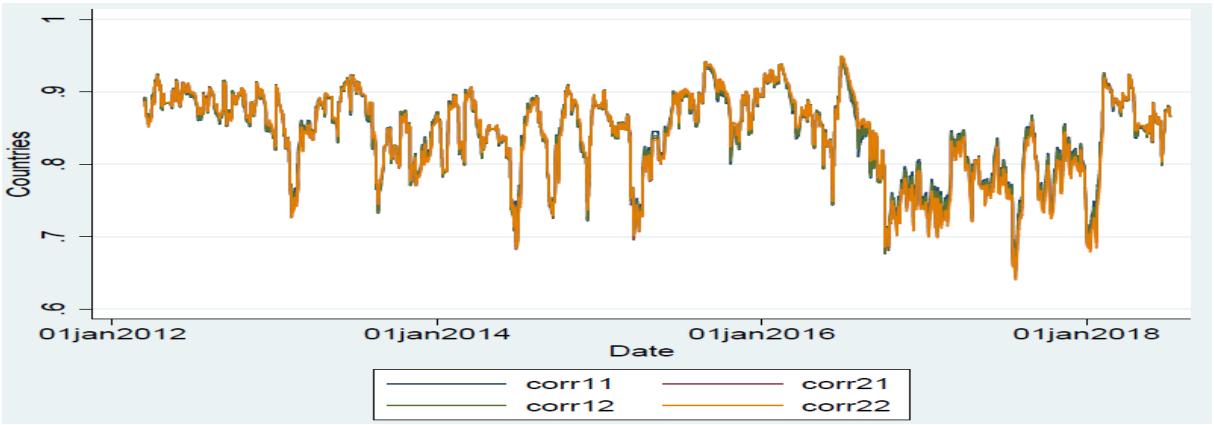


Figure 20: Countries: Robustness Check: changing the order of the GARCH model. Source: own calculations.

Finally, for our third robustness checks, we decided to use datasets from S&P rather than ours. We used the total gross return values of S&P United Kingdom Broad Market Index and S&P Europe Ex-U.K. Broad Market Index in local currency. We can see that, at the country level, both series behave in a similar pattern. There are differences, but the correlations using S&P's index are neither always above nor always beyond the correlations with our index. Some bigger differences appear, but they are short-lived (they only last for a very short-run). Our results are thus robust to the chosen index. For unknown reasons, the end of the sample correlation is ill-behaved.

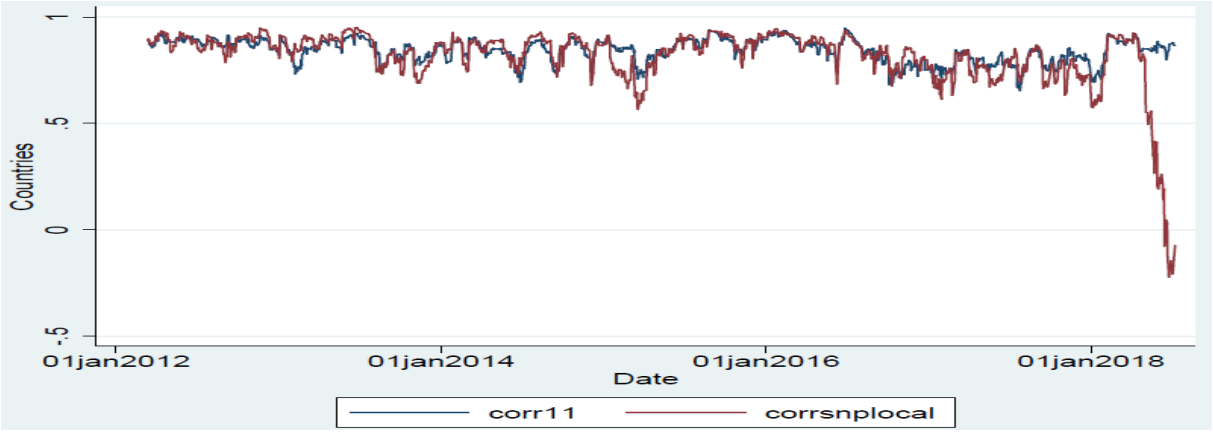


Figure 21: Countries: Robustness Check: S&P data, in local currency. Source: own calculations.

Conclusion

Our evidences point to a temporary decrease in correlations between the European Union and the United Kingdom. Both conditional and unconditional correlations decreased substantially after the referendum, but have recovered for some time now. In particular, by applying a MSM to our DCC, we could see that the transition to the state of low correlations only lasted several months, from end of September 2016 to the beginning of February 2018. Defining one's position on the simple mean-correlation therefore seems to be a bad idea since it does not show that the period of lower correlation has come to a(n) (temporary) end. Our three robustness checks increase our confidence in our results, as they all confirm the pattern we exhibited.

Based on our evidences, we conclude that Brexit had an effect on the correlations of the country indices, but that this effect has already come to an end. Our first hypothesis is therefore partially accepted.

We cannot conclude that correlations will remain as high in the future. We believe that the correlation will fall again in the future, as Brexit has not happened yet, and most of its (legal and economic) effects are still to come. However, for the current period (the very end of our sample), we showed that Brexit did not introduced additional diversification benefits.

Assessment of the second hypothesis

We will now try to accept or reject our second hypothesis, which is that sectors are now less correlated than before the Brexit referendum. We will study each sector successively. We will apply the same steps as for the country level correlations: first we look at the pre- versus post- referendum correlations; second we look at the six-month rolling-window correlations; third, we generate and analyze the Dynamic Conditional Correlations and test for the existence of a change in the level of the correlation by applying a Markov Switching Model and testing for the significance of the difference of its States.

Unconditional correlations

As a first estimate of changes in integration, we computed the simple unconditional correlations between European Union and United Kingdom and their sector, pre and post Brexit. The results are given in the table below:

Index	Pre-referendum Correlation	Post-referendum Correlation	Difference	Relative gain/loss (= Difference/ Pre-referendum Correlation)
Consumer discretionary	0,78466123	0,67722724	-0,10743398	-13,69%
Consumer staples	0,84493914	0,71176551	-0,13317363	-15,76%
Energy	0,81548895	0,77951233	-0,03597662	-4,41%
Financials	0,84841923	0,84771788	-0,00070135	-0,08%
Health Care	0,71288615	0,61200897	-0,10087718	-14,15%
Industrials	0,85178339	0,78834372	-0,06343967	-7,45%
Information Technologies	0,66757897	0,66194252	-0,00563645	-0,84%
Materials	0,69713137	0,60570553	-0,09142584	-13,11%
Real Estate	0,62839304	0,53344177	-0,09495127	-15,11%
Telecommunication Services	0,61924942	0,65005183	0,03080241	4,97%
Utilities	0,60671228	0,63150529	0,02479301	4,09%

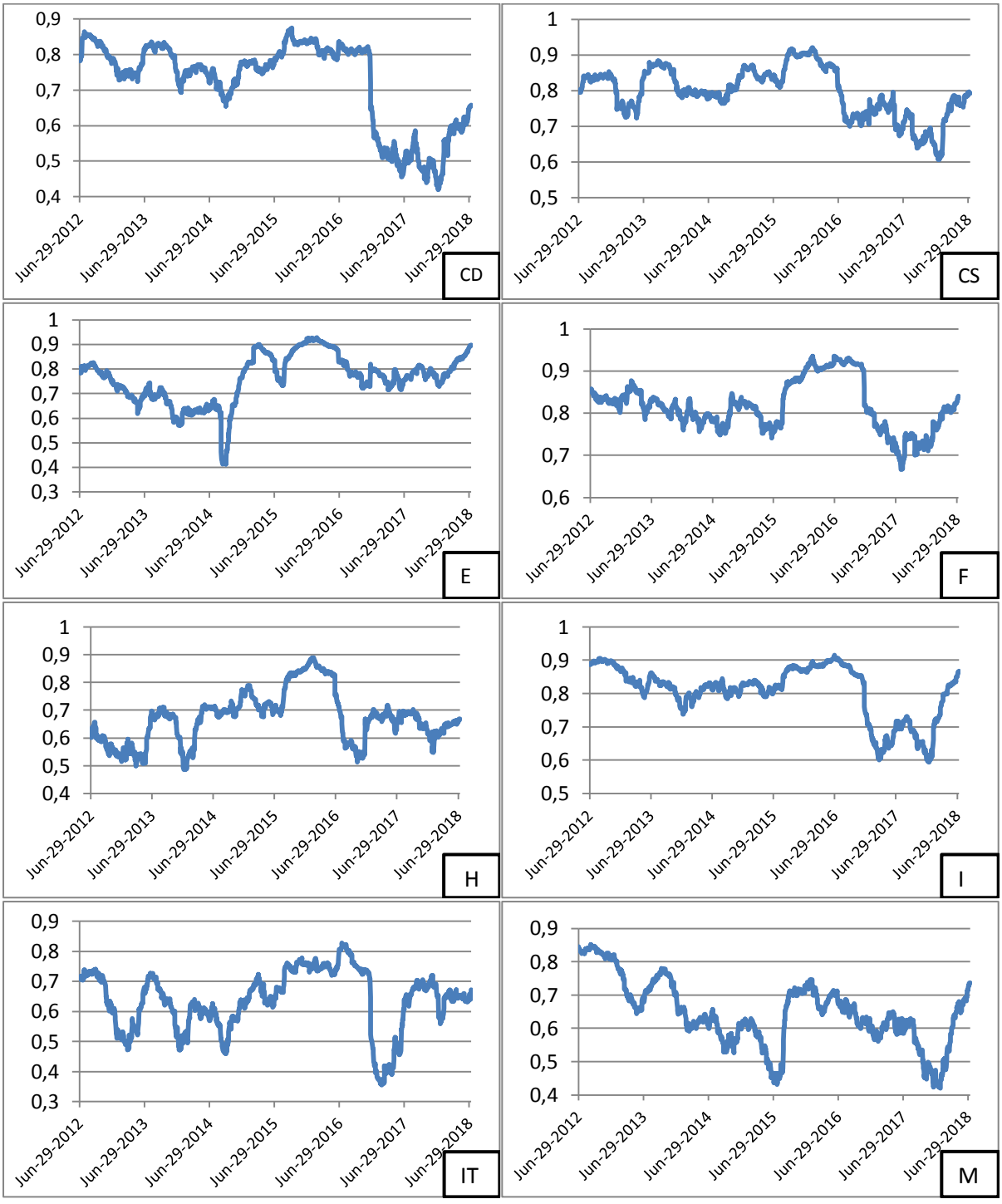
Figure 22: Unconditional Correlations pre- and post- referendum. Source: own calculations.

This figure first shows that the level of correlation varies among most sectors. Before the referendum, the returns are more correlated among industrials (0.852), financials (0.848) and consumer staples (0.845) sectors, than among the utilities (0.607), telecommunication services (0.619) or real estate (0.628) sectors.

From these static measures, we can also see that all correlations decreased following the referendum, except for telecommunication services and utilities sectors. We should stress that the effects differ widely between sectors, as some decreases are likely to be insignificant (see the case for financial companies) while other decreases are relatively important. In particular, the relative decrease is highest for the consumer staples (-15,76%), real estate (-15,11%), health care (-14,15%), consumer discretionary (-13,69%) and materials (-13,11%) sectors. Based only on this measure, we would be led to conclude that, from a portfolio manager point of view, the markets are less integrated after the referendum, at the sector level. Only two sectors seem to be more integrated after the vote: the returns of telecommunication services companies (+4,97%) and utilities companies (+4,09%) exhibit a higher correlation post referendum.

These static results are averages and say nothing of the dynamics of the correlations. Also, the referendum date has been arbitrarily chosen, correlations may have changed earlier

or later. We therefore need to turn to a dynamic measure of integration and compute the 6-month rolling-window correlations. Its results are given below.



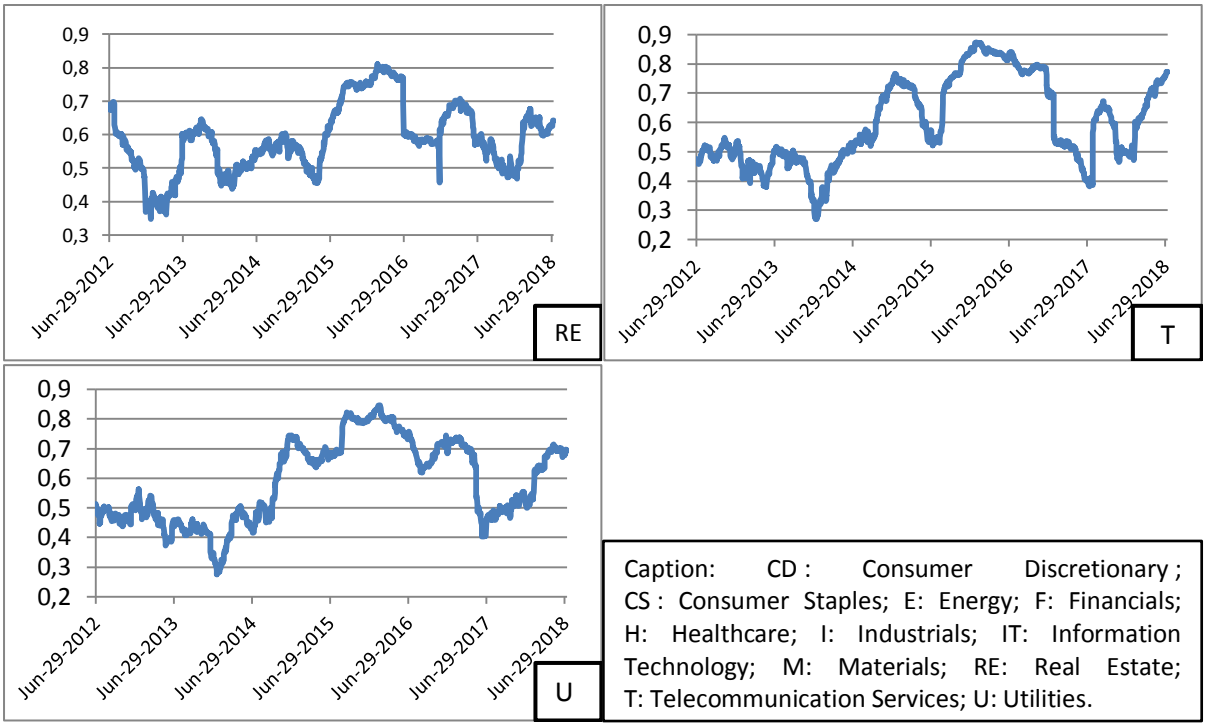


Figure 23: Sectors: 6-month rolling-window correlation. Source: own calculations.

For the Consumer Staples sector, we can see that the correlations vary between 0.65 and 0.85 before they fall on December 21st 2016 and continue decreasing gradually to 0.4 after the vote. At the end of the sample, we can see that they start increasing, though they remain around 0.65 and are accordingly far from their in-sample pre-referendum average.

For the Consumer Discretionary sector, the level of correlation was oscillating between 0.7 and 0.9 before July 2016. On June 23rd 2016, it was at 0.862 but started to decrease, and reached its lowest value on January 17th 2018, at 0.606. Since then, it increased back to its sample pre-referendum mean of around 0.8.

For the Energy sector, the dynamic unconditional correlations show a pattern we would not have suspected if we had only relied on the pre- versus post-referendum estimates. They gradually decrease from 0.8 to 0.4 before July 2014. They then increase rapidly to 0.9 in the beginning of 2015 and stabilize around this level until end of June 2016. After the vote, they decrease gradually and stabilize around 0.75. In the end of the sample, they increase to 0.9.

The correlations of returns among Financials companies are stable until June 2015, at around 0.8. They then suddenly increase to around 0.9, before suddenly falling back to 0.8 in December 2016 and then gradually decreasing to around 0.7. Here also, we can see the already usual pattern: correlations increase at the end of the sample and the recover their pre-referendum levels.

The Health Care sector's correlations increased from about 0.5 to 0.9 between January 2014 and June 2016. They then collapsed to around 0.5 in the end of June 2016. Interpreting this evolution is hardened by the fact that we use 6 months of returns. The collapse could be due to a general decrease in the correlations pre-referendum, or to a dramatic impact of the first daily correlations post-referendum.

For the Industrials sector, we can see that the level of the correlations was very stable trough the pre-referendum period and mostly varied between 0.8 and 0.9. It was at around

0.83 on December 15th 2016 before falling to 0.6 between this date and March 20th 2017. At the end of the sample period, the correlation increased back to their pre-referendum period, with the latest point estimate at around 0.867.

The 6-month rolling-window correlations of the Information Technology sector show high variations: between June 2012 and June 2015, they varied widely between 0.45 and 0.75. Since July 2015, it was much more stable at around 0.75. At the end of June 2016, it started decreasing and fell on December 21st 2016 to reach a level of 0.36 in February 2017. It then recovered quite fast its pre-referendum level by the end of June 2017.

For the Materials sector, the graph shows two periods of decrease in the correlation. It established at 0.85 at the beginning of the period and then fell to 0.443 by begin of July 2015. It then increased to 0.7 by end of September 2015, and decreased gradually to 0.43 at the beginning of 2017. Since this, it increased gradually, and reached 0.735 at the end of our sample.

We can see that the rolling-window correlation of the Real Estate sector were subject to different shocks. The mean was around 0.5 until mid-2015. Then it increased to about 0.8 in the beginning of 2016. There was a big shock at the end of June 2016, when it decreased to 0.6. It recovered a bit at the beginning of January 2017, but again decreased, to a level below 0.5. Once again, we see that the correlation increased at the end of the sample, to reach 0.65.

The correlations in the Telecommunication Services sector were below 0.6 until October 2014. They then increased to over 0.8 until July 2016. When the first post-referendum data were included in the calculation, in December 2016, correlations fell from about 0.8 to about 0.4 in June 2017. It then recovered gradually, with some variation, and is slightly over 0.77 at the end of the period.

Finally, the correlations of the Utilities sector were around 0.5 at the beginning of the period, until September 2014, when it started to increase to over 0.8 by the end of 2015. By the beginning of 2016, it started to decline, with some variation, and reached a low of 0.4 by June 2017. After this date, it increased steadily to reach 0.7 in April 2018 and remained close to this value.

As a conclusion, we can state that correlations for all sectors decrease following Brexit. We should keep in mind that correlations can range between -1 and 1. A sudden break, as has been found in several cases, can therefore be explained by a momentary highly negative correlation. We should stress that these breaks happened at very different times. It is not sure, therefore, if all can be explained by Brexit or if alternative explanations should be sought. Based on simple correlation, we would hence be led to conclude that all sectors witnessed decreased integration, but only momentarily, as they all recovered their pre-referendum level in the end of the sample.

We now turn to the assessment of the dynamic conditional correlations.

Dynamic conditional correlations

We first looked at the significance of the GARCH effect. We found all ARCH and GARCH estimates to be statistically significant, for all equations (see the screenshots in appendix 3 for more details). We then tested for the significance of the dynamic pattern of the correlations. The table below lists the chi-squared of the joint test for significance of the lambdas, which are the estimates of the dynamic pattern. We clearly see that all estimates are significant, as all p-values are below the threshold of 1%.

Sector	CD	CS	E	F	H	I
Chi²	3490.66	63.12	19250,33	897.64	88.97	6423.25
P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Interpretation	**We have great confidence that the conditional correlations are dynamic**					
Sector	IT	M	RE	T	U	
Chi²	255.86	6423.25	$2.6*10^5$	7815.32	12029.95	
P-value	0.0000	0.0000	0.0000	0.0000	0.0000	
Interpretation	**We have great confidence that the conditional correlations are dynamic**					

Caption: CD : Consumer Discretionary ; CS : Consumer Staples; E: Energy; F: Financials; H: Health Care; I: Industrials; IT: Information Technology; M: Materials; RE: Real Estate; T: Telecommunication Services; U: Utilities

Figure 24: Sectors: Test for the significance of the Dynamic pattern in conditional correlations. Source: own calculations.

The figure below shows the Dynamic Conditional Correlations of each sector. Several comments need to be made.

First, we should stress that the DCC of the real estate sector appears ill-behaved: the graph shows a continuous and important increase in correlations for most of the sample, from below 0.2 to 0.6. Based on our previous analysis of unconditional rolling-window correlations, we do not believe that the returns of these two sectors exhibited such a low correlation at the beginning of the sample. Furthermore, a MSM or our usual robustness checks based on the mean and variance cannot be fitted using these data. S&P data for this sector are only available at the end of the series, and show a very different graph. Facing such an uncertainty, we decided not to conduct further analyses on this sector.

Second, we can see that the level of conditional correlations varies across sectors, as we expected. The returns of some sectors, such as financials or energy, are more conditionally correlated than those of other sectors, such as utilities or telecommunication services. From a portfolio manager point of view, there are hence higher diversification benefits by investing in some sectors than in others, *ceteris paribus*[71].

Third, we can see that most graphs exhibit both an increase in correlation before the end of 2015 (point 1000) followed by a sharp decrease in correlation several weeks later. Rather than interpreting this now, we will rely on the MSM to determine the precise date of the switch from the state of high correlation to the state of low correlation.

[71] The main variables covered by the *ceteris paribus* condition are the returns and the volatility. If we find two shares with the same returns and volatility, then there are greater diversification benefits by investing in the share of the company active in the utilities sector.

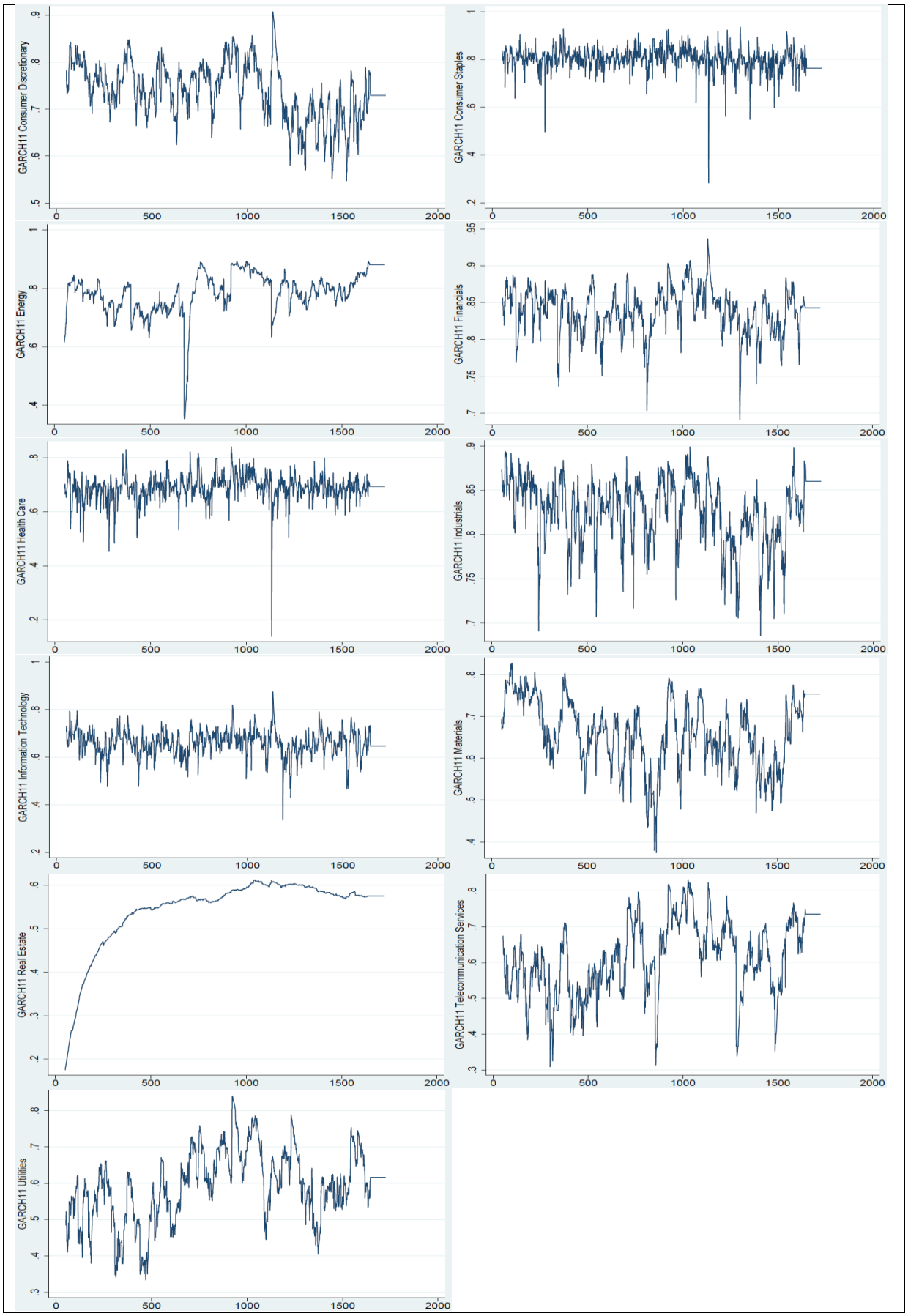


Figure 25: Sectors: Graphs of DCC-GARCH (1,1) . Source: own calculations.

In order to have a better understanding of the evolution of the correlations, we decided to apply a Markov Switching Model. We decided to distinguish two states. Stata consequently separated each point estimate in two categories: the points of high correlation and the estimates of low correlation[72]. Stata decided on its own whether each estimate belongs to the first or the second category.

For each sector, the following table shows the two means around which Stata assigned a State to each point estimate. It also shows the statistical significance of the difference between the two means, a test we performed in order to be sure that the states are clearly distinct. We should note that all means are statistically different, so that the two states do not overlap. The only exception is the Real Estate sector, which we saw has an ill-behaved pattern of correlation graph, for which Stata was unable to compute the Markov Switching Model.

Index	Mean of State 1 (low correlation)	Mean of State 2 (high correlation)	Chi² of the difference	P-value of the difference
Consumer discretionary	0.685	0.782	2589.81	0.0000
Consumer staples	0.759	0.817	549.00	0.0000
Energy	0.712	0.82	1610.79	0.0000
Financials	0.808	0.856	1850.61	0.0000
Health Care	0.602	0.697	376.63	0.0000
Industrials	0.785	0.847	2700.74	0.0000
Information Technologies	0.618	0.691	1300.77	0.0000
Materials	0.595	0.725	2921.31	0.0000
Real Estate	/	/	/	/
Telecommunication Services	0.523	0.69	3069.04	0.0000
Utilities	0.517	0.668	2359.36	0.0000

Figure 26: The two states of the MSM and the significance of their difference. Source: own calculations.

The following figure regroups all graphs and fits the probability of being in the first state, which is the state featuring the low conditional correlations.

We can see that five sectors exhibit a quite long period of low correlation following the Brexit referendum: Consumer discretionary, Financials, Industrials, Telecommunication services and Utilities. We include the Materials sector, even though longer periods of high correlations happen after the referendum. For the other sectors, the trend is hardly identifiable as their correlations vary continuously between the high and low states.

In the following lines, we will examine the evolution of each sector's correlations in further detail, and give the dates at which each sector exhibited a change in State according to the MSM. We will focus on the trend rather than on each point estimate: if a sector has a very temporary and unusual change in state, we will not report it. The idea is rather to give a general presentation of the events, to keep it simple and useful.

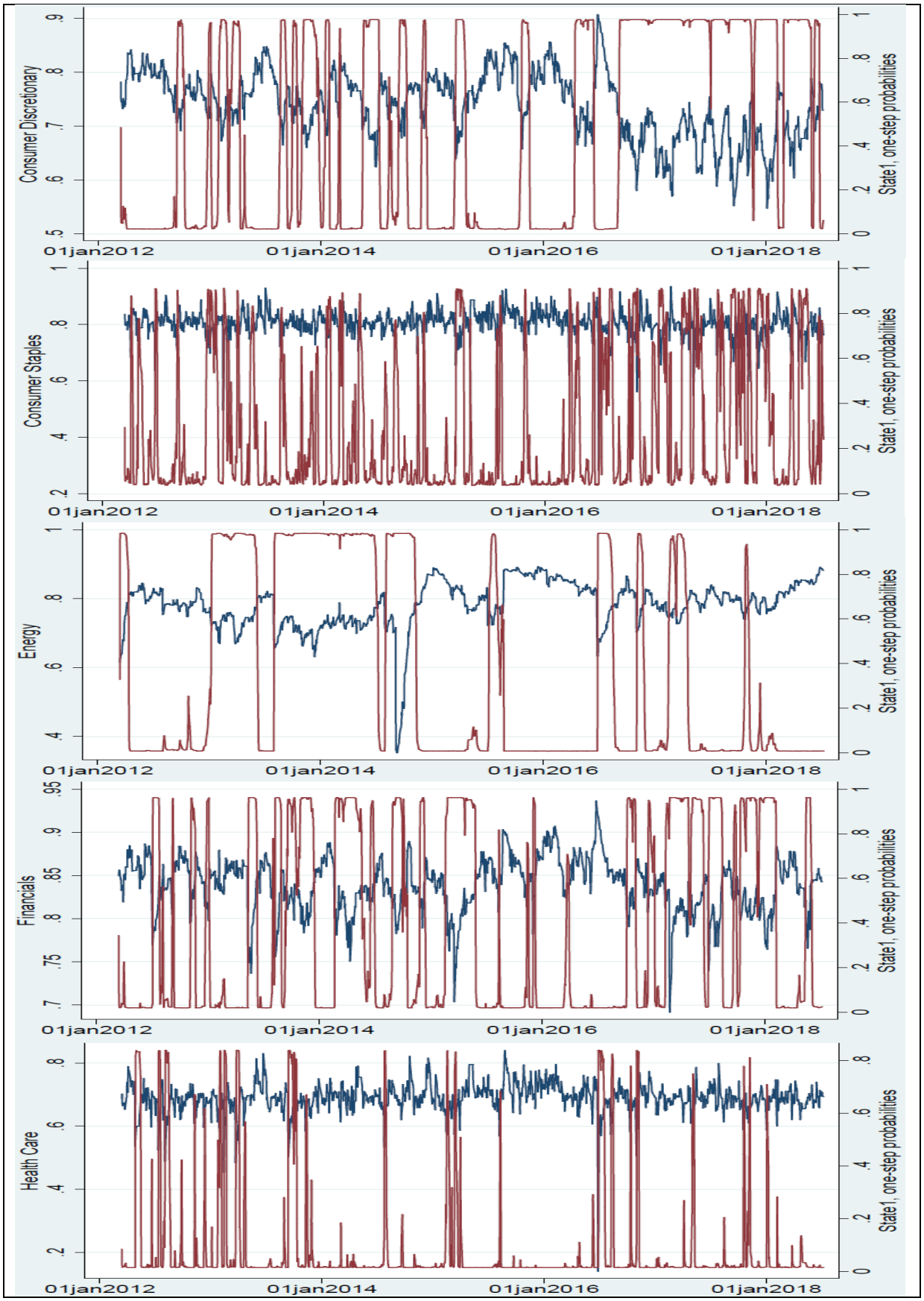
Six sectors clearly exhibit a trend after the referendum. In the beginning of the sample, they are more often than not in the high correlation state: the MSM has a rather consistent line at the bottom, only some estimates are evaluated as being in the low correlation state. Except the Consumer Discretionary sector, all of them seem to recover at the end of the sample.

[72] We could have done otherwise, though: we could have differentiated more than 2 States, or we could have used the variance rather than/along with the mean to differentiate the states. Here, for simplicity, we chose to work with two different means.

However, each sector has its own shape. For the Consumer Discretionary sector, the low correlation state begins after September 7th 2016 (point 1184), until the end of the sample. For the Financials sector, the start of the low correlation state begins on February 10th 2017[73] (point 1293) and lasts until February 7th 2018 (point 1543). The correlations fall on October 5th 2016 (point 1204) for the Industrials sector, and recovers on February 7th 2018 (point 1543). The Materials sector also constantly alternates states of high correlation and states of low correlation. The correlation was mostly low between November 4th 2013 (point 466) and August 25th 2015 (point 922). It then become mostly high until June 7th 2016 (point 1119), and then mostly low until March 1st 2017 (point 1306). There was then a small period of high correlation until May 17th 2017 (point 1358), followed by a period of low correlation until February 9th 2018 (point 1545) after what the correlation increased to remain high until the end of the sample. The correlations of the Telecommunication Services sector decrease on January 26th 2017 (point 1282) until January 18th 2018 (point 1529). The Utilities sector is characterized by a high state of correlation until February 1st 2017 (point 1286). It then falls and only recovers on January 31st 2018 (point 1538).

The other sectors have a more ambiguous, as they seem to alternate constantly between high and low probabilities. However, we can see that, for the consumer staples and IT sectors, the MSM lines seem to become thicker at the end of the sample. For the Consumer Staples sector, the frequency of the low correlation state increases around March 22nd 2016 (point 1068) until the end of the sample. For the Energy sector, there was a stable state of high correlation between November 10th 2014 (point 723) and June 28th 2016 (point 1134). At that date, the sector switches to a low correlation state, but recovers its former high correlation state already on April 13th 2017 (point 1337). The correlation remains high until the end of the sample. For the Health Care sector, the effects are barely identifiable. The correlation was high between October 10th 2013 (point 449) and June 28th 2016 (point 1134). It then had more low correlation states than usual until November 8th 2016 (point 1228). At the end of the sample, the sector has gone back to its high correlation state, with more consistency. For the Information Technology sector, the frequency of the low correlation increases after September 1st 2016 (point 1180) until June 6th 2017 (point 1371).

[73] Another acceptable date would have been October 6th 2016 (point 1205), though there were some periods of high correlation between this date and February 10th 2017.


Consumer Discretionary
Consumer Staples
Energy
Financials
Health Care
State1, one-step probabilities
01jan2012
01jan2014
01jan2016
01jan2018

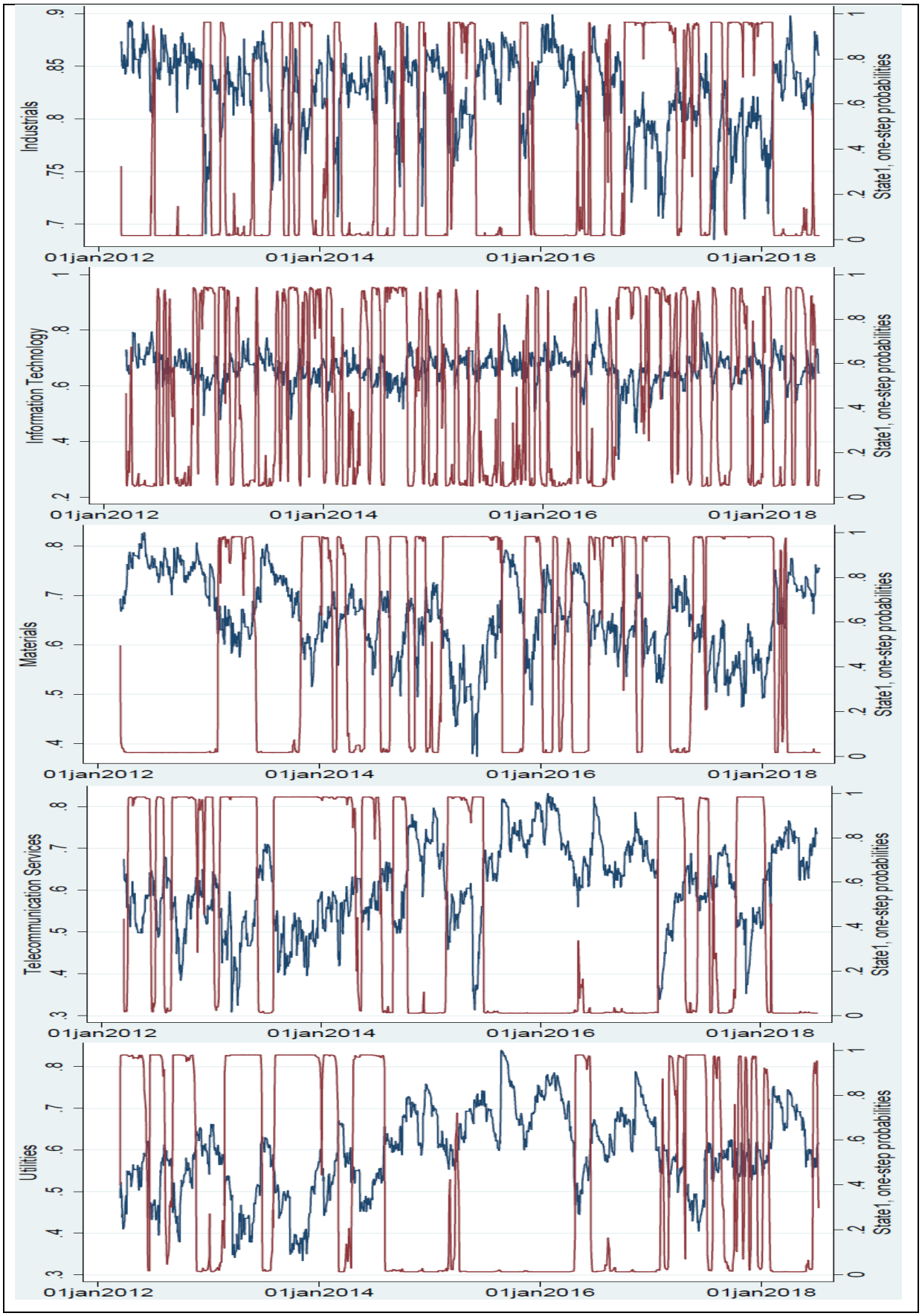


Figure 27: Sectors: DCC of the sectors and MSM. Source: own calculations.

Robustness Checks

In the following pages, we will test the robustness of our results by changing some of our assumptions, namely the mean equation, the variance equation and the portfolios.

First, as we explained in the chapter about our methodology, we decided to test the robustness of our results using our mean equations which encompassed five lags of each variable by defining the mean equations consisting of a simple constant and an error term.

As can be seen in the figure below, the estimates are very similar using both methods. In fact, for most point estimates, the two lines are undistinguishable. However, there are sometimes important differences, but they are always momentary. We can conclude that both models give similar results, though the simpler mean equation sometimes does not include significant variables (see appendix 3 for the screenshots of the output of Stata's DCC-GARCH (1,1) models, with the significance of each variable).

Second, we tested the variance equation by modifying the order of the GARCH model. In our basic model, we followed the crowd and used a GARCH (1,1) model. We then decided to check if other orders would have given the same shape of DCC, or if the model mattered heavily. In extent, we tested the robustness of our results by comparing them to those generated by DCC-GARCH (2,1), DCC-GARCH (1,2) and DCC-GARCH (2,2) models. The graphs below show clearly that the different models follow the same pattern. There are some differences but these differences are extremely temporary.

For our third test, we compared our conditional correlations with those we observed using other datasets. For our sectors, we used the total gross returns of S&P's United Kingdom Broad Market Indexes (BMI) and Europe Ex-United Kingdom Broad Market Indexes (BMI). We applied a DCC-GARCH(1,1) with our baseline mean equation.

Obviously, as we can see below, three tendencies must be noticed. First of all, we can see that, for most samples, our lines are clearly distinguished, meaning that our results differ widely if we use the first or the second method. S&P only includes companies valued above $100 million while our sample has no minimum worth condition. The higher correlation using S&P's sample can therefore be due to the fact that they include bigger companies than we do, so that their shares are probably widely traded at an international level.

The second tendency is that, however, for most sectors, using either portfolio leads to the same pattern. The two lines often only differ by their level. We can see that the pattern we exhibited in our analysis, in extent a (sharp and) temporary decrease in correlations, can be found using the alternative datasets. This gives us much confidence in our results. A noteworthy exception is the health care sector, whose correlations are seen as much more stable using our dataset than using S&P's. These differences led us to apply a 2-state MSM to the Health Care sector generated by S&P. This graph can be found in figure 30 below, and shows that the industry is currently in the low-correlation state. Another exception, that we could expect, is the Real Estate sector, for which we had ill-behaved results.

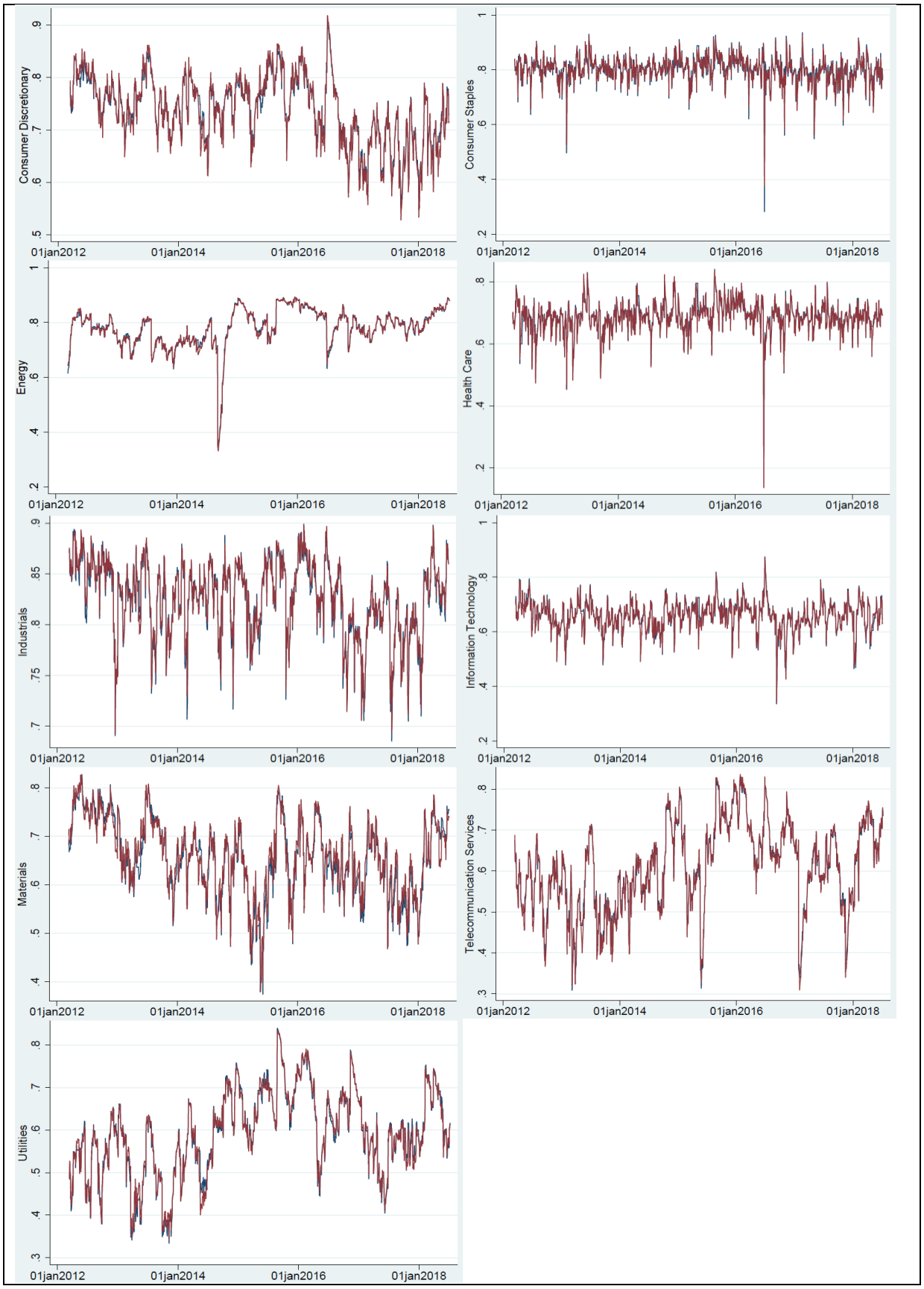


Figure 28: Robustness Check: comparison of DCC changing the mean equation. Source: own calculations.

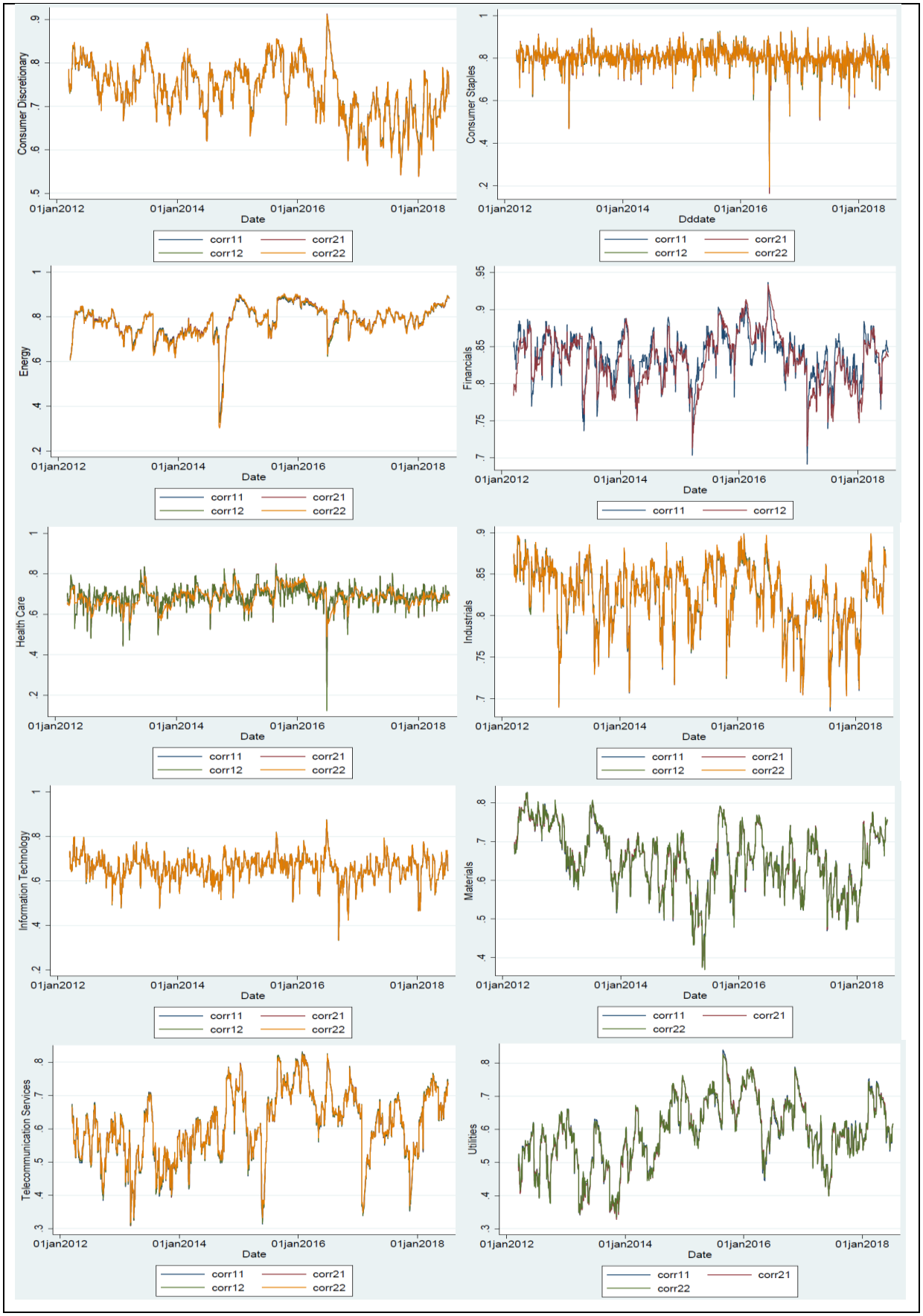
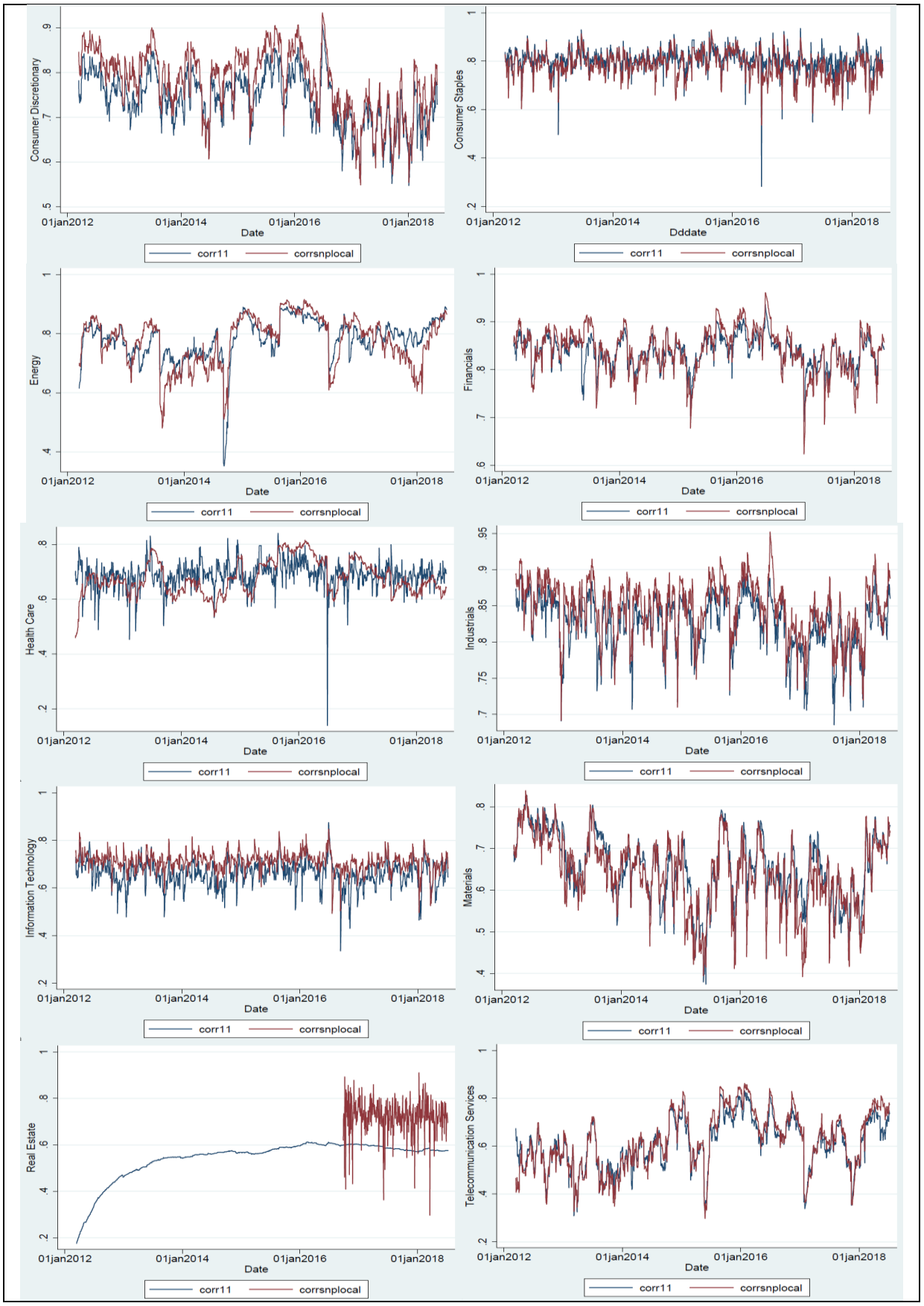


Figure 29: Robustness check: Effect of other GARCH orders on the DCC. Source: own calculations.


Consumer Discretionary
Consumer Staples
Energy
Financials
Health Care
Industrials
Information Technology
Materials
Real Estate
Telecommunication Services
Date
Ddate
01jan2012
01jan2014
01jan2016
01jan2018
corr11
corrsnplocal

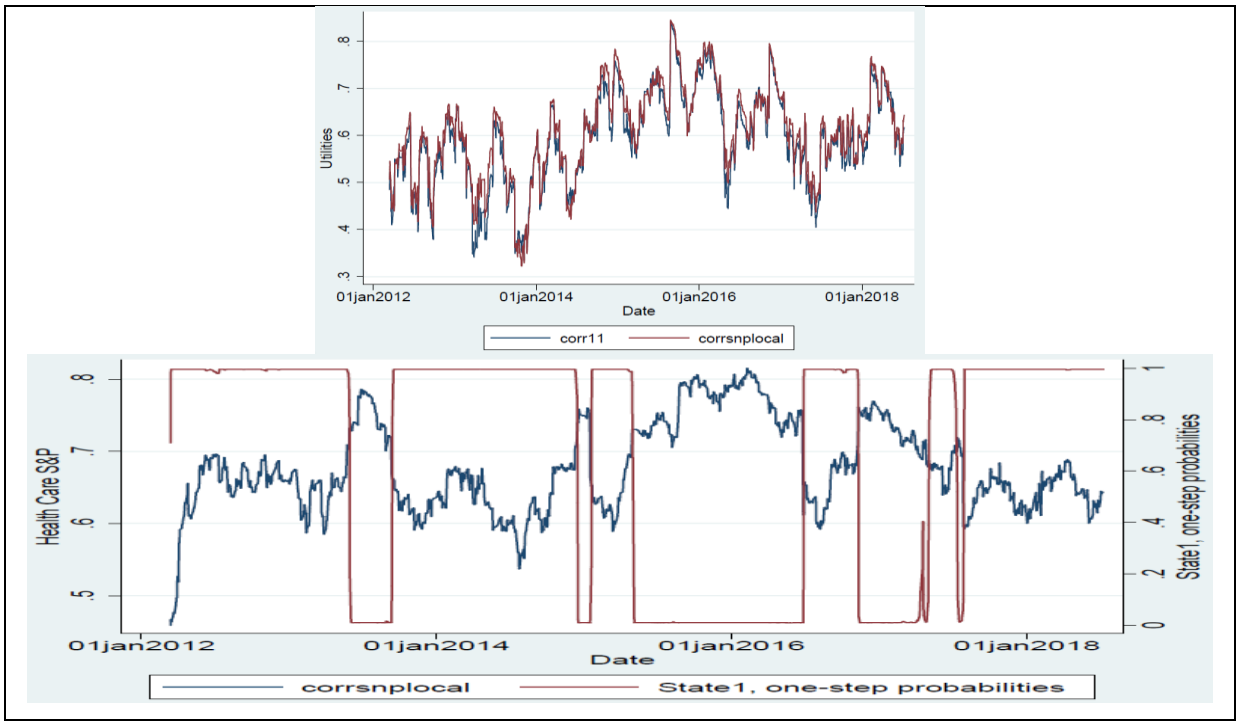


Figure 30: Sectors: Robustness Check: our portfolio versus S&P's. Source: own calculations.

Conclusion

Our first measure of dynamic correlation showed that the relationship between the returns of the sectors changed more than the simple two-period comparison of correlation showed. However, we favor the results of the DCC-GARCH model, as it controls for heteroskedasticity and its estimates are more reactive to sudden changes.

We showed that the level of conditional correlations was different among sectors. Some sectors are more integrated than others: for instance, the industrial sector is more integrated than the utility sector, as the correlation of the former is higher than that of the latter. We also showed that both the dynamics of conditional correlations were different among sectors. Some exhibited a long term decrease in correlation; others show an alternation between the states of high and low correlation. We should note that the period of lower correlation has come to an end for most sectors, as the current state is considered as high by the MSM. The possibilities for increased diversification can consequently be seen as temporary and over. As a summary of our results, the following table shows the extent of the main period of lower correlations. This length obviously varies among sectors.

Index	Begin of lower correlation	End of lower correlation	Length (in business days on the stock exchanges)
Consumer discretionary	September 7th 2016	/	/
Consumer staples	March 22nd 2016	/	/
Energy	June 29th 2016	April 12th 2017	202
Financials	February 10th 2017	February 7th 2018	251
Health Care	June 29th 2016	November 8th 2016	94
Industrials	October 5th 2016	February 7th 2018	340
Information Technologies	September 1st 2016	June 6th 2017	192
Materials	June 8th 2016	March 1st 2017	187
Real Estate	/	/	/
Telecommunication Services	January 26th 2017	January 18th 2018	248
Utilities	February 2nd 2017	January 30th 2018	251

Figure 31: Sectors: summary of the analysis. Source: own calculations.

Assessment of the third hypothesis

Unconditional correlations

The correlations of United Kingdom-focused (also called local) companies with our European portfolio was 0.804 pre-referendum, but decreased to 0.713 after the vote. This is a relative decrease of 11.31%. Foreign-focused (also called international) companies' correlations decreased from 0.821 pre-referendum to 0.599 after the vote, a relative decrease of 27.08%. We can hence see that foreign-focused companies had higher correlations pre-referendum but that they fell much more after the vote. In order to have a better understanding of the dynamics behind these falls, we now turn to the 6-month rolling-window correlations.

As we can see on this graph, the decrease in correlation was nearly the same for both series. But some difference remained: the decrease was more temporary for foreign-focused companies; it also happened sooner, directly after the results of the referendum. For both series, we find again the same pattern: the correlation fell after the referendum but increased close to their pre-referendum level at the end of the sample.

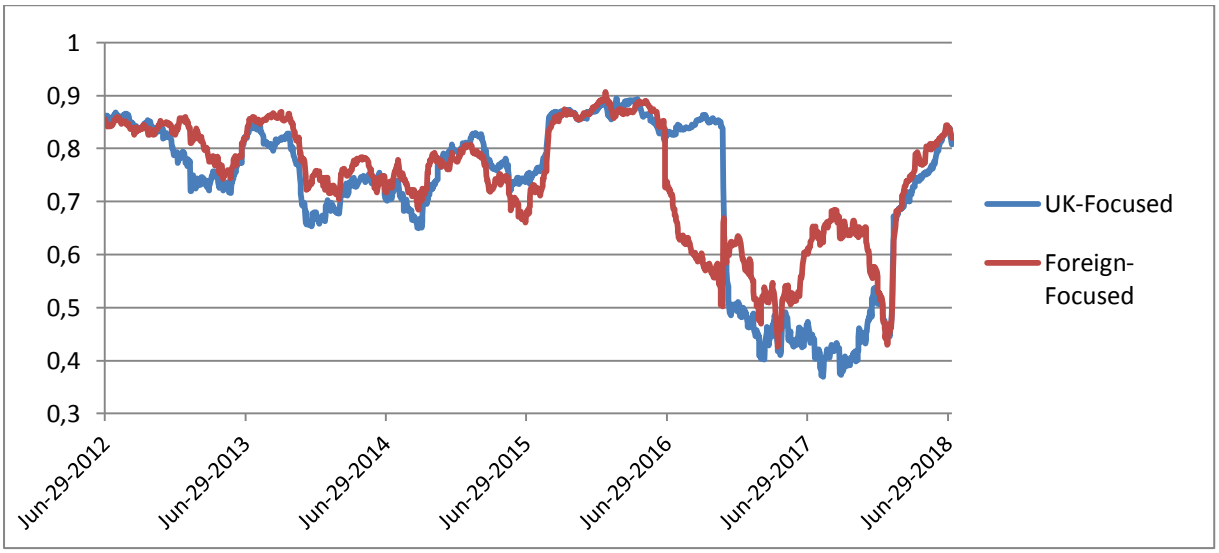


Figure 32: 6-month correlations of the Local and International companies. Source: own calculations.

Dynamic conditional correlations

The GARCH effects of our two models (one for UK-focused and one for Foreign-focused) were all significant, as the screenshots in appendix 3 show. We then checked for the joint significance of the lambdas terms, in order to check if correlations exhibit a dynamic pattern. For the local regression, the Wald test gives a chi-squared value of 9373.3 with associated p-value of 0.0000. For the international companies, the chi-squared was 7573.4, and the p-value was 0.0000. We thus reject the null hypothesis in both cases, and conclude that the correlations are dynamic. For clarity, we will first study UK-focused companies, and then turn to the foreign-focused companies.

UK-focused companies

The figure below shows the estimated dynamic conditional correlations pattern:

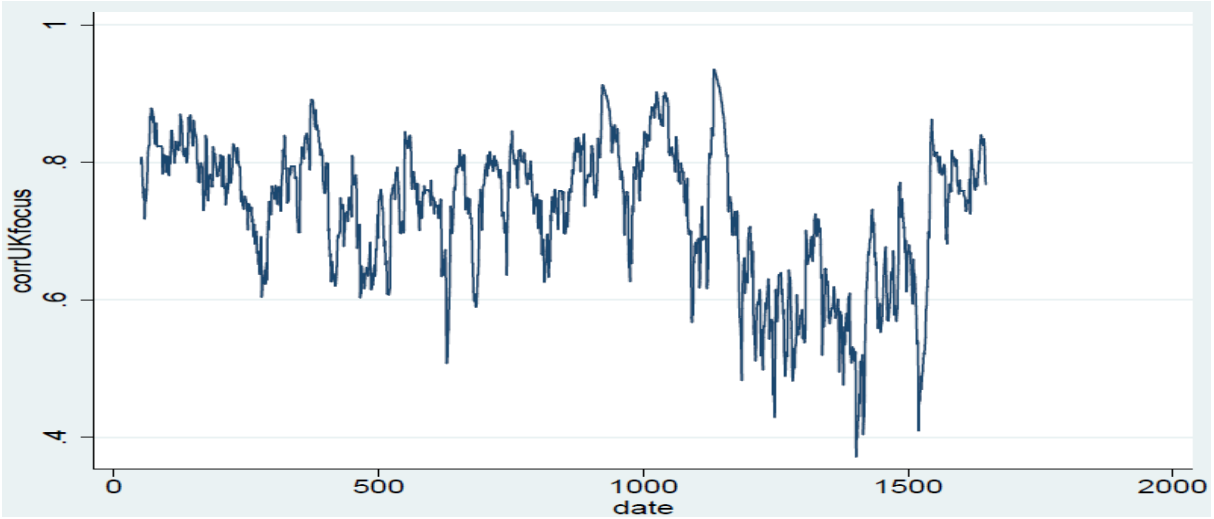


Figure 33: Focus: DCC UK-Focused. Source: own calculations.

We can see that the DCC of these companies dropped during the month of July and August 2016 (points 1137 to 1179), from a level of 0.9 to a level of 0.5. At the end of the sample, correlations increase to their pre-referendum level: on February 7th 2018, the correlations reach 0.85 and remains thereafter as their pre-referendum mean of 0.8.

In order to have a better idea of the process, we fitted a MSM. The model distinguishes two states, one with a low mean of 0.608 and one with a high mean of 0.786. The test for the significance of their differences gives a chi-squared statistics of 2942.6 and associated p-statistics of 0.0000. We are thus confident that both states are different. The following table displays both the DCC and the MSM.

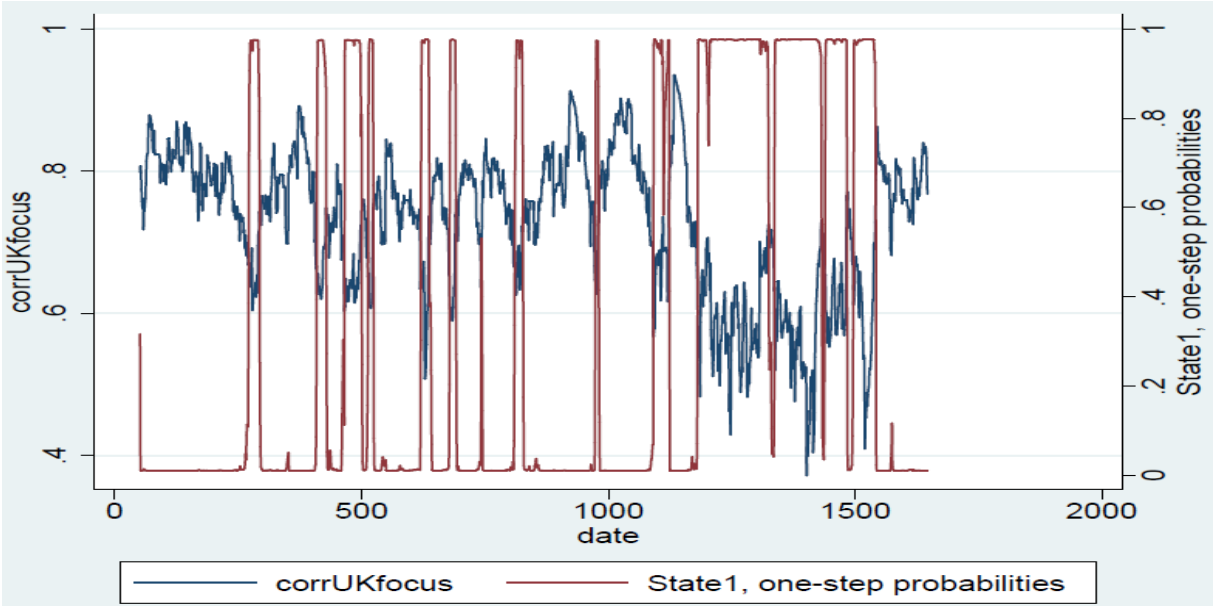


Figure 34: Focus: UK-focused: MSM. Source: own calculations.

We clearly distinguish three periods. A regime of high correlation prevails in the first period, which lasts from the beginning of the sample until September 2nd 2016 (point 1181). The second period, with low correlations, lasts between September 5th 2016 (point 1182) and February 6th 2018 (point 1542). Between February 7th 2018 and the end of the sample, the correlations are high.

International companies

The Dynamic Conditional Correlations of the Foreign-focused companies exhibit the same pattern: they decreased around the beginning of June 2016 (point 1100) and recovers at the end of the sample, around February 2018 (point 1550).

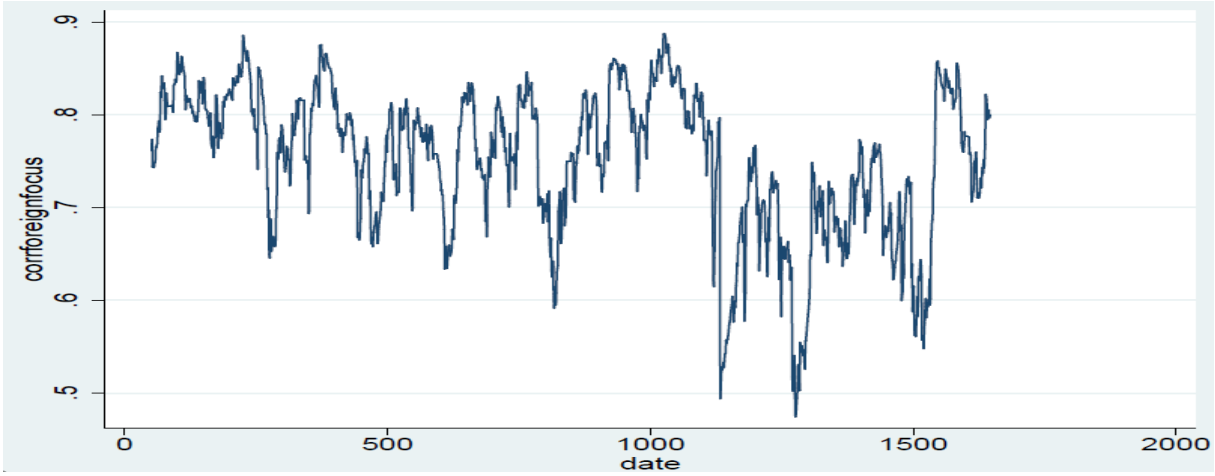


Figure 35: Focus: International companies: DCC. Source: own calculations.

We estimated a MSM on our data. The model distinguished two States: the first one with a low mean of 0.659 and the second with a high mean of 0.796. The test for the significance of the difference gave a chi-squared value of 2811.91, and associated p-value of 0.0000. The MSM fitted on the data gives the following figure:

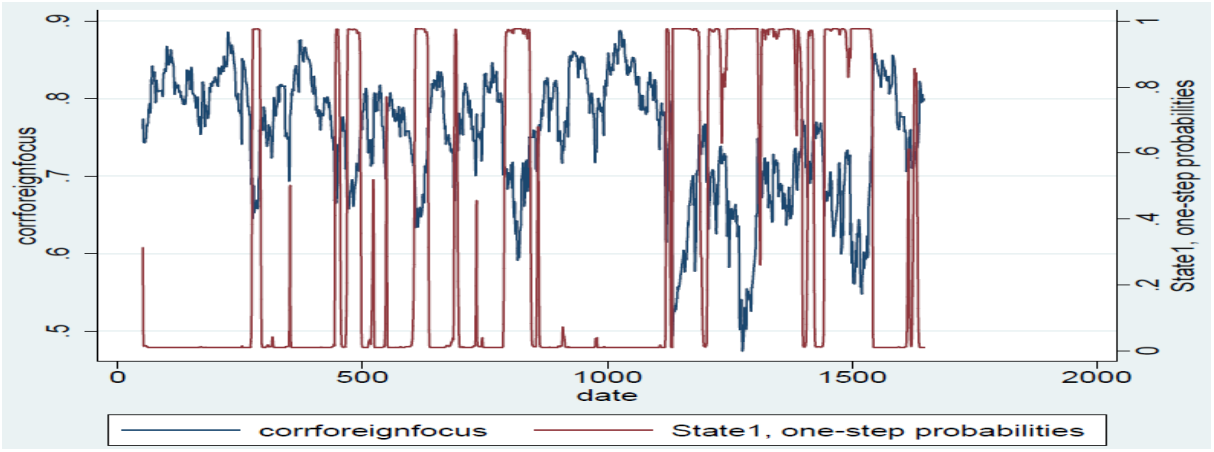


Figure 36: Focus: international companies: MSM. Source: own calculations.

The broad picture is the same as for the UK-focused firms: a substantial period of low correlations is found between two periods of high correlations. More precisely, the correlations can be considered as being in the higher State until June 7th 2016 (point 1119). On the next day, the correlation is seen as being in the low-mean State until February 6th 2018 (point 1542). After this date, the correlations are considered as high.

We can see that both indices exhibit the same pattern. Though, there are differences. First, the level of correlation is slightly lower for the UK-focused companies. Second, the correlations of UK-focused firms react later than that of the international firms, as they are considered in the low-state two months later than the foreign-focused firms. There is a striking similarity: both indices go back to the high-mean State on the same date, on February 7th 2018. The following graph shows the difference of the correlations (that is, the correlation

of the UK-centred firms minus that of the foreign-centred firms). We can clearly see that the points of the series are often negative (and consequently that the correlation is higher for foreign-centred firms). We can also see that the correlation of international firms decreased earlier than that of UK-centred firms (see the spike around point 1100).

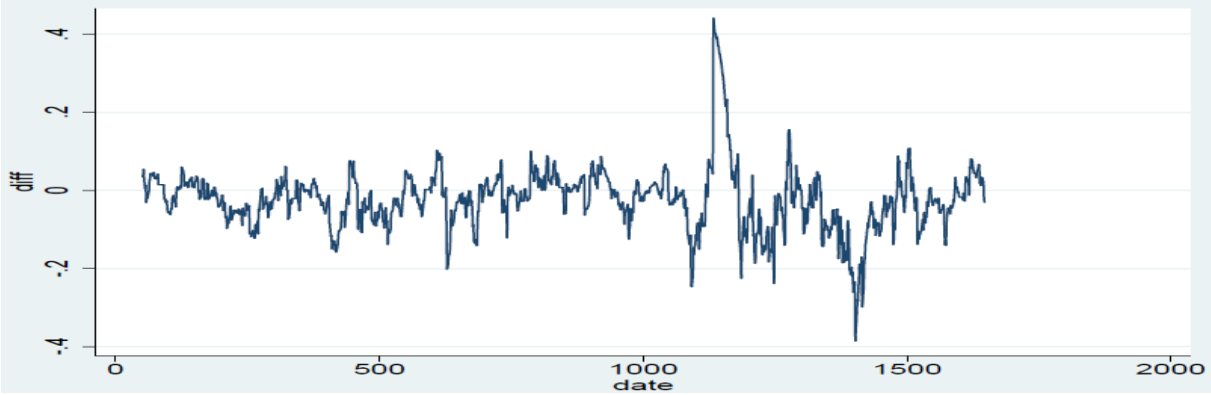


Figure 37: Focus: Difference between the International and local companies. Source: own calculations.

We applied the MSM on the difference equation, in order to identify if it has increased or not following the vote. The test for the significance of the two states gave a chi-squared of 877.93 with p-value of 0.0000. The low mean is equal to -0.093 and the high mean is set to 0.014. We can see that after September 7th 2016 (point 1184) and until November 7th 2017 (point 1482) the difference is considered in the low State, meaning that the correlation of local firms has decreased more than that of international firms. We therefore showed that the less geographically diversified firms have been more affected by the referendum.

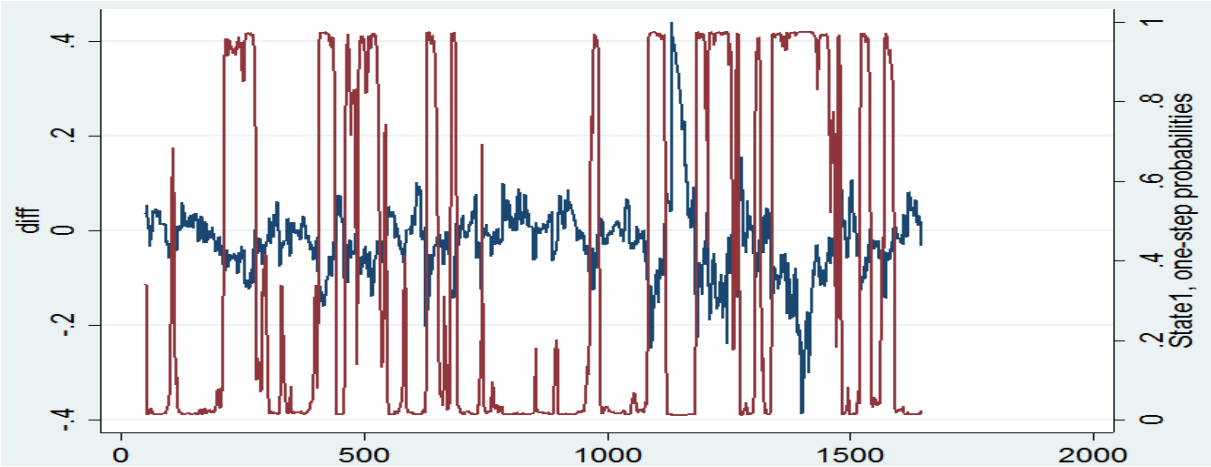


Figure 38: MSM of the difference between the International and local companies. Source: own calculations.

Conclusion

We saw that the level of correlation is higher for Foreign-focused companies, probably because they tend to be bigger on average. We also saw that both types of companies were highly affected by the referendum. However, the decrease in correlation is higher for UK-focused companies than for companies generating most of their revenues abroad. This can be due to the fact that foreign-focused companies are more diversified, and less sensitive to local shocks.

Robustness checks

Here, we also decided to study both types separately. We will also begin with the UK-centred firms.

Local firms

We apply our four usual robustness checks and can observe that the graphs are very similar. There are no big differences if we change the mean equation, the order of the GARCH[74] or if we use S&P data rather than our self-made portfolio. In the case of S&P data, we should emphasize that the estimated conditional correlations are higher than with our portfolios. However, the shape is the same as that we developed in more details above: there is a temporary drop in correlations after the referendum.

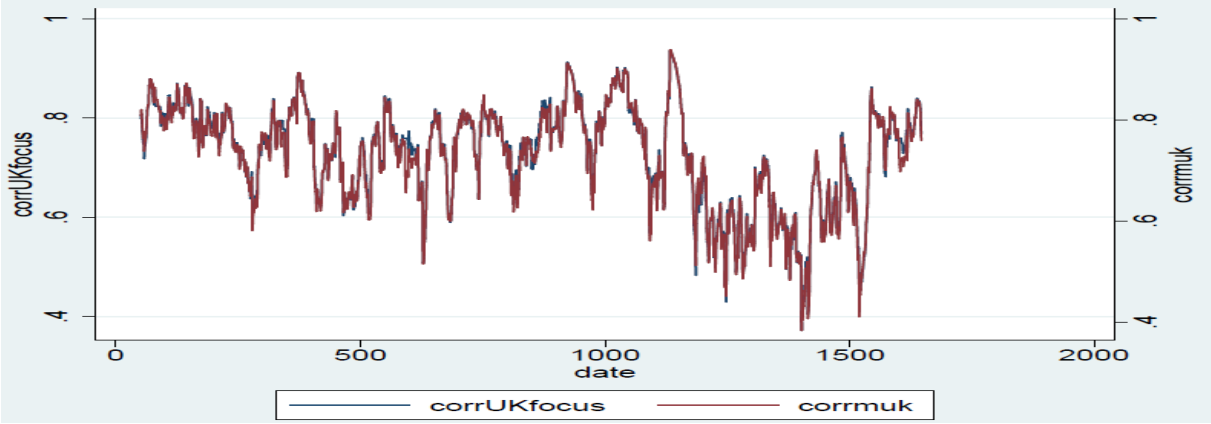


Figure 39: Focus: UK-Focused: Robustness Check: Mean equation. Source: own calculations.

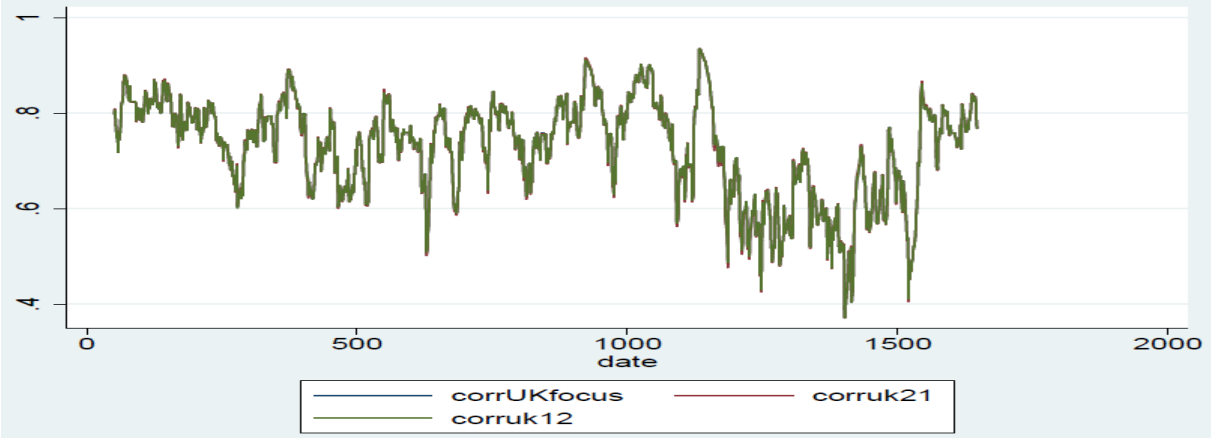


Figure 40: Focus: UK-focused: Robustness Checks: Orders of GARCH. Source: own calculations.

[74] Unfortunately, we could not fit the GARCH (2,2) model.

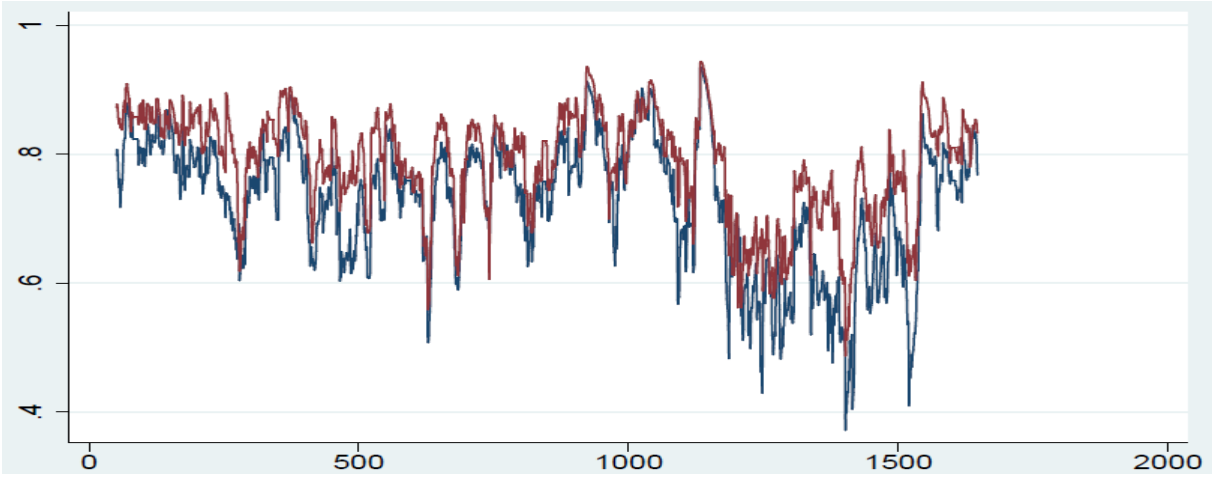


Figure 41: Focus: UK-focused: Robustness check: S&P data. Source: own calculations.

Foreign-focused

Our four usual robustness checks all carry the same conclusion: there is no big difference if we change the mean equation, the order of the GARCH or if we use S&P data rather than our self-made portfolio.

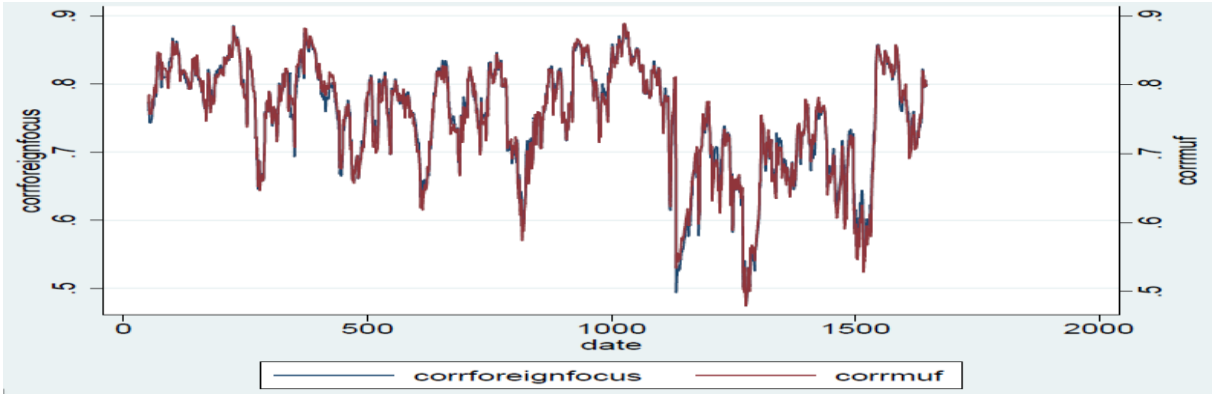


Figure 42: Focus: Foreign-focused: Robustness check: Mean equation. Source: own calculations.

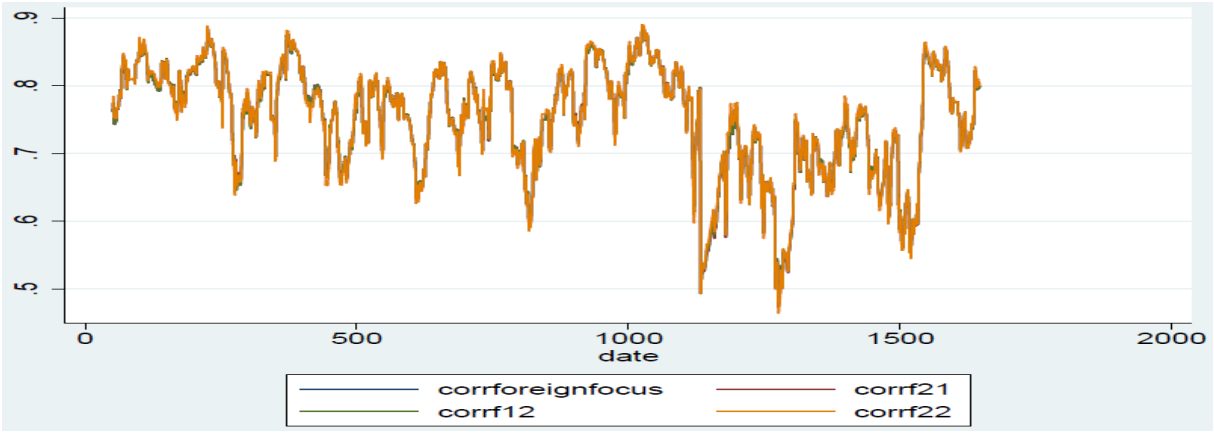


Figure 43: Focus: Foreign-focused: Robustness check: Order of GARCH. Source: own calculations.

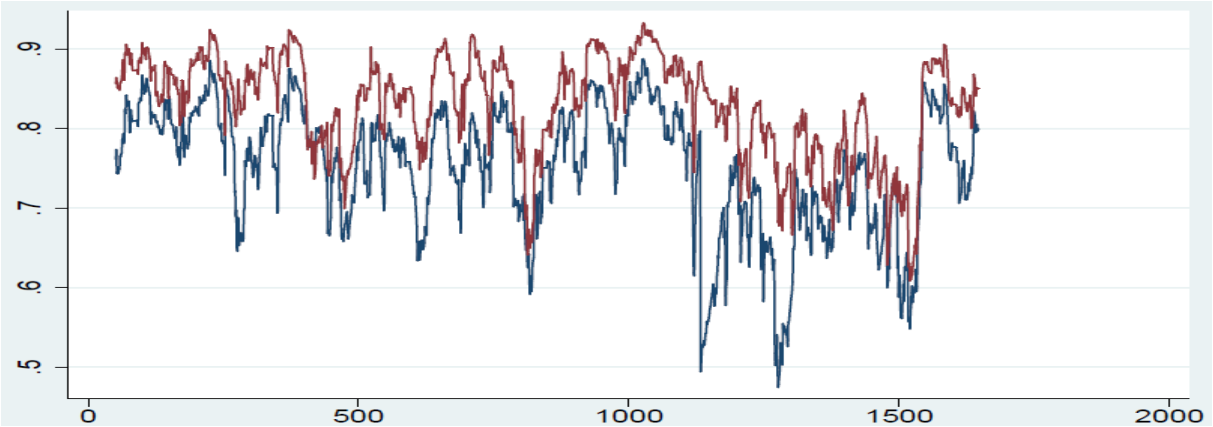


Figure 44: Focus: Foreign-focused: Robustness check: S&P data

The relationship between conditional correlation and conditional variance

A last question of interest is to know whether the dynamic conditional correlations increase or decrease when the conditional volatility increases. The square-root of the variance of the stocks, the standard deviation, is often taken as a measure of risk. In turbulent times, the risk on the market increases. The relationship between conditional volatility and conditional correlations is therefore important: if conditional correlations between the United Kingdom and the European Union increase in times of higher conditional variances, the diversification benefits of the United Kingdom are limited when they are needed the most. In order to test for the relationship between both time series, we followed Syllignakis and Kouretas (2011) and decided to estimate the following regression with a rolling window:

$$\rho_{EU-UK,t} = \beta_0 + \beta_1 * \sigma_{UK,t} + \beta_2 * \sigma_{EU,t} + \varepsilon_{EU-UK,t} ,$$

where $\rho_{EU-UK,t}$ is the correlation between the EU and UK markets at time t; $\sigma_{UK,t}$ and $\sigma_{EU,t}$ are the conditional volatility of the UK and EU markets, respectively; β_0 is the intercept; β_1 and β_2 are the slope coefficients of the regression and measure the relationship between the conditional correlation and each conditional volatility; $\varepsilon_{EU-UK,t}$ is the error term.

If we find statistically significant positive betas (β_1>0 and β_2>0), this would mean that the correlation between both markets increases when the volatility in the EU and the UK increases. In other words, the diversification possibilities would decrease in periods when they are needed the most. Our rolling window has a width of 200 data points. To perform the test, we use the S&P datasets in local currency we previously used for our robustness checks, as these indices are widely available to investors. We compute the betas (blue line) as well as their 95% confidence intervals (red lines).

The United Kingdom

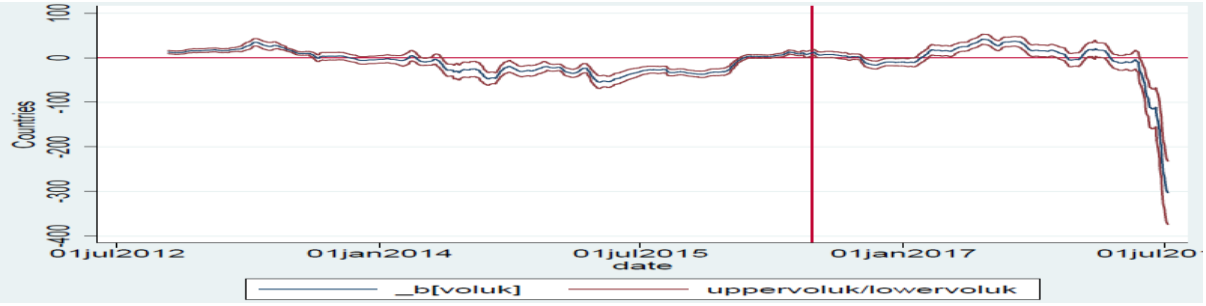
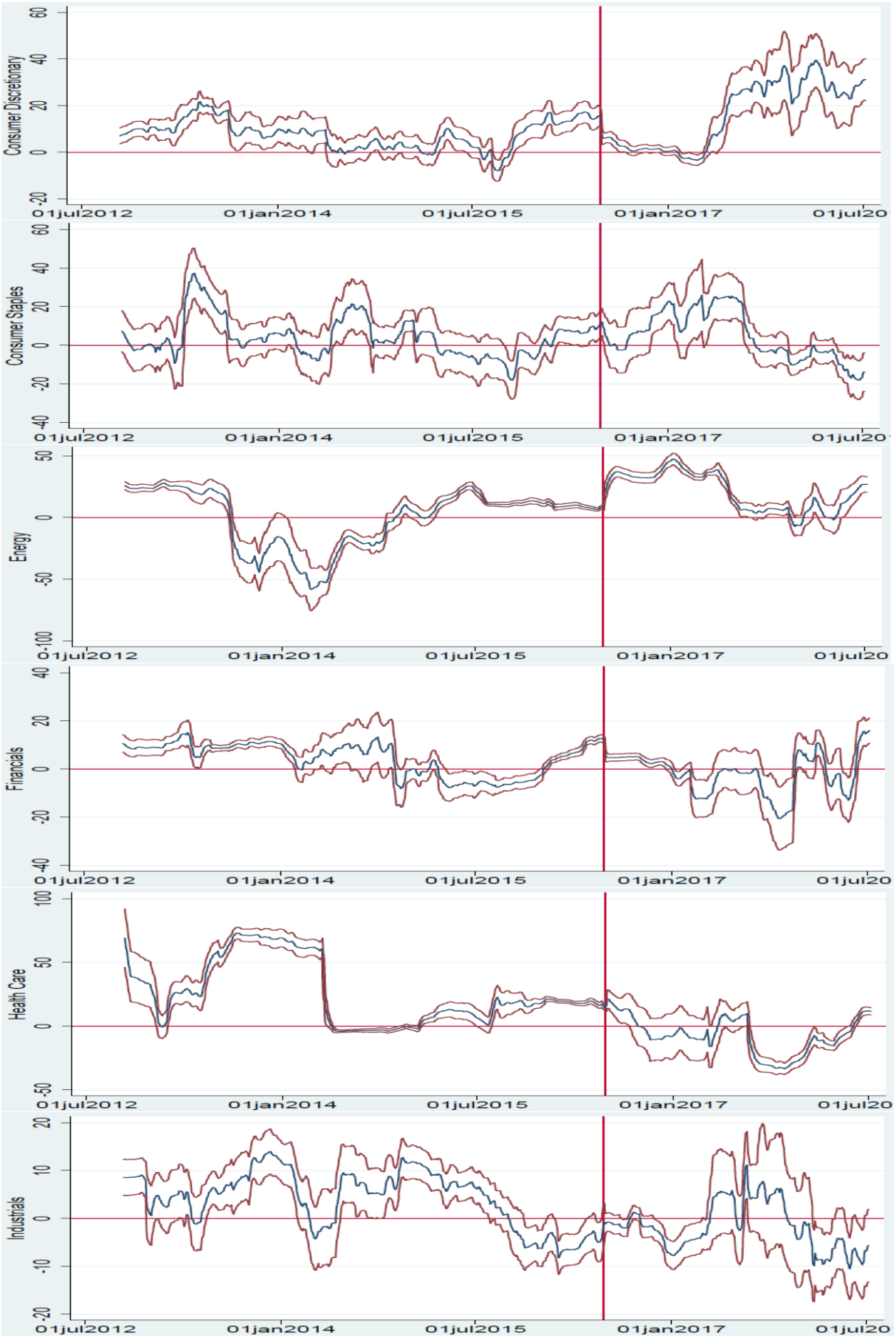


Figure 45: Relationship between the conditional volatility in the UK and the conditional correlation at the country level. Source: own calculations.


Consumer Discretionary
60
40
20
0
-20
01jul2012
01jan2014
01jul2015
01jan2017
Consumer Staples
60
40
20
0
-20
-40
Energy
50
0
-50
-100
Financials
40
20
0
-20
-40
Health Care
100
50
0
-50
Industrials
20
10
0
-10
-20

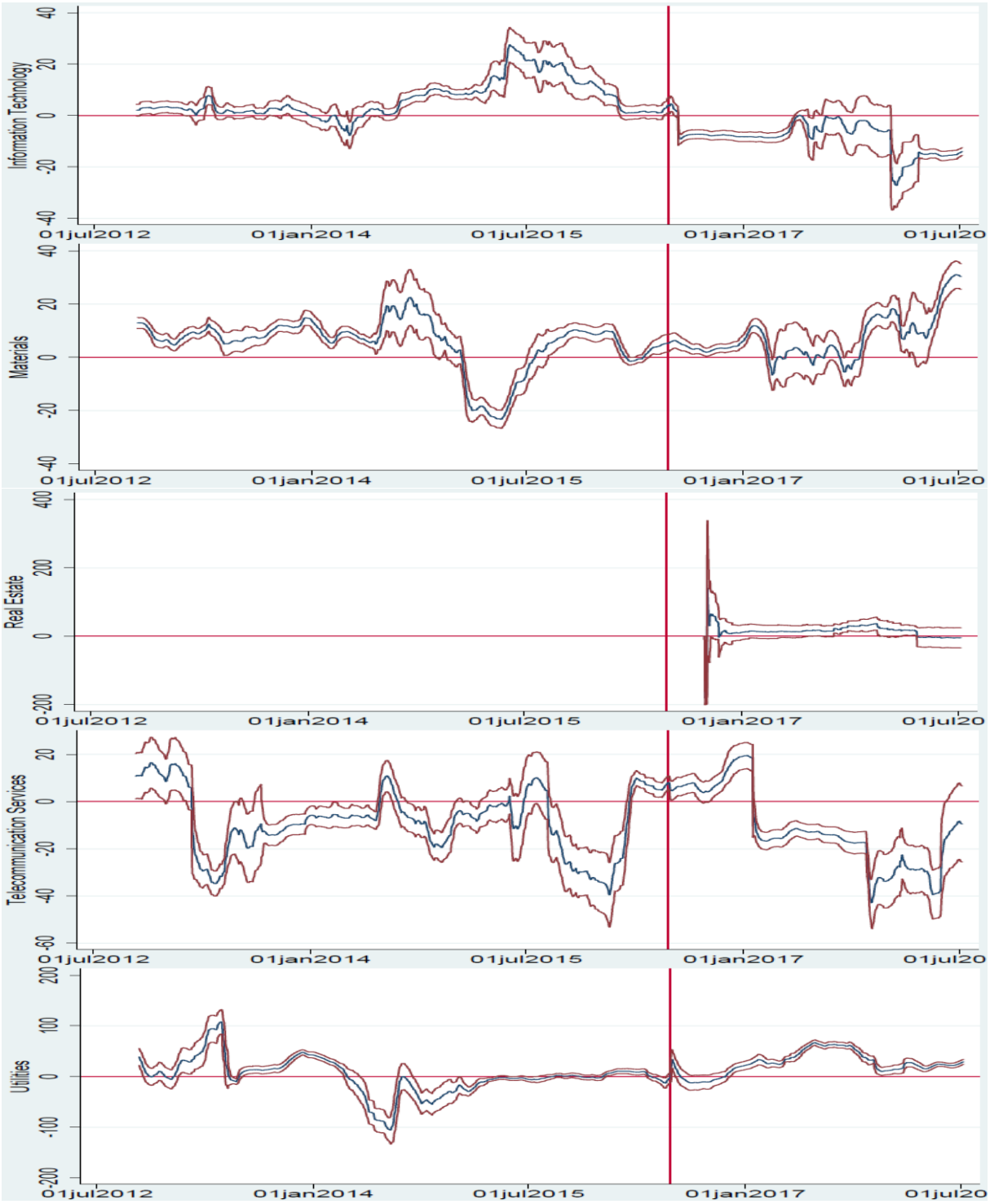


Figure 46: Relationship between the conditional volatility in the UK and the conditional correlation at the sector level. Source: own calculations.

On the graphs above, we can see that the relationship between the conditional volatility and the conditional correlation varies across countries and sectors and across time.

At the country level, the relationship was negative before the referendum: when conditional volatility increased, UK investors could diversify their risk by investing in the EU. Around the time of the vote, it became statistically insignificant. It turned positive at the beginning of the year 2017, which is bad news for portfolio investors as it means that the

correlation increases when the conditional volatility increases. At the end of the sample (if we exclude the ill-behaved data), it was seen as not statistically significant.

All sectors exhibit periods of statistically significant positive and statistically significant negative beta. On most graphs, we can easily see the reaction of the estimated beta after the referendum (the vertical red line). It sometimes increased the beta of the relationship (energy sector, for instance), decrease the beta (financial sector) or had a less obvious effect (telecommunication services).

In order to diversify their portfolio, asset managers should invest in sectors in which the correlation is negatively linked with the conditional volatility. Around the referendum, this did not seem to be possible, as all betas were either positive or statistically insignificant. Currently, only the information technologies and the consumer staples sectors have a significantly negative beta.

The European Union

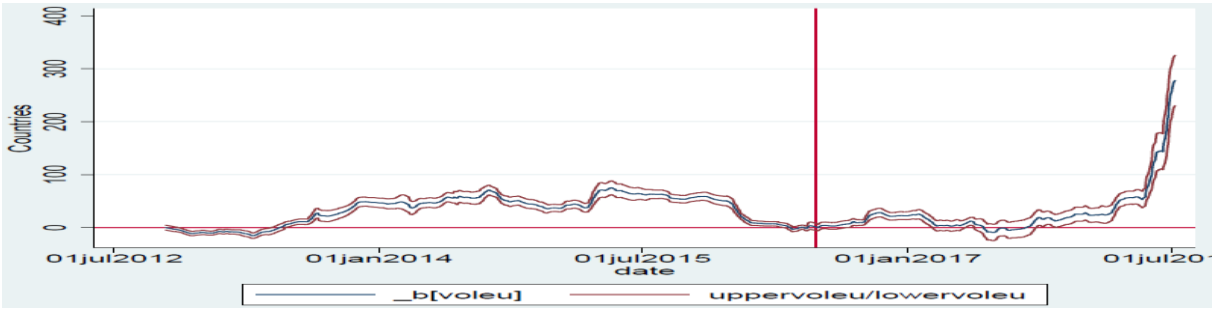
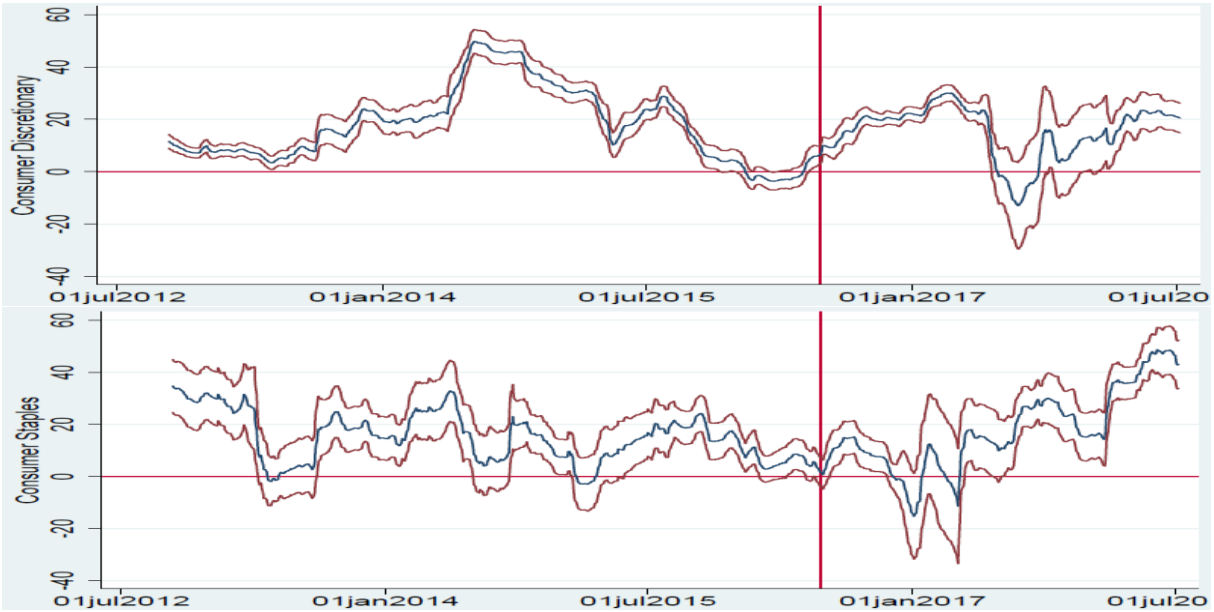
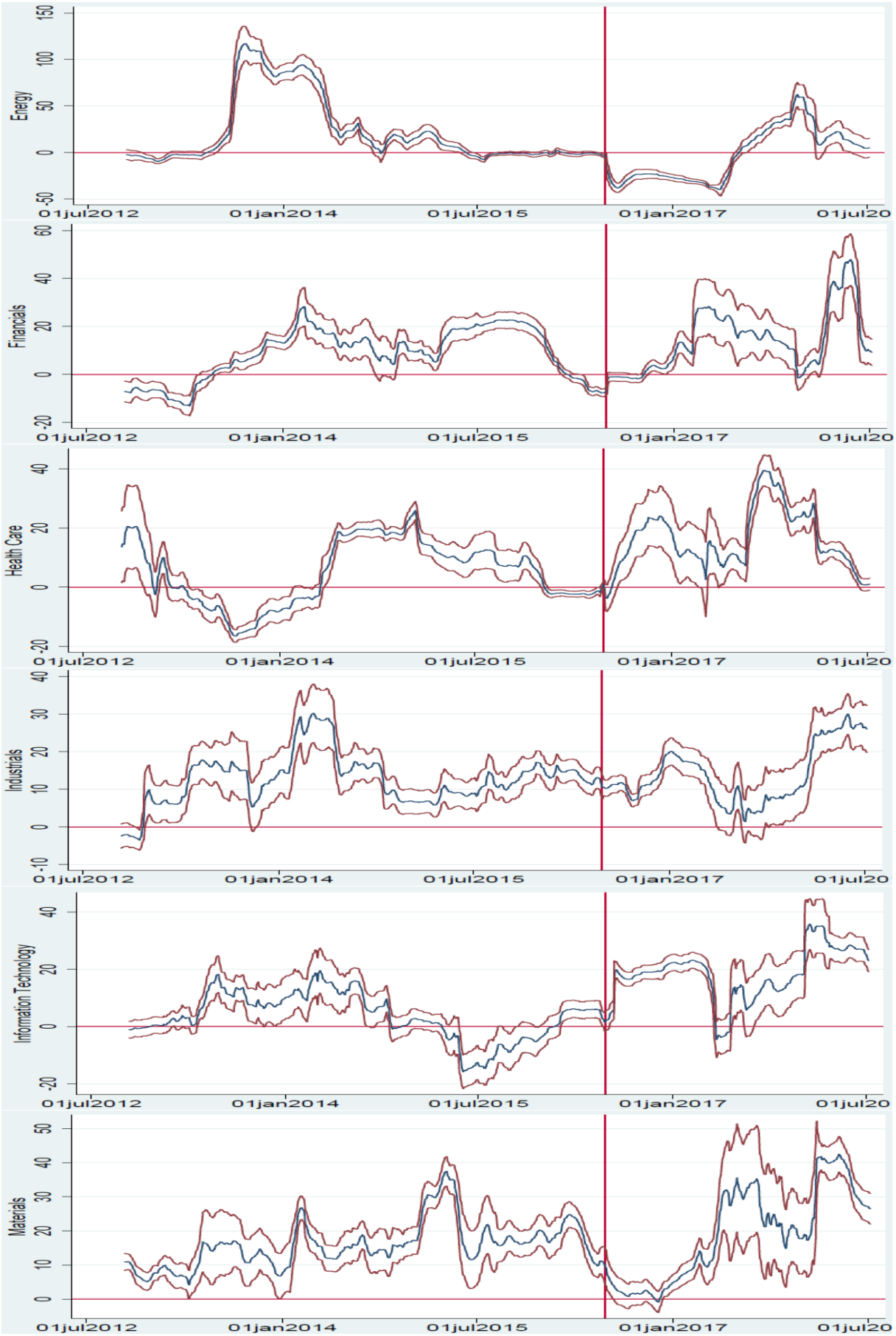


Figure 47: Relationship between the conditional volatility in the EU and the conditional correlation at the country level. Source: own calculations.




Energy
150
100
50
0
-50
Financials
60
40
20
0
-20
Health Care
40
20
0
-20
Industrials
40
30
20
10
0
-10
Information Technology
40
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Materials
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01jan2014
01jul2015
01jan2017
01jul20

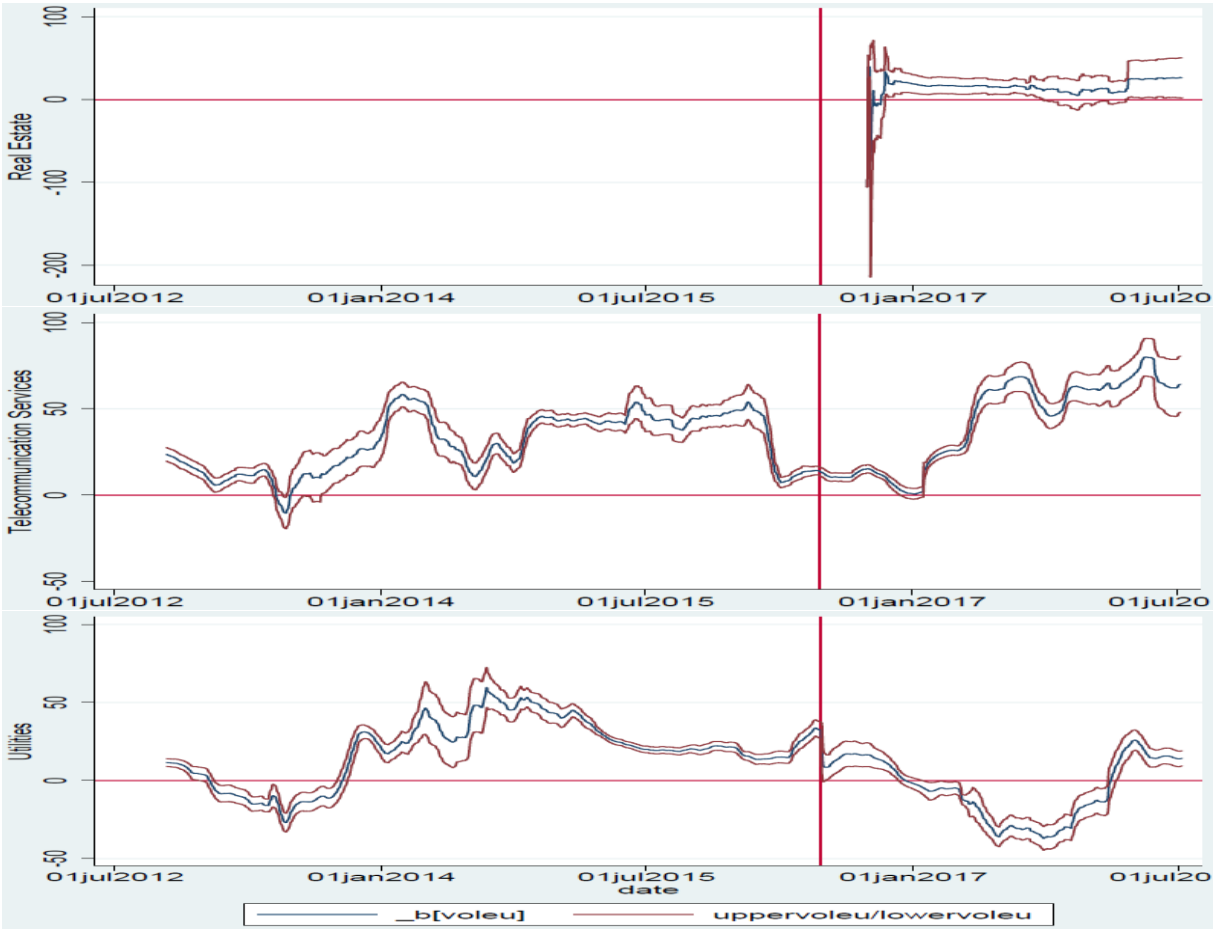

Figure 48: Relationship between the conditional volatility in the EU and the conditional correlation at the sector level. Source: own calculations.

We can see that the relationship between the conditional volatility in the EU and the conditional correlation changed widely across time, at the country and sector level.

At the country level, the relationship was positive before the referendum: an increase in the volatility was associated to an increase in correlations, meaning that investors could diversify less effectively during turbulent periods. After the vote, the relationship decreased and became statistically insignificant. At the end of the sample (if we exclude the latest estimates which are ill-behaved), the relationship is again positive and statistically significant.

At the industry level, there are heterogeneous results: some betas increase (in the health care sector, for instance), others decrease (such as the beta of the energy sector) and some do not exhibit any trend (see the beta of the telecommunication services sector). We can see that the beta of the energy sector is statistically significant negative after the referendum, implying an increase in diversification possibilities. The beta of the Information Technology sector, on the other hand, was not significant before the vote but then increased and became statistically significant.

Based on our estimates, we can say that, for the period just after the referendum, the diversification possibilities of EU investors in turbulent times (when conditional volatilities increase) increase for the utilities and energy sectors, which is have a statistically significant negative beta directly after the referendum. All other sectors have either positive betas or statistically insignificant betas. By the end of the sample, all betas are positive and statistically significant, except that of the health care and the energy sectors, which are not significant.

Conclusion

We could highlight that the relationship between the conditional correlation and the conditional volatility in the EU and the UK evolved across time, countries and sectors. The desirable feature of statistically significant negative betas is scarce in our sample. At the end of the sample, we could only spot such a relationship in the information technologies and the consumer staples in the United Kingdom.

Conclusion

On June 23rd 2016, the United Kingdom chose to leave the European Union, triggering Article 50 of the Treaty of Lisbon for the first time. This process will likely lead to political and economic disintegration as the United Kingdom could use its regain sovereignty to relax some European regulations. By the end of March 2019, the United Kingdom should formally leave the European Union, while it will still profit from some of its advantages, such as the Schengen Area, until the end of 2020. The current period is marked by a high level of uncertainty, as the future relationships between the United Kingdom and the European Union, its main trading partner, has still to be negotiated.

On the financial markets, the announcement of the results of the Brexit referendum implied a shock all over the world. However, it is unclear if the decrease of political integration will lead to longer term effects, in particular to a decrease in financial integration, as there have not yet been studies on the subject, to the best of our knowledge. Our thesis thus contributes to the literature.

In our literature review, we showed that the concept of financial integration has many definitions, with different focus: they can either focus on the legal aspect, the quantity of international flows, or the difference of prices across geographic areas. These different measures lead to the use of a wide range of indicators. We focus on price-based measures as we believe the other measures have major drawbacks.

In particular, we adopt the point of view of a portfolio manager and focus on the correlations as our measure of financial integration. We showed that portfolio managers have a contrasted relationship with financial integration: the set of available securities increases when countries are more integrated, but so does the correlation between markets. Increase in correlations limits the possibilities of risk diversification in the same fashion as for local equities. We saw that most studies conclude that the introduction of the European Union (or alternatively the Euro area) lead to higher correlation among countries' stock exchanges.

We decided to create two portfolios, one for the United Kingdom and one for the European Union. We retrieved daily data from January 2nd 2012 to July 9th 2018. We computed the log-returns based on the total gross return series, in local currency. We decided to weight the log-returns using US dollars market capitalizations.

Our three measures have contrasted results. The comparison of pre-referendum correlation with post-referendum correlations hides the dynamics of the data. We therefore turn to a dynamic measure, namely the 6-month rolling-window correlations. These exhibit larger movements as each data has a higher weight in the sample. However, these measures tend to hamper the study of shocks. For this reason, we apply a DCC-GARCH model to our data. In order to have a clearer analysis, we apply a Markov Switching Model to our Dynamic Conditional Correlations to distinguish two states: high and low correlations. For our robustness checks, we changed alternately the mean equations, the orders of the GARCH and the data of the model, and verify that these variations do not impact our results.

We verified three hypotheses. The first one was that the referendum implied a decrease of the correlations between countries. We partially accept the hypothesis as we find a significant decrease in the level of correlations, but this decrease is only temporary and has come to an end. The second hypothesis was that the referendum had different impacts on the sectors. We confirmed this hypothesis, as we showed that the correlations in five sectors were

unambiguously affected by the referendum's results, while the effect on the remaining sectors was less striking. Out third hypothesis was that more internationalized companies were less affected by the referendum due to the geographic diversification of their revenues. We found that the correlation of companies generating a bigger share of their revenues out of the United Kingdom with the European Union decreased less than the correlation of the European Union with companies generating most of their revenues in the United Kingdom. However, this process was only temporary. We therefore partially accepted our third hypothesis.

The fact that most correlations increased at the end of the sample means that the diversification benefits are not higher now than they were before the referendum. However, we should stress that Brexit has not happened yet. The future relations with the European Union are still unclear. We believe that the correlations between both markets could decrease if the final arrangement does not involve close relationships between the economies.

Future works could be oriented in different directions. They could test the impact of dollar returns, use alternative measures or use a longer dataset.

First, they could try to replicate our study with a different sample incorporating the exchange risk. In this study, we decided to use local currencies as investors could hedge this risk. We conducted this analysis, but decided not to incorporate them as it would have complicated our analysis. However, this is of importance as dollar returns are often used to evaluate the position of an international investor.

Second, they could study the impact of the referendum using alternative measures. For portfolio management purposes, they could focus on the change in the joint impact of the change in correlations and of the possible change in the risk-return relationship of United Kingdom equities after the Brexit. Future works could also focus on the study of the change in the portfolio allocation after Brexit, to see if the level of Foreign Portfolio Investments in the United Kingdom has increased after the referendum. Though all measures are useful, we believe that the measure proposed by Levy Yeyati, Schmukler and Van Horen (2009) is of particular interest as it tests for the Law of One Price.

Third, in the longer run, future researches could assess the effect of Brexit, while we studied the impact of the referendum. However, even the announcement of detailed future relationships could take time, and such research is not to be expected before a while.

List of acronyms

- ADF: Augmented Dickey-Fuller
- ARCH: AutoRegressive Conditional Heteroskedasticity
- BMI: Broad Market Index BoE: Bank of England
- BrExit: British Exit
- DCC: Dynamic Conditional Correlations
- ECB: European Central Bank
- EEA : European Economic Area
- EER: Effective Exchange Rate
- EFTA : European Free Trade Association
- EMU: Economic and Monetary Union
- EU: European Union
- Exchange Arrangements and Exchange Restrictions (AREAER)
- FDI: Foreign Direct Investments
- FTSE: Financial Times Stock Exchange
- GARCH: Generalized AutoRegressive Conditional Heteroskedasticity
- GDP: Gross Domestic Product
- GICS: Global Industry Classification Standard
- IMF: International Monetary Fund
- MiDaS: Mixed-Data Sampling
- MPC: Monetary Policy Committee
- MSM: Markov Switching Model
- OECD: Organisation for Economic Co-operation and Development
- OLS: Ordinary Least Squares
- PCA: Principal Component Analysis
- QE: Quantitative Easing
- S&P: Standard and Poor's
- UK: United Kingdom
- WTO: World Trade Organization

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Appendix 1: Economic survey of the UK

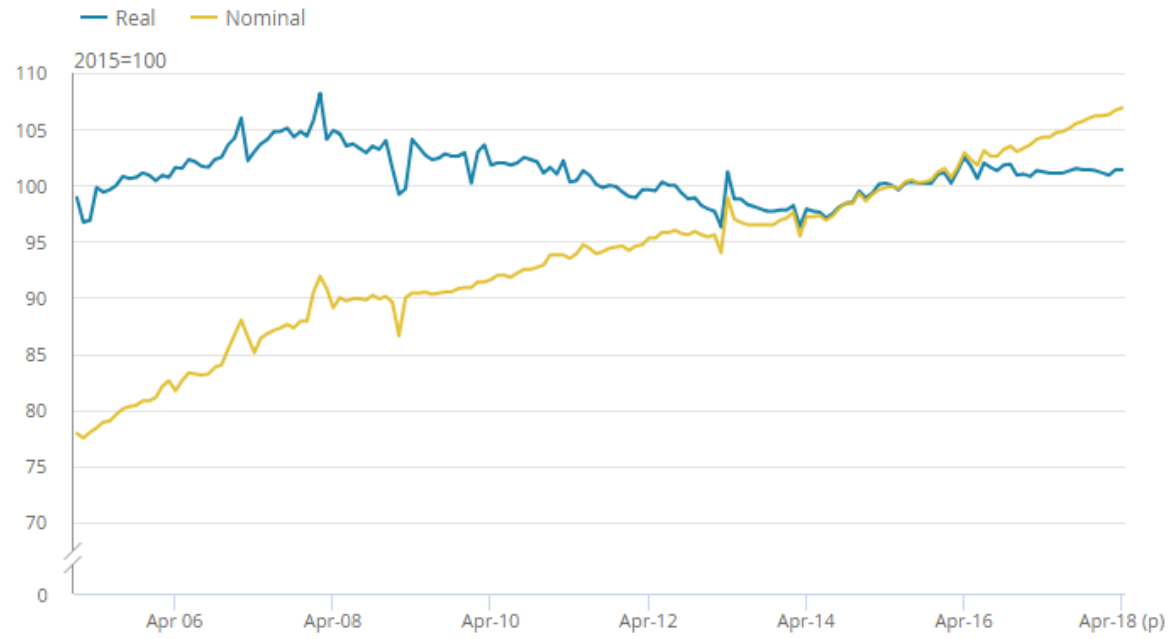


Figure 49: Nominal wages grow more than Real wages

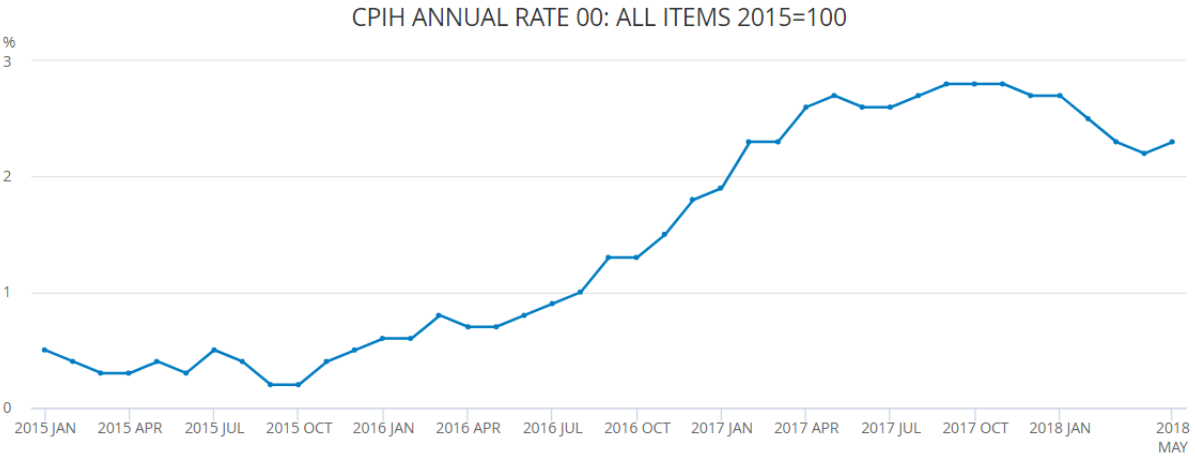


Figure 50: United Kingdom's annual inflation rate, Jan 2015- May2018[75]

[75] Source: ONS: https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l55o/mm23

	OECD	CBI / PwC		LSE / CEP		Treasury		
	WTO/FTA	FTA	WTO	Optimistic ("FTA")	Pessimistic ("WTO")	EEA	FTA	WTO
Outcomes								
Near term	***2020***	***2020***		***Static***				
GDP (%)	-3.3%	-3.1%	-5.5%	-1.3%	-2.6%			
GBP cost equivalent per household	-2200	-2100	-3700	-900	-1700			
Longer term	***2030***	***2030***		***Dynamic***		***Impact of leaving the EU after 15 years***		
GDP (%)	-5.1%	-1.2%	-3.5%			-3.8%	-6.2%	-7.5%
Range	*-2.7% to -7.7%*			*-6.3% to -9.5%*		*-3.4% to -4.3%*	*-4.6% to -7.8%*	*-5.4% to -9.5%*
GBP cost equivalent per household	-3200	-600	-1800			-2600	-4300	-5200
Range	*-1520 to -5000*			*-4200 to -6400*		*-2400 to -2900*	*-3200 to -5400*	*-3700 to -6600*
Channels								
Uncertainty in short-term	x	x	x					
Tariffs on goods trade with the EU	until 2023		x		x			x
Non-tariff barriers on trade with the EU	x	x	x	x	x		x	x
Current FTAs with non-EU countries maintained/replaced		x	from 2026	x	x	gradually replaced	gradually replaced	gradually replaced
Fall in migration	x	x	x					
Fall in FDI	x	x	x			x	x	x
Lower private R&D spending	x					x	x	x
Lower managerial skills	x							
Deregulation	x	x	x					
Lower or zero contributions to EU budget	x	x	x	x	x	x	x	x

Figure 51: Different studies' assessment of the Long Run effects of Brexit[76]

[76] Source: Kierzenkowski, Pain, Rusticelli and Zwart, 2016, p. 35.

The debate

Arguments for and against Brexit, according to the main campaigns

IN		OUT
TRADE		
Britain avoids exporter tariffs and red tape, important as 45% of British exports go to the EU. As a member, Britain can obtain better trade terms because of the EU's size.		Britain will negotiate a new EU relationship without being bound by EU law. It can secure trade deals with other important countries such as China, India and America.
EU BUDGET		
Britain pays the EU £340 a year per household, compared with an estimated £3,000 yearly benefit of membership. In or out, payment is needed to access the single market.		Britain can stop sending £350m, equivalent to half England's schools budget, to Brussels every week. This money could be spent on scientific research and new industries.
REGULATION		
Most EU regulation collapses 28 national standards into one European standard, reducing red tape and benefiting business. In, Britain can fight for better regulation.		Leaving will return control over areas like employment law and health and safety, measures that a recent Business for Britain poll found businesses favoured.
IMMIGRATION		
Leaving doesn't mean reduced immigration. Countries that trade with the EU from outside have higher rates of immigration, including from EU countries, than Britain.		Britain can change the "expensive and out-of-control" system that offers an open door to the EU and blocks non-EU immigrants who could contribute to the UK.
INFLUENCE		
At international summits, Britain is represented twice – by the foreign secretary and the EU high representative. Co-operation has helped fight Ebola and piracy in Africa.		Britain has little influence within the EU. From outside, it can retake seats on international institutions and be a stronger influence for free trade and co-operation.

Sources: Britain Stronger in Europe; Vote Leave

Economist.com

Figure 52: Arguments of tenants of Brexit and Remain[77]

Figure 53: Evolution of Pounds futures prices for June 2020[78]

[77] https://www.economist.com/graphic-detail/2016/02/24/a-background-guide-to-brexit-from-the-european-union

[78] Source: CME Group. Data available at: https://www.cmegroup.com/trading/fx/g10/british-pound.html

Appendix 2: indices composition and descriptive statistics

Generalities

#	Country	Main Index (Ticker)	#	Country	Main Index (Ticker)
1	Austria	ATX 20	15	Italy	FTSE MIB
2	Belgium	BEL 20	16	Latvia	OMXR
3	Bulgaria	SOFIX	17	Lithuania	VILSE
4	Croatia	CROBEX	18	Luxemburg	LUXXX
5	Cyprus	CYSMMAPA	19	Malta	MALTEX
6	Czech Republic	PX	20	Netherlands	AEX
7	Denmark	OMXC 25	21	Poland	WIG
8	Estonia	OMXT	22	Portugal	PSI 20
9	Finland	HEX 25	23	Romania	BET
10	France	CAC 40	24	Slovakia	SAX
11	Germany	DAX	25	Slovenia	SBITOP
12	Greece	ASE	26	Spain	IBEX
13	Hungary	BUX	27	Sweden	OMX
14	Ireland	ISEQ[79]	28	United Kingdom	FTSE 100

Table 1: Main country's indicators and tickers[80]

Sector	Industry Groups	Sector	Industry Groups
Energy	- Energy equipment and services - Oil, gas and consumable fuels	Consumer discretionary	- Automobiles and components - Consumer durables and apparel - Consumer services - Media - Retailing
Materials	- Chemicals - Construction materials - Containers and packaging - Metals and mining - Paper and forest products	Consumer staples	- Food and staples retailing - Food beverage and tobacco - Household and personal products
Industrials	- Aerospace and defense - Building products - Constructiona nd engineering - Electrical equipment - Industrial conglomerates - Machinery - Trading companies and distributors - Commercial services and	Telecommunication services	- Broadband Telecommunications Services - Satellite Communication Services - Calling Card Provider Services - Conferencing Services - Directory Assistance Services

[79] This index excludes United Kingdom registered companies
[80] Source : Bloomberg

	supplies - Professional services - Air freight and logistics - Airlines - Marine - Road and rail - Transportaion infrastructure		- Facsimile Transmission Services - Local Telecommunications Services - Long Distance Telecommunications Services - Pay Phone Provider Services - Ship-To-Shore Broadcasting Communications - Telephone Answering Services - Cellular Services - Mobile Data Services - Paging Services
Utilities	- Electric Utilities - Gas Utilities - Independent Power Producers and Energy Traders - Multi-Utilities - Water Utilities		
Financials	- Banks - Diversified Financials - Insurance	Information technology	- Semiconductors and Semiconductor Equipment - Software and Services - Technology Hardware and Equipment
Health Care	- Health Care equipment and services - Pharmaceuticals, Biotechnology and Life Sciences	Real estate	- Equity Real Estate Investment Trusts (REITs) - Real Estate Management and Development

Figure 54: The 11 sectors and 28 industries distinguished by CIQ[81]

#	Company Name	Sector	#	Company Name	Sector	#	Company Name	Sector
1	3i Group plc	Fin	35	Glencore Plc	Mat	69	Rentokil Initial plc	Indu
2	Admiral Group plc	Fin	36	GVC Holdings PLC	CD	70	Rightmove plc	IT
3	Anglo American plc	Mat	37	Halma plc	IT	71	Rio Tinto plc	Mat
4	Antofagasta plc	Mat	38	Hargreaves Lansdown plc	Fin	72	Rolls-Royce Holdings plc	Indu
5	Ashtead Group plc	Indu	39	HSBC Holdings plc	Fin	73	Royal Dutch Shell plc	En
6	Associated British Foods plc	CS	40	Imperial Brands PLC	CS	74	Royal Dutch Shell plc	En
7	AstraZeneca PLC	H	41	Informa plc	CD	75	Royal Mail plc	Indu
8	Aviva plc	Fin	42	InterContinental Hotels Group PLC	CD	76	RSA Insurance Group plc	Fin
9	BAE Systems plc	Indu	43	International Consolidated Airlines Group, S.A.	Indu	77	Schroders plc	Fin
10	Barclays PLC	Fin	44	Intertek Group plc	Indu	78	Scottish Mortgage Investment Trust PLC	Fin
11	Barratt	CD	45	ITV plc	CD	79	SEGRO Plc	RE

[81] Source : https://www.unm.edu/~maj/Security%20Analysis/GICS.pdf, last consulted

	Developments plc							
12	BHP Billiton plc	Mat	46	J Sainsbury plc	CS	80	Severn Trent Plc	UT
13	BP p.l.c.	En	47	Johnson Matthey Plc	Mat	81	Shire plc	H
14	British American Tobacco p.l.c.	CS	48	Just Eat plc	IT	82	Sky plc	CD
15	British Land Company Plc	RE	49	Kingfisher plc	CD	83	Smith & Nephew plc	H
16	BT Group plc	TS	50	Land Securities Group plc	RE	84	Smiths Group plc	Indu
17	Bunzl plc	Indu	51	Legal & General Group Plc	Fin	85	Smurfit Kappa Group plc	Mat
18	Burberry Group plc	CD	52	Lloyds Banking Group plc	Fin	86	SSE plc	UT
19	Carnival plc	CD	53	London Stock Exchange Group plc	Fin	87	St. James's Place plc	Fin
20	Centrica plc	UT	54	Marks and Spencer Group plc	CD	88	Standard Chartered PLC	Fin
21	Coca-Cola HBC AG	CS	55	Melrose Industries PLC	Indu	89	Standard Life Aberdeen plc	Fin
22	Compass Group PLC	CD	56	Micro Focus International plc	IT	90	Taylor Wimpey plc	CD
23	CRH plc	Mat	57	Mondi plc	Mat	91	Tesco PLC	CS
24	Croda International Plc	Mat	58	National Grid plc	UT	92	The Berkeley Group Holdings plc	CD
25	DCC plc	Indu	59	NEXT plc	CD	93	The Royal Bank of Scotland Group plc	Fin
26	Diageo plc	CS	60	NMC Health Plc	H	94	The Sage Group plc	IT
27	Direct Line Insurance Group plc	Fin	61	Ocado Group plc	CD	95	TUI AG	CD
28	DS Smith Plc	Mat	62	Paddy Power Betfair plc	CD	96	Unilever PLC	CS
29	easyJet plc	Indu	63	Pearson plc	CD	97	United Utilities Group PLC	UT
30	EVRAZ plc	Mat	64	Persimmon Plc	CD	98	Vodafone Group Plc	TS
31	Experian plc	Indu	65	Prudential plc	Fin	99	Whitbread PLC	CD
32	Ferguson plc	Indu	66	Randgold Resources Limited	Mat	100	Wm Morrison Supermarkets PLC	CS
33	Fresnillo PLC	Mat	67	Reckitt Benckiser Group plc	CS	101	WPP plc	CD
34	GlaxoSmithKline plc	H	68	RELX PLC	Indu			

Figure 55: Composition of FTSE100, July 9th 2018, with sector

#	Company Name	Sector	#	Company Name	Sector	#	Company Name	Sector
1	3i Infrastructure plc	Fin	85	Grafton Group plc	Indu	169	Polypipe Group plc	Indu
2	888 Holdings plc	CD	86	Grainger plc	RE	170	Premier Oil plc	En
3	A.G. BARR p.l.c.	CS	87	Great Portland Estates Plc	RE	171	Primary Health Properties Plc	RE
4	AA plc	CD	88	Greencoat United Kingdom Wind PLC	UT	172	Provident Financial plc	Fin
5	Aberforth Smaller Companies Trust Plc	Fin	89	Greencore Group plc	CS	173	PZ Cussons Plc	CS
6	Aggreko Plc	Indu	90	Greene King plc	CD	174	QinetiQ Group plc	Indu
7	Alfa Financial Software Holdings PLC	IT	91	Greggs plc	CD	175	Quilter plc	Fin

8	Alliance Trust PLC	Fin	92	Halfords Group plc	CD	176	Rathbone Brothers Plc	Fin
9	Ascential plc	CD	93	Hammerson plc	RE	177	RDI REIT P.L.C.	RE
10	Ashmore Group PLC	Fin	94	HarbourVest Global Private Equity Ltd.	Fin	178	Redrow plc	CD
11	Assura Plc	RE	95	Hastings Group Holdings plc	Fin	179	Renewi plc	Indu
12	Auto Trader Group plc	IT	96	Hays plc	Indu	180	Renishaw plc	IT
13	AVEVA Group plc	IT	97	Herald Investment Trust PLC	Fin	181	RHI Magnesita N.V.	Mat
14	B&M European Value Retail S.A.	CD	98	HICL Infrastructure Company Limited	Fin	182	RIT Capital Partners plc	Fin
15	Babcock International Group plc	Indu	99	Hikma Pharmaceuticals PLC	H	183	Riverstone Energy Limited	Fin
16	Bakkavor Group plc	CS	100	Hill & Smith Holdings PLC	Mat	184	Rotork plc	Indu
17	Balfour Beatty plc	Indu	101	Hilton Food Group plc	CS	185	RPC Group Plc	Mat
18	Bank of Georgia Group PLC	Fin	102	Hiscox Ltd	Fin	186	Safestore Holdings plc	RE
19	BBA Aviation plc	Indu	103	Hochschild Mining plc	Mat	187	Saga plc	Fin
20	BCA Marketplace plc	CD	104	HomeServe plc	Indu	188	Sanne Group plc	Fin
21	Beazley plc	Fin	105	Howden Joinery Group Plc	Indu	189	Savills plc	RE
22	Bellway p.l.c.	CD	106	Hunting plc	En	190	Schroder Investment Trust - Schroder AsiaPacific Fund plc	Fin
23	Big Yellow Group Plc	RE	107	Ibstock plc	Mat	191	Senior plc	Indu
24	Bodycote plc	Indu	108	IG Group Holdings plc	Fin	192	Sequoia Economic Infrastructure Income Fund Limited	Fin
25	Bovis Homes Group PLC	CD	109	IMI plc	Indu	193	Serco Group plc	Indu
26	Brewin Dolphin Holdings PLC	Fin	110	Inchcape plc	CD	194	Shaftesbury PLC	RE
27	British Empire Trust Plc	Fin	111	Indivior PLC	H	195	SIG plc	Indu
28	Britvic plc	CS	112	Inmarsat Plc	TS	196	Sirius Minerals Plc	Mat
29	BTG plc	H	113	IntegraFin Holdings plc	Fin	197	Softcat plc	IT
30	Cairn Energy PLC	En	114	Intermediate Capital Group plc	Fin	198	Sophos Group plc	IT
31	Caledonia Investments plc	Fin	115	International Public Partnerships Limited	Fin	199	Spectris plc	IT
32	Capita plc	Indu	116	intu properties plc	RE	200	Spirax-Sarco Engineering plc	Indu
33	Capital & Counties Properties PLC	RE	117	Investec plc	Fin	201	Spire Healthcare Group plc	H
34	Card Factory plc	CD	118	IP Group Plc	Fin	202	Sports Direct International plc	CD
35	Centamin plc	Mat	119	IWG PLC	Indu	203	SSP Group plc	CD
36	Charter Court	Fin	120	J D Wetherspoon plc	CD	204	St. Modwen	RE

	Financial Services Group plc						Properties PLC	
37	Cineworld Group plc	CD	121	James Fisher and Sons plc	Indu	205	Stagecoach Group plc	Indu
38	Clarkson PLC	Indu	122	Jardine Lloyd Thompson Group plc	Fin	206	Stobart Group Limited	En
39	Close Brothers Group plc	Fin	123	JD Sports Fashion plc	CD	207	Superdry Plc	CD
40	CLS Holdings plc	RE	124	John Laing Group plc	Indu	208	Syncona Limited	Fin
41	Coats Group plc	CD	125	John Laing Infrastructure Fund Ltd.	Fin	209	Synthomer plc	Mat
42	Cobham plc	Indu	126	John Wood Group PLC	En	210	TalkTalk Telecom Group PLC	TS
43	Computacenter plc	IT	127	JPMorgan American Investment Trust plc	Fin	211	Tate & Lyle plc	CS
44	ContourGlobal plc	UT	128	JPMorgan Emerging Markets Investment Trust plc	Fin	212	TBC Bank Group PLC	Fin
45	Convatec Group Plc	H	129	JPMorgan Indian Investment Trust plc	Fin	213	Ted Baker Plc	CD
46	Countryside Properties PLC	CD	130	JPMorgan Japanese Investment Trust plc	Fin	214	Telecom Plus PLC	UT
47	Cranswick plc	CS	131	Jupiter European Opportunities Trust PLC	Fin	215	Temple Bar Investment Trust PLC	Fin
48	Crest Nicholson Holdings plc	CD	132	Jupiter Fund Management Plc	Fin	216	Templeton Emerging Markets Investment Trust plc	Fin
49	CYBG PLC	Fin	133	Just Group Plc	Fin	217	The Baillie Gifford Japan Trust PLC	Fin
50	Daejan Holdings Plc	RE	134	KAZ Minerals PLC	Mat	218	The Bankers Investment Trust PLC	Fin
51	Dairy Crest Group plc	CS	135	Keller Group plc	Indu	219	The City of London Investment Trust plc	Fin
52	Dechra Pharmaceuticals plc	H	136	Kier Group plc	Indu	220	The Edinburgh Investment Trust plc	Fin
53	Derwent London Plc	RE	137	Lancashire Holdings Limited	Fin	221	The Go-Ahead Group plc	Indu
54	Diploma PLC	Indu	138	LondonMetric Property Plc	RE	222	The Mercantile Investment Trust plc	Fin
55	Dixons Carphone plc	CD	139	Man Group plc	Fin	223	The Monks Investment Trust PLC	Fin
56	Domino's Pizza Group plc	CD	140	Marshalls plc	Mat	224	The Rank Group Plc	CD
57	Drax Group plc	UT	141	McCarthy & Stone plc	CD	225	The Renewables Infrastructure Group Limited	UT
58	Dunelm Group plc	CD	142	Mediclinic International plc	H	226	The Scottish Investment Trust PLC	Fin
59	Edinburgh Dragon	Fin	143	Meggitt PLC	Indu	227	The Unite Group plc	RE

	Trust plc							
60	Electrocomponents plc	IT	144	Merlin Entertainments plc	CD	228	The Weir Group PLC	Indu
61	Elementis plc	Mat	145	Metro Bank PLC	Fin	229	Thomas Cook Group plc	CD
62	Energean Oil & Gas plc	En	146	Millennium & Copthorne Hotels plc	CD	230	TI Fluid Systems plc	CD
63	Entertainment One Ltd.	CD	147	Mitchells & Butlers plc	CD	231	TP ICAP plc	Fin
64	Equiniti Group plc	IT	148	Moneysupermarket.com Group PLC	IT	232	TR Property Investment Trust plc	Fin
65	Essentra plc	Mat	149	Morgan Advanced Materials plc	Indu	233	Travis Perkins plc	Indu
66	esure Group plc	Fin	150	Murray International Trust PLC	Fin	234	Tritax Big Box REIT plc	RE
67	Euromoney Institutional Investor PLC	CD	151	National Express Group PLC	Indu	235	Tullow Oil plc	En
68	F&C Commercial Property Trust Limited	RE	152	NB Global Floating Rate Income Fund Limited	Fin	236	UDG Healthcare plc	H
69	F&C Global Smaller Companies PLC	Fin	153	NewRiver REIT plc	RE	237	United Kingdom Commercial Property REIT Limited	RE
70	FDM Group (Holdings) PLC	IT	154	NEX Group plc	Fin	238	Ultra Electronics Holdings plc	Indu
71	Ferrexpo Plc	Mat	155	On the Beach Group plc	CD	239	Vedanta Resources plc	Mat
72	Fidelity China Special Situations PLC	Fin	156	OneSavings Bank Plc	Fin	240	Vesuvius plc	Indu
73	Fidelity Investment Trust - Fidelity European Values plc	Fin	157	PageGroup plc	Indu	241	Victrex plc	Mat
74	Fidelity Investment Trust - Fidelity Special Values PLC	Fin	158	Pantheon International PLC	Fin	242	Vietnam Enterprise Investments Limited	Fin
75	Fidessa group plc	IT	159	Paragon Banking Group PLC	Fin	243	VinaCapital Vietnam Opportunity Fund Limited	Fin
76	Finsbury Growth & Income Trust PLC	Fin	160	Pennon Group Plc	UT	244	Virgin Money Holdings (United Kingdom) plc	Fin
77	Firstgroup plc	Indu	161	Perpetual Income and Growth Investment Trust plc	Fin	245	WH Smith PLC	CD
78	Foreign & Colonial Investment Trust PLC	Fin	162	Pershing Square Holdings, Ltd.	Fin	246	William Hill plc	CD
79	G4S plc	Indu	163	Personal Assets Trust plc	Fin	247	Witan Investment Trust plc	Fin
80	Galliford Try plc	Indu	164	Petrofac Limited	En	248	Wizz Air Holdings Plc	Indu
81	Games Workshop	CD	165	Phoenix Group	Fin	249	Workspace Group	RE

	Group PLC			Holdings			plc	
82	GCP Infrastructure Investments Limited	Fin	166	Playtech plc	CD	250	Worldwide Healthcare Trust PLC	Fin
83	Genesis Emerging Markets Fund	Fin	167	Polar Capital Technology Trust plc	Fin			
84	Genus plc	H	168	Polymetal International Plc	Mat			

Figure 56: Composition of FTSE 250, July 9th 2018, with sector

#	Company name	Sector	#	Company name	Sector	#	Company name	Sector
1	Telenet Group Holding NV	CD	181	Banca Generali S.p.A.	Fin	361	Aegean Airlines S.A.	Indu
2	Accor SA	CD	182	Banca Mediolanum S.p.A.	Fin	362	GEK TERNA Holdings, Real Estate, Construction S.A.	Indu
3	Compagnie Générale des Établissements Michelin	CD	183	Banco BPM Società per Azioni	Fin	363	Piraeus Port Authority S.A.	Indu
4	Hermès International Société en commandite par actions	CD	184	BPER Banca S.p.A.	Fin	364	Ellaktor S.A.	Indu
5	Kering SA	CD	185	Exor N.V.	Fin	365	Autohellas SA	Indu
6	LVMH Moët Hennessy Louis Vuitton S.E.	CD	186	FinecoBank Banca Fineco S.p.A.	Fin	366	OPUS GLOBAL Nyrt.	Indu
7	Peugeot S.A.	CD	187	Intesa Sanpaolo S.p.A.	Fin	367	ANY Security Printing Company Public Limited Company	Indu
8	Publicis Groupe S.A.	CD	188	Mediobanca Banca di Credito Finanziario S.p.A.	Fin	368	Rába Járműipari Holding Nyrt.	Indu
9	Renault SA	CD	189	Poste Italiane SpA	Fin	369	Irish Continental Group plc	Indu
10	Sodexo S.A.	CD	190	UniCredit S.p.A.	Fin	370	Kingspan Group plc	Indu
11	Valeo SA	CD	191	Unione di Banche Italiane S.p.A.	Fin	371	Ryanair Holdings plc	Indu
12	Vivendi SA	CD	192	Unipol Gruppo S.p.A.	Fin	372	Malta International Airport p.l.c.	Indu
13	Bayerische Motoren Werke Aktiengesellschaft	CD	193	UnipolSai Assicurazioni S.p.A.	Fin	373	MaltaPost p.l.c.	Indu
14	Continental Aktiengesellschaft	CD	194	Erste Group Bank AG	Fin	374	Slovenské Energetické Strojárne a.s.	Indu
15	adidas AG	CD	195	Raiffeisen Bank International AG	Fin	375	Luka Koper d.d.	Indu
16	Volkswagen Aktiengesellschaft	CD	196	BAWAG P.S.K.	Fin	376	InterEuropa d.d.	Indu
17	Daimler AG	CD	197	Vienna Insurance Group AG	Fin	377	Cargotec Corporation	Indu

18	Altice Europe N.V.	CD	198	UNIQA Insurance Group AG	Fin	378	Konecranes Plc	Indu
19	SES S.A.	CD	199	First Investment Bank AD	Fin	379	KONE Oyj	Indu
20	RTL Group SA	CD	200	Eurohold Bulgaria AD	Fin	380	Metso Corporation	Indu
21	Industria de Diseño Textil, S.A.	CD	201	Central Cooperative Bank Plc	Fin	381	Outotec Oyj	Indu
22	CIE Automotive, S.A.	CD	202	Holding Varna PLC	Fin	382	Valmet Oyj	Indu
23	Meliá Hotels International, S.A.	CD	203	Doverie United Holding AD	Fin	383	Wärtsilä Oyj Abp	Indu
24	Mediaset España Comunicación, S.A.	CD	204	Zagrebacka banka dd	Fin	384	YIT Oyj	Indu
25	Ibersol, S.G.P.S., S.A.	CD	205	Hellenic Bank Public Company Limited	Fin	385	Atos SE	IT
26	NOS, S.G.P.S., S.A.	CD	206	Bank of Cyprus Holdings Public Limited Company	Fin	386	Capgemini SE	IT
27	Brembo S.p.A.	CD	207	Demetra Investment Public Limited	Fin	387	STMicroelectronics N.V.	IT
28	Ferrari N.V.	CD	208	SFS Group Public Company Limited	Fin	388	SAP SE	IT
29	Fiat Chrysler Automobiles N.V.	CD	209	Komercní banka, a.s.	Fin	389	Infineon Technologies AG	IT
30	Luxottica Group S.p.A.	CD	210	MONETA Money Bank, a.s.	Fin	390	ASML Holding N.V.	IT
31	Mediaset S.p.A.	CD	211	Erste Group Bank AG	Fin	391	Gemalto N.V.	IT
32	Moncler S.p.A.	CD	212	Vienna Insurance Group AG	Fin	392	Amadeus IT Group, S.A.	IT
33	Pirelli & C. S.p.A.	CD	213	Danske Bank A/S	Fin	393	Indra Sistemas, S.A.	IT
34	Salvatore Ferragamo S.p.A.	CD	214	Tryg A/S	Fin	394	STMicroelectronics N.V.	IT
35	Albena AD	CD	215	Jyske Bank A/S	Fin	395	AT & S Austria Technologie & Systemtechnik Aktiengesellschaft	IT
36	Valamar Riviera d.d.	CD	216	Eften Real Estate Fund III As	Fin	396	Sirma Group Holding AD	IT
37	Maistra d.d.	CD	217	AS LHV Group	Fin	397	Ericsson Nikola Tesla d.d.	IT
38	Arena Hospitality Group d.d. za turizam i ugostiteljstvo	CD	218	Siauliu Bankas AB	Fin	398	Logicom Public Limited	IT
39	AD Plastik d.d.	CD	219	Nordea Bank AB (publ)	Fin	399	A/S SAF Tehnika	IT
40	Cyprus Trading Corporation Plc	CD	220	Swedbank AB (publ)	Fin	400	HansaMatrix, SA	IT
41	The Cyprus Cement Public	CD	221	Svenska Handelsbanken	Fin	401	Telefonaktiebolaget LM Ericsson	IT

	Company Ltd			AB (publ)			(publ)	
42	Louis plc	CD	222	Skandinaviska Enskilda Banken AB (publ.)	Fin	402	Hexagon AB (publ)	IT
43	PFNonwovens a.s.	CD	223	Kinnevik AB	Fin	403	RS2 Software p.l.c.	IT
44	Central European Media Enterprises Ltd.	CD	224	Investor AB	Fin	404	CD Projekt S.A.	IT
45	Pandora A/S	CD	225	Alpha Bank A.E.	Fin	405	Nokia Corporation	IT
46	AS Baltika	CD	226	National Bank of Greece S.A.	Fin	406	Tieto Oyj	IT
47	AS Ekspress Grupp	CD	227	Eurobank Ergasias S.A.	Fin	407	Solvay SA	Mat
48	AS Silvano Fashion Group	CD	228	Piraeus Bank S.A.	Fin	408	Umicore S.A.	Mat
49	Olympic Entertainment Group AS	CD	229	OTP Bank Plc.	Fin	409	ArcelorMittal	Mat
50	Novaturas AB	CD	230	CIG Pannónia Életbiztosító Nyrt	Fin	410	L'Air Liquide S.A.	Mat
51	APB Apranga	CD	231	Takarék Jelzálogbank Nyrt.	Fin	411	Solvay SA	Mat
52	H & M Hennes & Mauritz AB (publ)	CD	232	Plotinus Holding Nyrt	Fin	412	BASF SE	Mat
53	AB Electrolux (publ)	CD	233	AIB Group PLC	Fin	413	Covestro AG	Mat
54	Autoliv, Inc.	CD	234	Bank Of Ireland Group plc	Fin	414	HeidelbergCement AG	Mat
55	Greek Organization of Football Prognostics S.A.	CD	235	Bank of Valletta p.l.c.	Fin	415	Linde Aktiengesellschaft	Mat
56	Jumbo S.A.	CD	236	HSBC Bank Malta p.l.c.	Fin	416	thyssenkrupp AG	Mat
57	Fourlis Holdings S.A.	CD	237	Lombard Bank Malta p.l.c.	Fin	417	Akzo Nobel N.V.	Mat
58	Cairn Homes plc	CD	238	MAPFRE Middlesea p.l.c.	Fin	418	ArcelorMittal	Mat
59	Dalata Hotel Group plc	CD	239	GlobalCapital p.l.c.	Fin	419	Koninklijke DSM N.V.	Mat
60	Glenveagh Properties PLC	CD	240	FIMBank p.l.c.	Fin	420	Aperam S.A.	Mat
61	Paddy Power Betfair plc	CD	241	Santumas Shareholdings plc	Fin	421	Aperam S.A.	Mat
62	International Hotel Investments p.l.c.	CD	242	Powszechna Kasa Oszczednosci Bank Polski Spólka Akcyjna	Fin	422	ArcelorMittal	Mat
63	Grand Harbour Marina p.l.c	CD	243	Powszechny Zaklad Ubezpieczen Spólka Akcyjna	Fin	423	Acerinox, S.A.	Mat
64	LPP SA Capital Group	CD	244	Bank Polska Kasa Opieki S.A.	Fin	424	ArcelorMittal	Mat
65	Cyfrowy Polsat S.A.	CD	245	mBank S.A.	Fin	425	Altri, S.G.P.S., S.A.	Mat

66	CCC S.A.	CD	246	Alior Bank S.A.	Fin	426	Corticeira Amorim, S.G.P.S., S.A.	Mat
67	Tatry Mountain Resorts, a.s.	CD	247	Bank Zachodni WBK S.A.	Fin	427	F. Ramada Investimentos, SGPS, S.A.	Mat
68	Best Hotel Properties a.s.	CD	248	Banca Transilvania S.A.	Fin	428	Semapa - Sociedade de Investimento e Gestão, SGPS, S.A.	Mat
69	Petrol d.d.	CD	249	BRD - Groupe Société Générale S.A.	Fin	429	The Navigator Company, S.A.	Mat
70	Gorenje, d.d.	CD	250	Fondul Proprietatea SA	Fin	430	Buzzi Unicem SpA	Mat
71	Amer Sports Corporation	CD	251	Bucharest Stock Exchange	Fin	431	Voestalpine AG	Mat
72	Nokian Renkaat Oyj	CD	252	Vseobecná úverová banka, a.s.	Fin	432	Lenzing Aktiengesellschaft	Mat
73	Anheuser-Busch InBev SA/NV	CS	253	OTP Banka Slovensko, a.s.	Fin	433	Wienerberger AG	Mat
74	Etn. Fr. Colruyt NV	CS	254	OTP Banka Slovensko, a.s.	Fin	434	UNIPETROL, a.s.	Mat
75	Ontex Group NV	CS	255	Zavarovalnica Triglav, d.d.	Fin	435	Novozymes A/S	Mat
76	Carrefour SA	CS	256	Pozavarovalnica Sava, d.d.	Fin	436	Chr. Hansen Holding A/S	Mat
77	Danone SA	CS	257	KD Group, financna druzba, d. d.	Fin	437	Grigeo AB	Mat
78	L'Oréal S.A.	CS	258	Nordea Bank AB (publ)	Fin	438	Boliden AB	Mat
79	Pernod Ricard SA	CS	259	Sampo Oyj	Fin	439	Svenska Cellulosa Aktiebolaget SCA (publ)	Mat
80	Beiersdorf Aktiengesellschaft	CS	260	argenx SE	H	440	SSAB AB (publ)	Mat
81	Henkel AG & Co. KGaA	CS	261	Galapagos NV	H	441	Titan Cement Company S.A.	Mat
82	Heineken N.V.	CS	262	UCB SA	H	442	Plastika Kritis S.A.	Mat
83	Koninklijke Ahold Delhaize N.V.	CS	263	Essilor International Société Anonyme	H	443	CRH plc	Mat
84	Unilever N.V.	CS	264	Sanofi	H	444	Smurfit Kappa Group plc	Mat
85	Socfinasia S.A.	CS	265	Bayer Aktiengesellschaft	H	445	KGHM Polska Miedz Spólka Akcyjna	Mat
86	Socfinaf S.A.	CS	266	Fresenius SE & Co. KGaA	H	446	Jastrzebska Spólka Weglowa S.A.	Mat
87	Viscofan, S.A.	CS	267	MERCK Kommanditgesellschaft auf Aktien	H	447	Cinkarna Celje, d. d.	Mat

88	Distribuidora Internacional de Alimentación, S.A.	CS	268	Fresenius Medical Care AG & Co. KGaA	H	448	Unior Kovaska industrija d.d.	Mat
89	Jerónimo Martins, SGPS, S.A.	CS	269	Galapagos NV	H	449	Huhtamäki Oyj	Mat
90	Sonae, SGPS, S.A.	CS	270	Koninklijke Philips N.V.	H	450	Metsä Board Oyj	Mat
91	Davide Campari-Milano S.p.A.	CS	271	Grifols, S.A.	H	451	Outokumpu Oyj	Mat
92	Atlantic Grupa d.d.	CS	272	Recordati Industria Chimica e Farmaceutica S.p.A.	H	452	Stora Enso Oyj	Mat
93	Podravka d.d.	CS	273	Sopharma AD	H	453	UPM-Kymmene Oyj	Mat
94	Kras d.d.	CS	274	Novo Nordisk A/S	H	454	Cofinimmo SA	RE
95	Philip Morris CR a.s.	CS	275	Coloplast A/S	H	455	Unibail-Rodamco-Westfield SE	RE
96	Kofola CeskoSlovensko a.s.	CS	276	H. Lundbeck A/S	H	456	Vonovia SE	RE
97	Stock Spirits Group PLC	CS	277	William Demant Holding A/S	H	457	Unibail-Rodamco-Westfield SE	RE
98	Carlsberg A/S	CS	278	Genmab A/S	H	458	MERLIN Properties SOCIMI, S.A.	RE
99	Tallinna Kaubamaja Grupp AS	CS	279	Ambu A/S	H	459	Inmobiliaria Colonial, SOCIMI, S.A.	RE
100	AS PRFoods	CS	280	GN Store Nord A/S	H	460	CA Immobilien Anlagen AG	RE
101	Pieno Zvaigzdes, AB	CS	281	AS Olainfarm	H	461	IMMOFINANZ AG	RE
102	Rokiskio Suris AB	CS	282	AS Grindeks	H	462	S IMMO AG	RE
103	AB Vilkyskiu pienine	CS	283	Getinge AB	H	463	Advance Terrafund REIT	RE
104	AB Linas Agro Group	CS	284	AstraZeneca PLC	H	464	Bulgarian Real Estate Fund REIT	RE
105	Essity Aktiebolag (publ)	CS	285	Richter Gedeon Vegyészeti Gyár Nyilvánosan Muködo Rt.	H	465	Pandora Investments Public Limited	RE
106	Swedish Match AB (publ)	CS	286	Med Life S.A.	H	466	Arco Vara AS	RE
107	Gr. Sarantis S.A.	CS	287	Biotika a.s.	H	467	Grivalia Properties REIC	RE
108	Zwack Unicum Nyrt.	CS	288	Biotika a.s.	H	468	LAMDA Development S.A.	RE
109	ARYZTA AG	CS	289	Krka, d. d.	H	469	Graphisoft Park SE Real Estate Development European Company Limited	RE
110	C&C Group plc	CS	290	Orion Oyj	H	470	Appeninn	RE

							Vagyonkezelo Holding Nyrt	
111	Glanbia plc	CS	291	bpost SA/NV	Indu	471	Green REIT plc	RE
112	Kerry Group plc	CS	292	Airbus SE	Indu	472	Hibernia REIT Plc	RE
113	Origin Enterprises plc	CS	293	Bouygues SA	Indu	473	Irish Residential Properties REIT Plc	RE
114	Total Produce plc	CS	294	Compagnie de Saint-Gobain S.A.	Indu	474	Plaza Centres p.l.c.	RE
115	Simonds Farsons Cisk plc	CS	295	Legrand SA	Indu	475	MIDI p.l.c.	RE
116	PG p.l.c.	CS	296	Safran SA	Indu	476	Malita Investments p.l.c.	RE
117	Eurocash S.A.	CS	297	Schneider Electric S.E.	Indu	477	Tigné Mall p.l.c.	RE
118	Kesko Oyj	CS	298	VINCI SA	Indu	478	Malta Properties Company p.l.c.	RE
119	TechnipFMC plc	En	299	Siemens Aktiengesellschaft	Indu	479	Trident Estates Limited	RE
120	TOTAL S.A.	En	300	Deutsche Lufthansa AG	Indu	480	Main Street Complex p.l.c.	RE
121	Koninklijke Vopak N.V.	En	301	Deutsche Post AG	Indu	481	Proximus PLC	Tele
122	Royal Dutch Shell plc	En	302	Aalberts Industries N.V.	Indu	482	Orange S.A.	Tele
123	Repsol, S.A.	En	303	Randstad NV	Indu	483	Deutsche Telekom AG	Tele
124	Enagás, S.A.	En	304	RELX NV	Indu	484	Koninklijke KPN N.V.	Tele
125	Técnicas Reunidas, S.A.	En	305	Signify N.V.	Indu	485	Telefónica, S.A.	Tele
126	Galp Energia, SGPS, S.A.	En	306	Wolters Kluwer N.V.	Indu	486	Cellnex Telecom, S.A.	Tele
127	Eni S.p.A.	En	307	Aena S.M.E., S.A.	Indu	487	Pharol, SGPS S.A.	Tele
128	Saipem S.p.A.	En	308	Ferrovial, S.A.	Indu	488	Telecom Italia S.p.A.	Tele
129	Snam S.p.A.	En	309	ACS, Actividades de Construcción y Servicios, S.A.	Indu	489	Telekom Austria Aktiengesellschaft	Tele
130	Tenaris S.A.	En	310	Siemens Gamesa Renewable Energy, S.A.	Indu	490	Hrvatski Telekom d.d.	Tele
131	OMV Aktiengesellschaft	En	311	International Consolidated Airlines Group, S.A.	Indu	491	OT-Optima Telekom d.d.	Tele
132	Schoeller-Bleckmann Oilfield Equipment Aktiengesellschaft	En	312	CTT - Correios De Portugal, S.A.	Indu	492	O2 Czech Republic a.s.	Tele
133	AB Klaipedos nafta	En	313	Mota-Engil, SGPS, S.A.	Indu	493	Telia Lietuva, AB	Tele
134	Hellenic Petroleum S.A.	En	314	Sonae Capital, SGPS, SA	Indu	494	Telia Company AB (publ)	Tele
135	Motor Oil (Hellas) Corinth Refineries	En	315	Atlantia S.p.A.	Indu	495	Tele2 AB (publ)	Tele

	S.A.							
136	MOL Magyar Olaj- es Gazipari Nyilvanosan Mukodo Reszvenytarsasag	En	316	CNH Industrial N.V.	Indu	496	Hellenic Telecommunications Organization S.A.	Tele
137	Medserv p.l.c.	En	317	Leonardo S.p.a.	Indu	497	Magyar Telekom Telecommunications Public Limited Company	Tele
138	Polski Koncern Naftowy ORLEN Spólka Akcyjna	En	318	Prysmian S.p.A.	Indu	498	GO p.l.c.	Tele
139	Polskie Górnictwo Naftowe i Gazownictwo S.A.	En	319	Andritz AG	Indu	499	Orange Polska S.A.	Tele
140	Grupa LOTOS Spólka Akcyjna	En	320	Österreichische Post AG	Indu	500	Digi Communications N.V.	Tele
141	OMV Petrom S.A.	En	321	PORR AG	Indu	501	Telekom Slovenije, d.d.	Tele
142	S.N.G.N. RomGaz S.A.	En	322	FACC AG	Indu	502	Elisa Oyj	Tele
143	S.N.T.G.N. Transgaz S.A.	En	323	Chimimport AD	Indu	503	Telia Company AB (publ)	Tele
144	Societatea Conpet S.A.	En	324	MonBat AD	Indu	504	ENGIE SA	Ut
145	SLOVNAFT, a.s.	En	325	Stara Planina Hold Plc	Indu	505	ENGIE SA	Ut
146	SLOVNAFT, a.s.	En	326	Industrial Holding Bulgaria AD	Indu	506	Veolia Environnement S.A.	Ut
147	Neste Oyj	En	327	Trace Group Hold PLC	Indu	507	E.ON SE	Ut
148	Ackermans & Van Haaren NV	Fin	328	Koncar - Elektroindustrija d.d.	Indu	508	RWE Aktiengesellschaft	Ut
149	ageas SA/NV	Fin	329	Atlantska Plovidba d.d.	Indu	509	Iberdrola, S.A.	Ut
150	Groupe Bruxelles Lambert SA	Fin	330	Luka Rijeka d.d.	Indu	510	Naturgy Energy Group, S.A.	Ut
151	ING Groep N.V.	Fin	331	Dalekovod D.D.	Indu	511	Endesa, S.A.	Ut
152	KBC Group NV	Fin	332	Đuro Đakovic Grupa d.d.	Indu	512	Red Eléctrica Corporación, S.A.	Ut
153	Sofina Société Anonyme	Fin	333	Brodogradiliste Viktor Lenac d.d.	Indu	513	Acciona, S.A.	Ut
154	AXA SA	Fin	334	Institut IGH d.d.	Indu	514	EDP - Energias de Portugal, S.A.	Ut
155	BNP Paribas SA	Fin	335	Uljanik Plovidba D.D.	Indu	515	EDP Renováveis, S.A.	Ut
156	Crédit Agricole S.A.	Fin	336	INGRA d.d.	Indu	516	REN - Redes Energéticas Nacionais, SGPS, S.A.	Ut
157	Société Générale Société anonyme	Fin	337	Jadroplov d.d.	Indu	517	A2A S.p.A.	Ut
158	Allianz SE	Fin	338	Adris grupa d.d.	Indu	518	Enel SpA	Ut

159	Münchener Rückversicherungs -Gesellschaft Aktiengesellschaft	Fin	339	A.P. Møller - Mærsk A/S	Indu	519	Italgas S.p.A.	Ut
160	Deutsche Bank Aktiengesellschaft	Fin	340	DSV A/S	Indu	520	Terna - Rete Elettrica Nazionale Società per Azioni	Ut
161	Commerzbank AG	Fin	341	Vestas Wind Systems A/S	Indu	521	VERBUND AG	Ut
162	Deutsche Börse Aktiengesellschaft	Fin	342	ISS A/S	Indu	522	CEZ, a. s.	Ut
163	ABN AMRO Group N.V.	Fin	343	FLSmidth & Co. A/S	Indu	523	Ørsted A/S	Ut
164	Aegon N.V.	Fin	344	AS Tallink Grupp	Indu	524	AS Tallinna Vesi	Ut
165	ASR Nederland N.V.	Fin	345	AS Tallinna Sadam	Indu	525	Energijos Skirstymo Operatorius AB	Ut
166	ING Groep N.V.	Fin	346	AS Harju Elekter	Indu	526	Lietuvos energijos gamyba, AB	Ut
167	NN Group N.V.	Fin	347	AS Merko Ehitus	Indu	527	Terna Energy Societe Anonyme Commercial Technical Company S.A.	Ut
168	Reinet Investments S.C.A.	Fin	348	Nordecon AS	Indu	528	Athens Water Supply and Sewerage Company S.A.	Ut
169	Luxempart S.A.	Fin	349	AB Panevezio Statybos Trestas	Indu	529	Public Power Corporation S.A.	Ut
170	Brederode SA	Fin	350	AB Volvo (publ)	Indu	530	Admie Holding S.A.	Ut
171	Banco Santander, S.A.	Fin	351	Atlas Copco AB	Indu	531	Budapesti Elektromos Muvek Nyrt.	Ut
172	Banco Bilbao Vizcaya Argentaria, S.A.	Fin	352	ASSA ABLOY AB (publ)	Indu	532	Észak-magyarországi Áramszolgáltató Nyrt.	Ut
173	CaixaBank, S.A.	Fin	353	Sandvik AB	Indu	533	PannErgy Plc	Ut
174	Bankia, S.A.	Fin	354	Alfa Laval AB (publ)	Indu	534	PGE Polska Grupa Energetyczna S.A.	Ut
175	Banco de Sabadell, S.A.	Fin	355	AB SKF (publ)	Indu	535	Energa SA	Ut
176	Mapfre, S.A.	Fin	356	Skanska AB (publ)	Indu	536	Societatea Energetica Electrica S.A.	Ut
177	Bankinter, S.A.	Fin	357	Securitas AB	Indu	537	S.N. Nuclearelectrica S.A.	Ut
178	Banco Comercial Português, S.A.	Fin	358	Atlas Copco AB	Indu	538	C.N.T.E.E. Transelectrica	Ut

							S.A.	
179	Assicurazioni Generali S.p.A.	Fin	359	ABB Ltd	Indu	539	Fortum Oyj	Ut
180	Azimut Holding S.p.A.	Fin	360	Mytilineos Holdings S.A.	Indu			

Figure 57: Composition of our European Index, July 9th 2018, with sector

Countries indices

#	Date	January 3rd 2012	July 9th 2018	Change
1	Austria	1,36%	1,37%	0,01%
2	Belgium	5,31%	5,65%	0,34%
3	Bulgaria	0,02%	0,02%	0,00%
4	Croatia	0,18%	0,12%	-0,05%
5	Cyprus	0,01%	0,02%	0,02%
6	Czech Republic	1,04%	0,69%	-0,36%
7	Denmark	3,36%	4,62%	1,26%
8	Estonia	0,03%	0,04%	0,01%
9	Finland	3,76%	3,67%	-0,09%
10	France	21,19%	22,78%	1,60%
11	Germany	18,20%	18,17%	-0,03%
12	Greece	0,33%	0,47%	0,14%
13	Hungary	0,32%	0,30%	-0,02%
14	Ireland	0,86%	1,73%	0,87%
15	Italy	7,06%	7,60%	0,54%
16	Latvia	0,00%	0,00%	0,00%
17	Lithuania	0,04%	0,04%	0,00%
18	Luxemburg	1,29%	0,77%	-0,52%
19	Malta	0,07%	0,07%	0,00%
20	Netherlands	11,50%	12,37%	0,88%
21	Poland	1,73%	1,23%	-0,50%
22	Portugal	1,13%	0,94%	-0,19%
23	Romania	0,22%	0,23%	0,00%
24	Slovakia	0,10%	0,08%	-0,02%
25	Slovenia	0,08%	0,08%	-0,01%
26	Spain	10,34%	9,11%	-1,23%
27	Sweden	10,48%	7,82%	-2,66%

Figure 58: Countries: Relative weight of each country in the European Union portfolio

Index	United Kingdom350	European Union
Consumer discretionary	61 (17.5%)	72 (13.4%)
Consumer staples	19 (5.4%)	46 (8.5%)
Energy	11 (3.1%)	29 (5.4%)
Financials	101 (28.8%)	112 (20.8%)
Health Care	14 (4.0%)	31 (5.7%)
Industrials	56 (16.0%)	94 (17.4%)
Information Technologies	18 (5.1%)	22 (4.1%)
Materials	30 (8.5%)	47 (8.7%)
Real Estate	26 (7.4%)	27 (5.0%)

Telecommunication Services	4 (1.1%)	23 (4.3%)
Utilities	11 (3.1%)	36 (6.7%)
Total	**351 (100%)**	**539 (100%)**

Figure 59: Countries: Number of companies of a sector in the index

	United Kingdom350			European Union		
Date	January 2nd 2012	July 9th 2018	Change	January 2nd 2012	July 9th 2018	Change
Consumer discretionary	6,37%	9,69%	3,32%	12,25%	14,31%	2,07%
Consumer staples	14,32%	14,21%	-0,11%	10,01%	11,03%	1,02%
Energy	22,42%	19,49%	-2,93%	12,35%	9,21%	-3,14%
Financials	15,57%	19,19%	3,62%	17,08%	18,59%	1,51%
Health Care	7,16%	7,53%	0,37%	8,67%	9,24%	0,58%
Industrials	6,61%	9,10%	2,49%	11,97%	13,46%	1,50%
Information Technologies	0,65%	1,91%	1,26%	3,81%	5,78%	1,97%
Materials	16,27%	11,88%	-4,39%	8,33%	7,83%	-0,51%
Real Estate	1,43%	1,99%	0,56%	0,16%	1,42%	1,26%
Telecommunication Services	5,84%	2,60%	-3,24%	6,72%	3,63%	-3,09%
Utilities	3,36%	2,42%	-0,94%	8,65%	5,50%	-3,15%

Figure 60: Countries: Relative market capitalization of each sector, January 2nd 202 and July 9th 2018

	FTSE350	Europe	S&P UK in USD	S&P EU in USD	S&P UK in local currency	S&P EU in local currency
Number of observations (n)	1647	1642	1647	1647		1646
Mean daily return	0,05%	0,05%	0,03%	0,04%		0,04%
Median daily return	0,08%	0,09%	0,07%	0,04%		0,07%
Standard deviation (S-D)	0,81%	1,00%	1,03%	1,05%		0,94%
Maximum	3,28%	4,00%	5,74%	5,83%		3,96%
Minimum	-6,19%	-7,45%	-12,20%	-7,90%		-5,91%
Skewness (Sk.)	-0,618	-0,423	-1,16	-0,34		-0,338
Kurtosis (Kurt.)	5,192	3,427	15,00	4,27		2,693
Coefficient of variation (CV)	16,84	18,70	36,35	26,09		21,43
P value of Stat's SK test for Normality[82]	0.0000	0.0000	0.0000	0.0000		0.0000

Figure 61: Countries: Descriptive statistics of the index

[82] Stata's sktest command enables to test for the Normal distribution of the returns. This test is similar to a JArque Bera test. Its null hypothesis is that the data follow a Normal distribution. For more details, see: Stata: https://www.stata.com/manuals13/rsktest.pdf

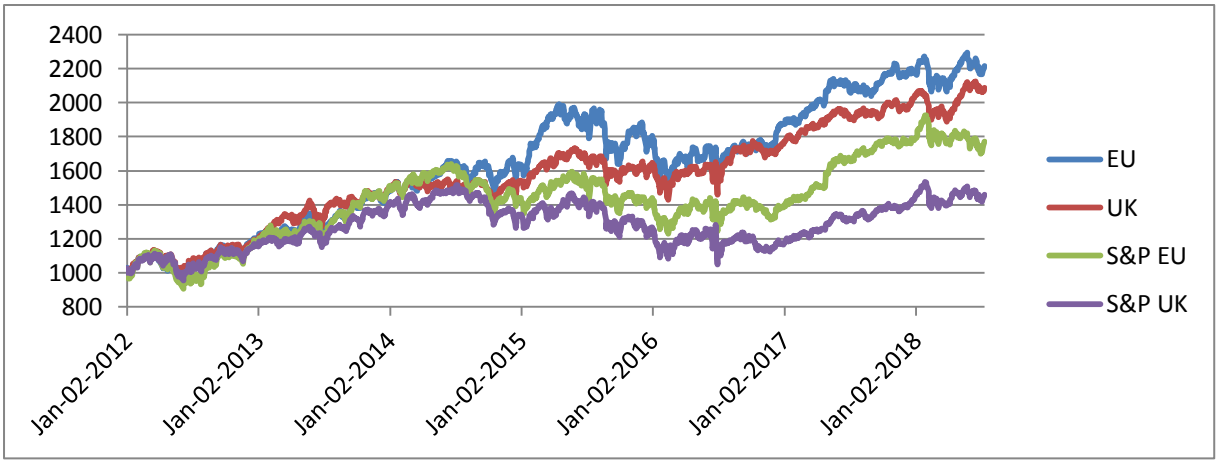


Figure 62: Countries: Reconstitution of the index

Sector indices

	CD	CS	E	RE	F	H	I	IT	M	T	U
N	1647	1647	1647	1647	1647	1647	1647	1647	1647	1647	1647
Mean	0,07%	0,04%	0,01%	0,06%	0,05%	0,05%	0,05%	0,09%	0,02%	0,02%	0,03%
Median	0,08%	0,06%	0,00%	0,08%	0,06%	0,07%	0,06%	0,13%	0,01%	0,02%	0,06%
S-D	0,88%	0,88%	0,34%	1,04%	1,13%	0,85%	0,74%	1,04%	1,27%	1,18%	0,90%
Max	3,43%	4,25%	1,75%	5,60%	4,71%	6,77%	3,18%	5,02%	5,59%	6,48%	5,33%
Min	-7,31%	-3,73%	-2,30%	-15,53%	-9,87%	-4,52%	-4,39%	-7,14%	-5,69%	-9,21%	-5,14%
Sk.	-0,720	0,034	-0,117	-2,444	-0,536	0,171	-0,144	-0,692	0,085	-0,386	-0,094
Kurt.	5,735	1,500	3,606	36,232	6,162	4,582	1,860	4,395	1,790	4,978	2,950
CV	13,15	20,81	50,66	18,24	21,84	18,37	15,05	10,97	64,55	77,57	31,10
P-value SK test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: the following abbreviations have been used: CD= Consumer discretionary; CS= Consumer staples; RE= Real Estate; F= Financials; H= Health Care; I= Industrials; IT= Information Technologies; M= Materials; T= Telecommunication Services; U= Utilities. SK test is Stata's Skewness and Kurtosis test for normality (H0: data are Normally distributed).

Figure 63: Descriptive statistics on the United Kingdom sectoral indices

	CD	CS	E	RE	F	H	I	IT	M	T	U
N	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642
Mean	0,06%	0,05%	0,03%	0,07%	0,05%	0,06%	0,06%	0,08%	0,04%	0,02%	0,03%
Median	0,08%	0,06%	0,05%	0,08%	0,07%	0,08%	0,07%	0,12%	0,06%	0,01%	0,05%
S-D	1,11%	0,97%	1,17%	1,02%	1,34%	1,01%	1,03%	1,09%	0,88%	1,11%	0,95%
Max	4,08%	3,71%	5,63%	6,00%	5,95%	3,83%	4,62%	3,75%	3,40%	4,59%	3,45%
Min	-7,40%	-4,76%	-7,88%	-4,90%	-13,86%	-4,08%	-8,09%	-5,31%	-5,29%	-8,92%	-7,50%
Sk.	-0,351	-0,086	-0,223	0,041	-0,681	-0,144	-0,523	-0,340	-0,348	-0,217	-0,473
Kurt.	2,385	1,853	3,382	2,695	8,451	1,259	3,883	1,369	2,160	3,743	3,320
CV	17,76	18,52	34,13	14,20	28,51	16,66	16,52	14,50	19,61	49,91	28,46
P-value SK test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: the following abbreviations have been used: CD= Consumer discretionary; CS= Consumer staples; RE= Real Estate; F= Financials; H= Health Care; I= Industrials; IT= Information Technologies; M= Materials; T= Telecommunication Services; U= Utilities. SK test is Stata's Skewness and Kurtosis test for normality (H0: data are Normally distributed).

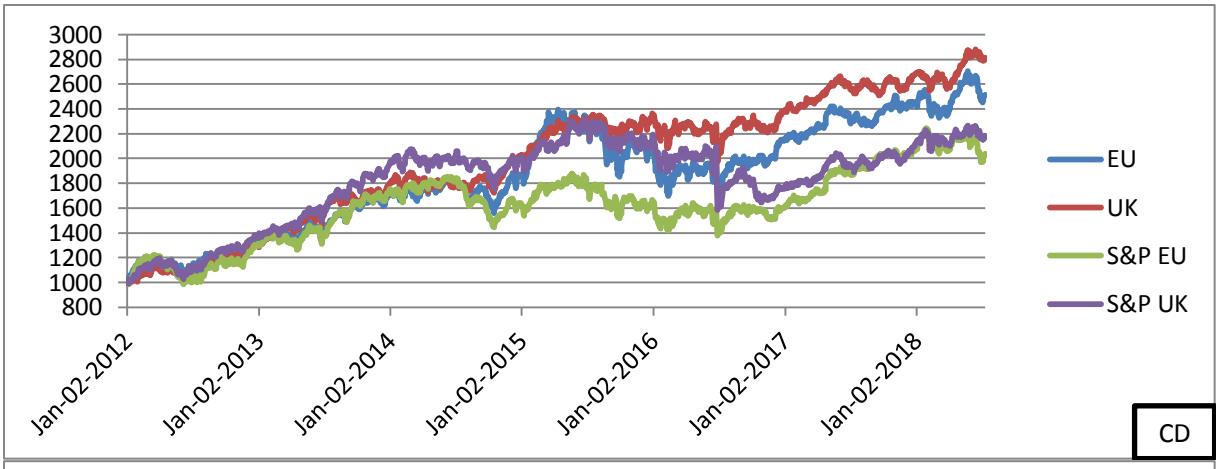
Figure 64: Descriptive statistics of the European Union27 sectoral indices

	CD	CS	E	F	H	I	IT	M	RE	T	U
N	1645	1646	1644	1646	1646	1646	1647	1647	455	1643	1643
Mean	0,05%	0,04%	0,02%	0,04%	0,05%	0,05%	0,07%	0,04%	0,03%	0,02%	0,03%
Median	0,06%	0,04%	0,05%	0,07%	0,06%	0,07%	0,11%	0,06%	0,01%	0,02%	0,03%
S-D	1,06%	0,83%	1,28%	1,27%	0,95%	1,00%	1,04%	1,06%	0,72%	1,09%	1,13%
Max	4,40%	3,39%	6,07%	5,49%	4,30%	4,54%	4,69%	4,29%	2,26%	4,62%	4,44%
Min	-6,26%	-4,63%	-7,73%	-10,70%	-4,21%	-5,64%	-5,28%	-5,11%	-3,44%	-7,53%	-8,45%
Sk.	-0,307	-0,075	-0,162	-0,416	-0,150	-0,369	-0,354	-0,276	-0,410	-0,132	-0,392
Kurt.	2,057	1,959	2,791	4,556	1,688	2,349	1,607	1,687	1,645	2,811	3,139
CV	19,99	19,52	55,43	29,77	20,33	19,74	15,37	24,08	24,45	60,77	38,52
P-value SK test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Note: the following abbreviations have been used: CD= Consumer discretionary; CS= Consumer staples; RE= Real Estate; F= Financials; H= Health Care; I= Industrials; IT= Information Technologies; M= Materials; T= Telecommunication Services; U= Utilities. SK test is Stata's Skewness and Kurtosis test for normality (H0: data are Normally distributed).											

Figure 65: sectors: descriptive statistics of S&P indices for the EU, in local currency

	CD	CS	E	F	H	I	IT	M	RE	T	U
N	1647	1647	1646	1647	1647	1647	1647	1647	455	1647	1647
Mean	0,06%	0,04%	0,03%	0,05%	0,04%	0,05%	0,07%	0,02%	0,02%	0,02%	0,03%
Median	0,07%	0,07%	0,04%	0,07%	0,08%	0,07%	0,11%	0,03%	0,05%	0,02%	0,06%
S-D	0,90%	0,87%	1,27%	1,12%	1,00%	0,91%	1,05%	1,65%	0,76%	1,13%	0,87%
Max	3,66%	4,07%	5,71%	4,34%	4,90%	3,54%	11,88%	7,35%	3,15%	6,43%	4,89%
Min	-7,82%	-3,89%	-7,01%	-11,35%	-6,69%	-6,52%	-8,60%	-8,64%	-2,71%	-9,18%	-5,14%
Sk.	-0,777	-0,050	-0,003	-0,851	-0,213	-0,358	0,293	-0,032	-0,019	-0,240	-0,126
Kurt.	6,208	1,544	2,721	9,432	3,266	3,309	13,822	2,087	1,298	4,359	3,062
CV	14,41	23,65	46,64	23,98	26,36	19,75	15,33	76,61	32,35	54,28	34,37
P-value SK test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000
Note: the following abbreviations have been used: CD= Consumer discretionary; CS= Consumer staples; RE= Real Estate; F= Financials; H= Health Care; I= Industrials; IT= Information Technologies; M= Materials; T= Telecommunication Services; U= Utilities. SK test is Stata's Skewness and Kurtosis test for normality (H0: data are Normally distributed).											

Figure 66: sectors: descriptive statistics of S&P indices for the United Kingdom, in local currency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Jan-02-2017
Jan-02-2018
EU
UK
S&P EU
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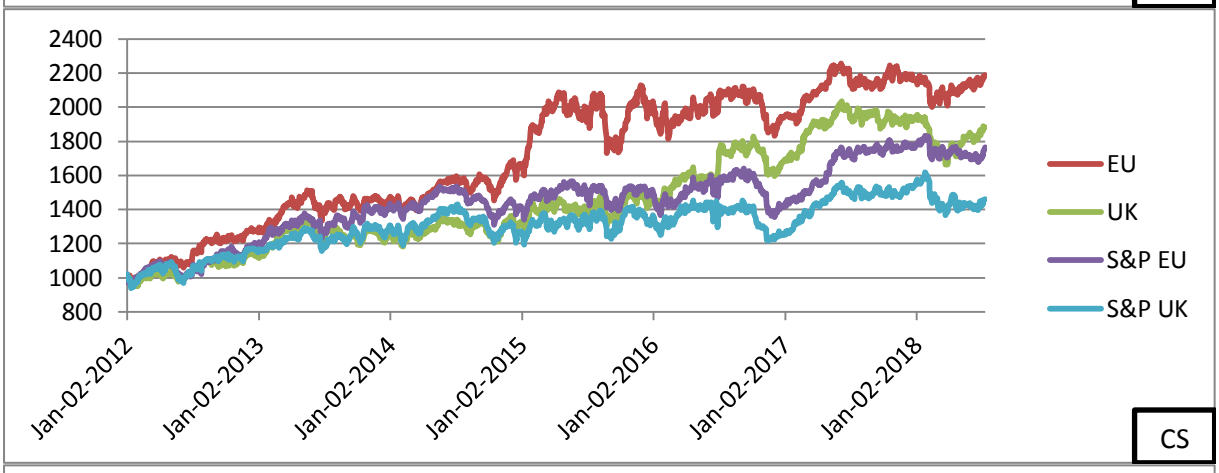
CD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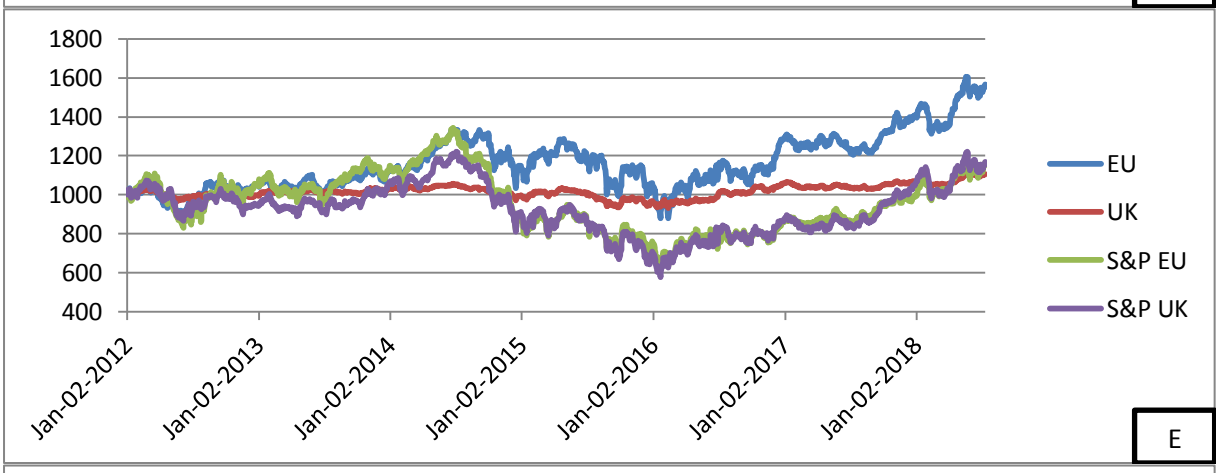
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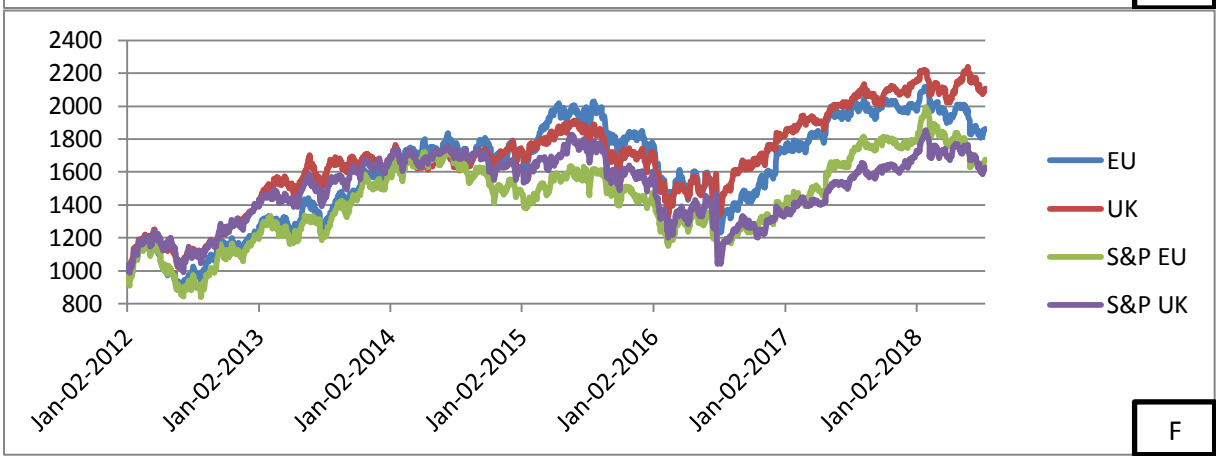
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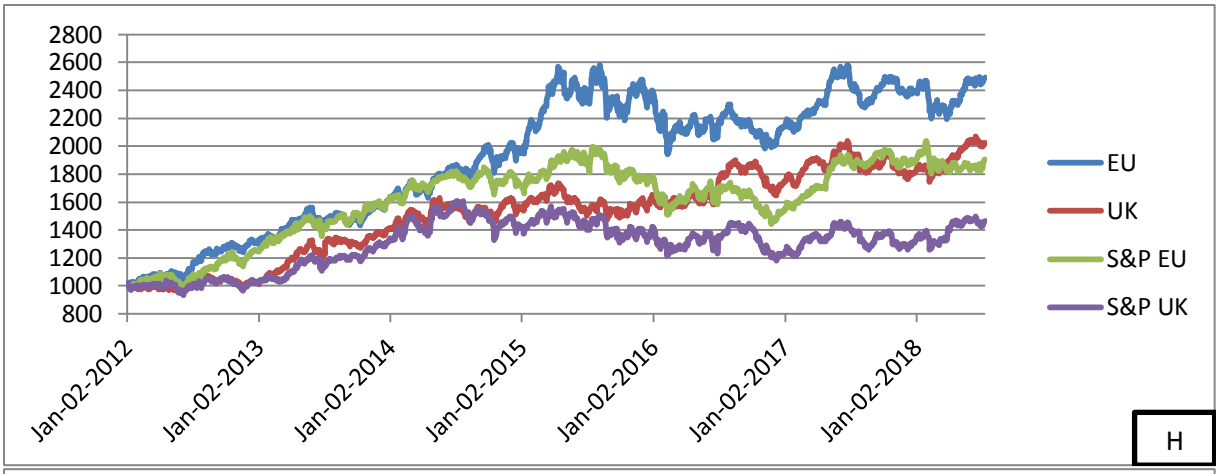
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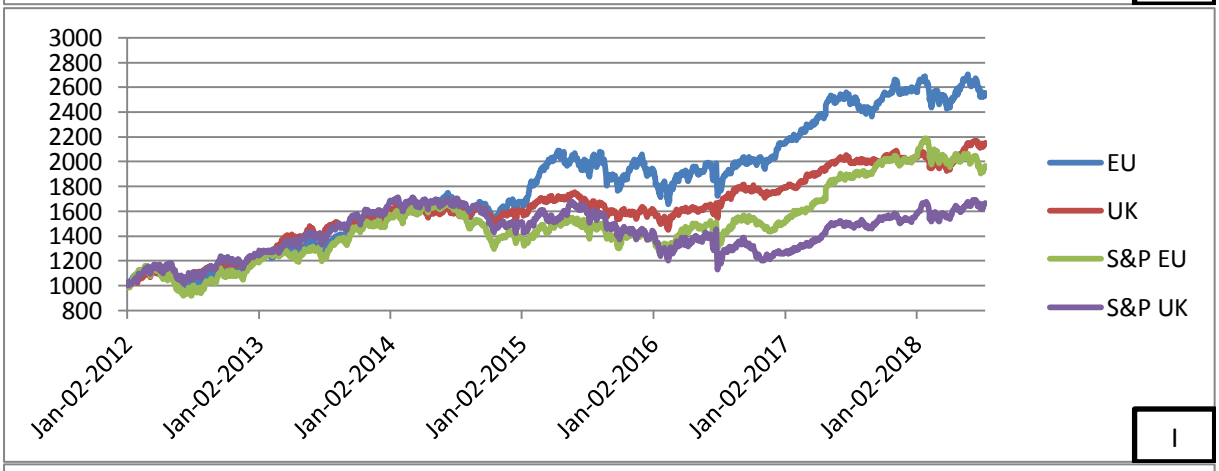
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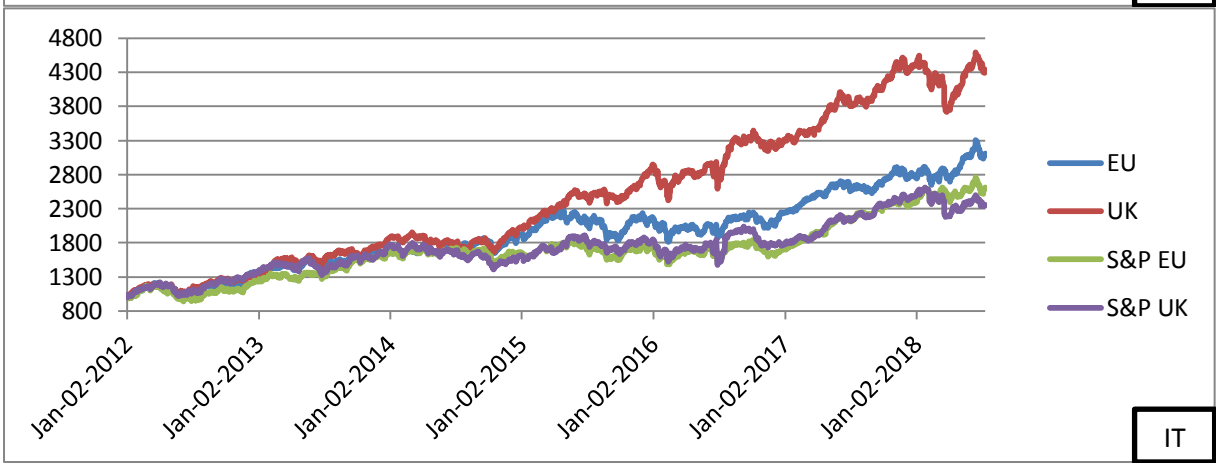
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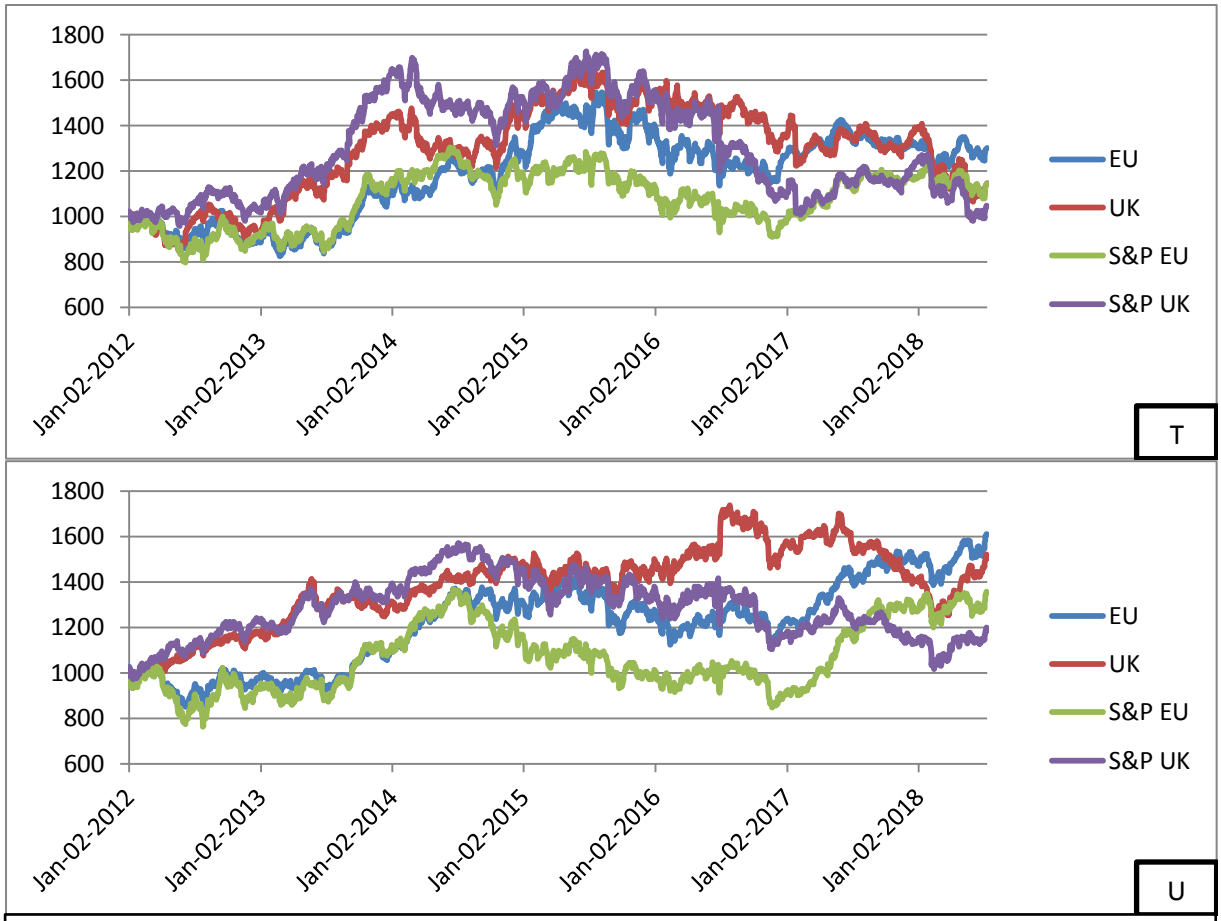

Caption: CD: Consumer Discretionary; CS: Consumer Staples; E: Energy; F: Financials; H: Health Care; I: Industrials; IT: Information Technology; M: Materials; RE: Real Estate; T: Telecommunication Services; U: Utilities

Figure 67: Sectors: Reconstitution of the indices

Focus Indices

#	Name	Sector	#	Name	Sector	#	Name	Sector
1	Barratt Developments plc	CD	28	Dixons Carphone plc	CD	55	NewRiver REIT plc	RE
2	British Land Company Plc	RE	29	Drax Group plc	U	56	Paragon Banking Group PLC	F
3	Direct Line Insurance Group plc	F	30	Dunelm Group plc	CD	57	Perpetual Income and Growth Investment Trust plc	F
4	Hargreaves Lansdown plc	F	31	Equiniti Group plc	IT	58	Personal Assets Trust plc	F
5	J Sainsbury plc	CS	32	esure Group plc	F	59	Phoenix Group Holdings	F
6	Land Securities Group plc	RE	33	F&C Commercial Property Trust Limited	RE	60	Primary Health Properties Plc	RE
7	Ocado Group plc	CD	34	Fidelity Investment Trust - Fidelity Special Values PLC	F	61	Redrow plc	CD
8	Persimmon Plc	CD	35	Finsbury Growth & Income Trust PLC	F	62	RIT Capital Partners plc	F
9	St. James's Place plc	F	36	Galliford Try plc	IT	63	Saga plc	F
10	The Berkeley Group Holdings plc	CD	37	Grainger plc	RE	64	Shaftesbury PLC	RE
11	United Utilities Group PLC	U	38	Great Portland Estates Plc	RE	65	Sirius Minerals Plc	M
12	Wm Morrison Supermarkets PLC	CS	39	Greene King plc	CD	66	Softcat plc	IT
13	AA plc	CD	40	Greggs plc	CD	67	Spire Healthcare Group plc	H
14	Aberforth Smaller Companies Trust Plc	F	41	Halfords Group plc	CD	68	St. Modwen Properties PLC	RE
15	Alliance Trust PLC	F	42	Hastings Group Holdings plc	F	69	TalkTalk Telecom Group PLC	T
16	Assura Plc	RE	43	IntegraFin Holdings plc	F	70	Telecom Plus PLC	U
17	Bellway p.l.c.	CD	44	IP Group Plc	F	71	Temple Bar Investment Trust PLC	F
18	Big Yellow Group Plc	RE	45	J D Wetherspoon plc	CD	72	The Baillie Gifford Japan Trust PLC	F
19	Bovis Homes Group PLC	CD	46	JPMorgan American Investment Trust plc	F	73	The City of London Investment Trust plc	F
20	Capital & Counties Properties PLC	RE	47	JPMorgan Emerging Markets Investment Trust	F	74	The Unite Group plc	RE

				plc				
21	Card Factory plc	CD	48	JPMorgan Japanese Investment Trust plc	F	75	Travis Perkins plc	IT
22	Charter Court Financial Services Group plc	F	49	Jupiter European Opportunities Trust PLC	F	76	Tritax Big Box REIT plc	RE
23	Close Brothers Group plc	F	50	Just Group Plc	F	77	United Kingdom Commercial Property REIT Limited	RE
24	Countryside Properties PLC	CD	51	LondonMetric Property Plc	RE	78	Virgin Money Holdings (United Kingdom) plc	F
25	Crest Nicholson Holdings plc	CD	52	McCarthy & Stone plc	CD	79	Workspace Group plc	RE
26	CYBG PLC	F	53	Metro Bank PLC	F	55	NewRiver REIT plc	RE
27	Derwent London Plc	RE	54	Moneysupermarket.com Group PLC	IT	56	Paragon Banking Group PLC	F

Figure 68: Focus: Composition of the United Kingdom-focused index

#	Name	Sector	#	Name	Sector	#	Name	Sector
1	Anglo American plc	M	25	RSA Insurance Group plc	F	49	IMI plc	I
2	Antofagasta plc	M	26	Scottish Mortgage Investment Trust PLC	F	50	Inmarsat Plc	IT
3	Ashtead Group plc	I	27	Smith & Nephew plc	H	51	JPMorgan Indian Investment Trust plc	F
4	BHP Billiton plc	M	28	Smiths Group plc	I	52	Keller Group plc	I
5	British American Tobacco p.l.c.	CS	29	Standard Chartered PLC	F	53	Man Group plc	F
6	Bunzl plc	I	30	Tesco PLC	CS	54	Meggitt PLC	I
7	Burberry Group plc	CD	31	WPP plc	CD	55	Morgan Advanced Materials plc	I
8	Compass Group PLC	CD	32	Aggreko Plc	I	56	Polar Capital Technology Trust plc	F
9	Croda International Plc	M	33	AVEVA Group plc	IT	57	Renewi plc	I
10	Diageo plc	CS	34	BBA Aviation plc	I	58	Renishaw plc	IT
11	GlaxoSmithKline plc	H	35	Bodycote plc	I	59	Rotork plc	I
12	GVC Holdings PLC	CD	36	BTG plc	H	60	Spectris plc	IT
13	Imperial Brands PLC	CS	37	Coats Group plc	CD	61	Spirax-Sarco Engineering plc	I
14	Informa plc	CD	38	Cobham plc	I	62	Synthomer plc	M
15	InterContinental Hotels Group PLC	CD	39	Convatec Group Plc	H	63	Tate & Lyle plc	CS
16	Intertek Group plc	I	40	Edinburgh Dragon Trust plc	F	64	TBC Bank Group PLC	F

17	Melrose Industries PLC	I	41	Electrocomponents plc	IT	65	The Weir Group PLC	I
18	Micro Focus International plc	IT	42	Elementis plc	M	66	TI Fluid Systems plc	CD
19	Mondi plc	M	43	Energean Oil & Gas plc	E	67	Tullow Oil plc	E
20	NMC Health Plc	H	44	Essentra plc	M	68	Vedanta Resources plc	M
21	Pearson plc	CD	45	Ferrexpo Plc	M	69	Vesuvius plc	I
22	Rentokil Initial plc	I	46	Hikma Pharmaceuticals PLC	H	70	Victrex plc	M
23	Rio Tinto plc	M	47	Hochschild Mining plc	M			
24	Rolls-Royce Holdings plc	I	48	Hunting plc	E			

Figure 69: Focus: Composition of the Foreign-focused index

Index	United Kingdom-focused	Foreign-focused
Consumer discretionary	18 (22.8 %)	9 (12.9 %)
Consumer staples	2 (2.5 %)	5 (7.1 %)
Energy	0 (0.0 %)	3 (4.3 %)
Financials	30 (38.0 %)	8 (11.4 %)
Health Care	1 (1.3 %)	6 (8.6 %)
Industrials	2 (2.5 %)	20 (28.6 %)
Information Technologies	3 (3.8 %)	5 (7.1 %)
Materials	1 (1.2 %)	13 (18.6 %)
Real Estate	18 (22.8 %)	0 (0.0 %)
Telecommunication Services	1 (1.3 %)	1 (1.4 %)
Utilities	3 (3.8 %)	0 (0.0 %)
Total	**79 (100%)**	**70 (100 %)**
Note: mean value[83]	2987,33	15142,29

Figure 70: Focus: Weights of each sector

	United Kingdom-Focused			Foreign-Focused		
Date	January 2nd 2012	July 9th 2018	Change	January 2nd 2012	July 9th 2018	Change
Consumer discretionary	16,17%	24,47%	8,30%	6,80%	11,41%	4,61%
Consumer staples	20,53%	7,40%	-13,13%	25,48%	29,57%	4,10%
Energy	0,00%	0,00%	0,00%	2,27%	0,75%	-1,53%
Financials	20,52%	34,06%	13,54%	7,07%	6,11%	-0,96%
Health Care	0,00%	0,57%	0,57%	12,30%	14,44%	2,14%
Industrials	3,44%	2,48%	-0,96%	8,33%	14,27%	5,95%
Information Technologies	0,76%	2,23%	1,47%	0,64%	2,75%	2,11%

[83] We calculated this in order to see if United Kingdom-focused companies are generally smaller than foreign-focused companies. Based on this, we decided to use S&P small cap BMI and large cap BMI as indicators of United Kingdom-focused and foreign-focused companies respectively.

Materials	0,37%	0,88%	0,51%	36,81%	30,96%	-5,85%
Real Estate	26,67%	22,94%	-3,73%	0,00%	0,00%	0,00%
Telecommunication Services	1,80%	0,76%	-1,04%	0,31%	0,33%	0,02%
Utilities	9,74%	4,21%	-5,53%	0,00%	0,00%	0,00%

Figure 71: Focus: Relative weight of each sector

	United Kingdom-focused	Foreign-focused
N	1647	1647
Mean	0,07%	0,04%
Median	0,09%	0,05%
S-D	0,94%	0,96%
Max	4,57%	3,96%
Min	-13,65%	-4,82%
Sk.	-2,55	-0,06
Kurt.	35,17	1,42
CV	14,22	25,13
P-value SK test	0.0000	0.0000

Figure 72: Focus: Descriptive statistics

Appendix 3: Stata's outputs

Countries

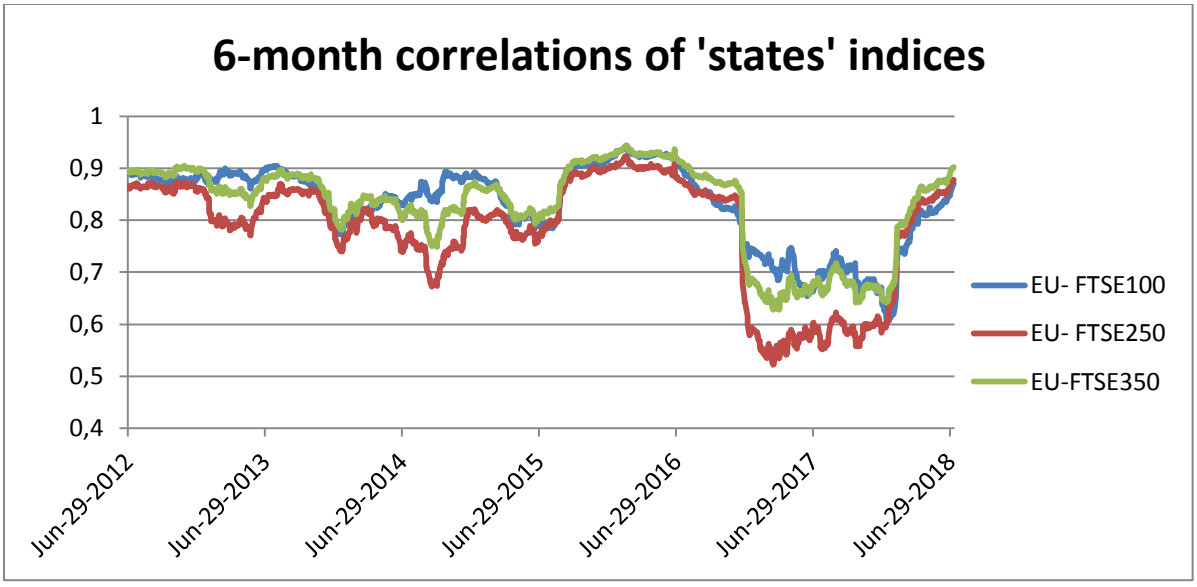

Figure 73: 6-month rolling-window correlation of FTSE100, FTSE250 and FTSE350

We can see that the correlation falls more for the more United Kingdom-centered FTSE250 than for the FTSE100 which is more international. This can be taken as a hint that there was a modification in the financial integration between the United Kingdom and the European Union, though, as we already underlined, this measure has some serious drawbacks.

Dynamic conditional correlation MGARCH model

Sample: 1 - 1719, but with gaps — Number of obs = 1,493
Distribution: Gaussian — Wald chi2(20) = 42.49
Log likelihood = 11070.43 — Prob > chi2 = 0.0024

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UK350						
UK350						
L1.	-.0056779	.0460627	-0.12	0.902	-.0959591	.0846032
L2.	-.0243046	.045103	-0.54	0.590	-.1127048	.0640957
L3.	.0356861	.0451963	0.79	0.430	-.052897	.1242692
L4.	-.0110122	.0457145	-0.24	0.810	-.1006111	.0785866
L5.	.0260682	.0447913	0.58	0.561	-.0617211	.1138575
European						
L1.	.0241833	.0352711	0.69	0.493	-.0449467	.0933134
L2.	-.0136673	.0348097	-0.39	0.695	-.0818931	.0545585
L3.	-.0008878	.0351444	-0.03	0.980	-.0697695	.067994
L4.	-.0677003	.0351457	-1.93	0.054	-.1365846	.001184
L5.	-.0505626	.0352205	-1.44	0.151	-.1195936	.0184683
_cons	.0005382	.0001756	3.06	0.002	.0001939	.0008824
ARCH_UK350						
arch						
L1.	.0963858	.0123652	7.79	0.000	.0721506	.1206211
garch						
L1.	.8278918	.0250344	33.07	0.000	.7788253	.8769584
_cons	4.09e-06	9.50e-07	4.30	0.000	2.22e-06	5.95e-06
European						
UK350						
L1.	-.0687251	.0552412	-1.24	0.213	-.1769959	.0395457
L2.	-.0478947	.0546915	-0.88	0.381	-.1550881	.0592988
L3.	.0299218	.0552815	0.54	0.588	-.0784279	.1382715
L4.	-.066931	.0559578	-1.20	0.232	-.1766062	.0427442
L5.	.045394	.0550261	0.82	0.409	-.0624552	.1532431
European						
L1.	.0317336	.0456713	0.69	0.487	-.0577805	.1212476
L2.	.0265408	.045025	0.59	0.556	-.0617065	.1147881
L3.	-.0019176	.0457327	-0.04	0.967	-.0915521	.0877169
L4.	-.0328761	.0456218	-0.72	0.471	-.1222931	.0565409
L5.	-.0910427	.0457418	-1.99	0.047	-.180695	-.0013903
_cons	.0006716	.0002193	3.06	0.002	.0002419	.0011014
ARCH_European						
arch						
L1.	.0749873	.0107872	6.95	0.000	.0538447	.0961298
garch						
L1.	.8910175	.0166772	53.43	0.000	.8583309	.9237041
_cons	2.90e-06	8.36e-07	3.47	0.001	1.26e-06	4.54e-06
corr(UK350,European)	.8427808	.0132571	63.57	0.000	.8167975	.8687642
Adjustment						
lambda1	.0446088	.01085	4.11	0.000	.0233432	.0658745
lambda2	.9011567	.0259128	34.78	0.000	.8503686	.9519448

Figure 74: Countries: GARCH

Sectors

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 30.98
Log likelihood = 11210.43 — Prob > chi2 = 0.0554

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKd						
UKd						
L1.	-.0172158	.0363205	-0.47	0.636	-.0884026	.0539711
L2.	-.034567	.0353538	-0.98	0.328	-.1038591	.0347251
L3.	.0200787	.0359162	0.56	0.576	-.0503158	.0904731
L4.	-.0388806	.035706	-1.09	0.276	-.1088631	.031102
L5.	-.003528	.0354151	-0.10	0.921	-.0729404	.0658844
Eud						
L1.	.0184886	.0274278	0.67	0.500	-.035269	.0722461
L2.	-.0273462	.0269803	-1.01	0.311	-.0802266	.0255342
L3.	-.0207113	.027616	-0.75	0.453	-.0748376	.0334151
L4.	-.0433918	.0274929	-1.58	0.114	-.0972768	.0104933
L5.	-.0081081	.0276769	-0.29	0.770	-.0623539	.0461377
_cons	.0008337	.0001921	4.34	0.000	.0004572	.0012103
ARCH_UKd						
arch						
L1.	.0769643	.0118073	6.52	0.000	.0538224	.1001062
garch						
L1.	.8604852	.0258182	33.33	0.000	.8098826	.9110879
_cons	4.21e-06	1.24e-06	3.40	0.001	1.78e-06	6.63e-06
Eud						
UKd						
L1.	-.0329264	.0432484	-0.76	0.446	-.1176916	.0518389
L2.	-.045186	.0424627	-1.06	0.287	-.1284114	.0380395
L3.	.006462	.0430054	0.15	0.881	-.077827	.090751
L4.	-.0504248	.0427983	-1.18	0.239	-.134308	.0334584
L5.	.008725	.042815	0.20	0.839	-.0751908	.0926409
Eud						
L1.	.0313778	.0355559	0.88	0.378	-.0383103	.101066
L2.	.0139161	.0350983	0.40	0.692	-.0548753	.0827075
L3.	.0057794	.0356109	0.16	0.871	-.0640167	.0755755
L4.	-.0390215	.0354221	-1.10	0.271	-.1084475	.0304044
L5.	-.0507138	.0357837	-1.42	0.156	-.1208485	.0194209
_cons	.0007977	.0002373	3.36	0.001	.0003326	.0012629
ARCH_Eud						
arch						
L1.	.0482135	.0083849	5.75	0.000	.0317793	.0646477
garch						
L1.	.9316037	.0121042	76.97	0.000	.9078799	.9553276
_cons	2.10e-06	6.26e-07	3.36	0.001	8.74e-07	3.33e-06
corr(UKd,Eud)	.7303828	.0206275	35.41	0.000	.6899538	.7708119
Adjustment						
lambda1	.0374403	.0098671	3.79	0.000	.0181012	.0567794
lambda2	.9143053	.0233183	39.21	0.000	.8686023	.9600084

Figure 75: Sector : GARCH Consumer Discretionary

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 21.20
Log likelihood = 11466.96 — Prob > chi2 = 0.3852

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKs						
UKs						
L1.	.0064263	.041035	0.16	0.876	-.0740008	.0868535
L2.	.0435175	.0407716	1.07	0.286	-.0363934	.1234283
L3.	.0487145	.0405114	1.20	0.229	-.0306864	.1281154
L4.	.0584881	.0408085	1.43	0.152	-.0214951	.1384713
L5.	-.0014869	.0402027	-0.04	0.970	-.0802828	.077309
Eus						
L1.	-.0353738	.0369062	-0.96	0.338	-.1077086	.0369611
L2.	-.0500525	.0370467	-1.35	0.177	-.1226627	.0225578
L3.	-.0264471	.0368843	-0.72	0.473	-.0987389	.0458448
L4.	-.0801554	.0372269	-2.15	0.031	-.1531188	-.0071921
L5.	.0080811	.0369759	0.22	0.827	-.0643903	.0805526
_cons	.000445	.0002078	2.14	0.032	.0000378	.0008522
ARCH_UKs						
arch						
L1.	.0481004	.0167168	2.88	0.004	.0153362	.0808647
garch						
L1.	.8959113	.0482791	18.56	0.000	.801286	.9905366
_cons	4.29e-06	2.53e-06	1.69	0.091	-6.78e-07	9.25e-06
Eus						
UKs						
L1.	.0231184	.0420281	0.55	0.582	-.0592551	.105492
L2.	.0400125	.0417585	0.96	0.338	-.0418326	.1218575
L3.	.0459887	.0419423	1.10	0.273	-.0362166	.128194
L4.	.0075891	.0422319	0.18	0.857	-.0751838	.0903621
L5.	.0488871	.0418266	1.17	0.242	-.0330915	.1308657
Eus						
L1.	-.0420273	.0402031	-1.05	0.296	-.120824	.0367694
L2.	-.0405266	.0402485	-1.01	0.314	-.1194122	.038359
L3.	-.0356652	.0402652	-0.89	0.376	-.1145835	.0432531
L4.	-.0579452	.0403866	-1.43	0.151	-.1371014	.021211
L5.	-.0525038	.0403325	-1.30	0.193	-.1315539	.0265464
_cons	.0005371	.0002206	2.44	0.015	.0001048	.0009694
ARCH_Eus						
arch						
L1.	.0349193	.0087596	3.99	0.000	.0177507	.0520878
garch						
L1.	.942904	.015447	61.04	0.000	.9126284	.9731797
_cons	2.00e-06	7.28e-07	2.74	0.006	5.70e-07	3.43e-06
corr(UKs,Eus)	.7996132	.0110055	72.66	0.000	.7780429	.8211835
Adjustment						
lambda1	.0939239	.0309788	3.03	0.002	.0332066	.1546411
lambda2	.5284139	.1979006	2.67	0.008	.1405359	.9162919

Figure 76: Sector: GARCH Consumer Staples

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 27.48
Log likelihood = 12832.76 — Prob > chi2 = 0.1223

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKen						
UKen						
L1.	-.0337655	.039553	-0.85	0.393	-.111288	.0437569
L2.	-.0493409	.0399463	-1.24	0.217	-.1276342	.0289524
L3.	.0838922	.0393499	2.13	0.033	.0067677	.1610166
L4.	-.0085645	.0393401	-0.22	0.828	-.0856696	.0685407
L5.	.0050544	.0396537	0.13	0.899	-.0726654	.0827742
Euen						
L1.	.0232266	.0114354	2.03	0.042	.0008136	.0456396
L2.	-.0009198	.0116138	-0.08	0.937	-.0236824	.0218428
L3.	-.0231787	.0114459	-2.03	0.043	-.0456123	-.0007452
L4.	-.0083477	.0113404	-0.74	0.462	-.0305745	.0138791
L5.	-.0025595	.0117938	-0.22	0.828	-.0256749	.0205559
_cons	.000096	.0000731	1.31	0.189	-.0000474	.0002394
ARCH_UKen						
arch						
L1.	.0294535	.0091014	3.24	0.001	.0116151	.047292
garch						
L1.	.9551061	.0164925	57.91	0.000	.9227814	.9874308
_cons	1.57e-07	8.35e-08	1.88	0.061	-7.04e-09	3.20e-07
Euen						
UKen						
L1.	.043179	.1292788	0.33	0.738	-.2102028	.2965608
L2.	-.0775317	.1289354	-0.60	0.548	-.3302405	.1751771
L3.	.1899767	.1286968	1.48	0.140	-.0622645	.4422178
L4.	-.1272316	.1292438	-0.98	0.325	-.3805448	.1260816
L5.	.0391904	.1308925	0.30	0.765	-.2173542	.2957351
Euen						
L1.	.0096533	.0386041	0.25	0.803	-.0660093	.0853159
L2.	.0108601	.0388215	0.28	0.780	-.0652287	.0869489
L3.	-.0347968	.0386458	-0.90	0.368	-.1105412	.0409476
L4.	-.0054178	.0386723	-0.14	0.889	-.0812141	.0703786
L5.	-.0218296	.04003	-0.55	0.586	-.100287	.0566277
_cons	.0004743	.000239	1.98	0.047	5.93e-06	.0009426
ARCH_Euen						
arch						
L1.	.032824	.0126703	2.59	0.010	.0079908	.0576573
garch						
L1.	.9548694	.0184735	51.69	0.000	.918662	.9910767
_cons	1.27e-06	7.25e-07	1.75	0.080	-1.52e-07	2.69e-06
corr(UKen,Euen)	.7766347	.0207767	37.38	0.000	.7359131	.8173564
Adjustment						
lambda1	.0245154	.0055493	4.42	0.000	.0136391	.0353918
lambda2	.9529641	.0098285	96.96	0.000	.9337007	.9722275

Figure 77: Sector: GARCH Energy

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 39.16
Log likelihood = 10866.09 — Prob > chi2 = 0.0064

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKf						
UKf						
L1.	-.1245348	.0434068	-2.87	0.004	-.2096105	-.0394591
L2.	-.0710835	.0425068	-1.67	0.094	-.1543952	.0122283
L3.	-.0650562	.0425082	-1.53	0.126	-.1483708	.0182584
L4.	-.0449389	.0426308	-1.05	0.292	-.1284937	.0386159
L5.	.0210837	.0427609	0.49	0.622	-.0627261	.1048934
Euf						
L1.	.1171099	.0352154	3.33	0.001	.048089	.1861307
L2.	.0216636	.034481	0.63	0.530	-.0459179	.0892451
L3.	.0775031	.0347222	2.23	0.026	.0094489	.1455573
L4.	-.0317687	.0350223	-0.91	0.364	-.1004113	.0368738
L5.	-.030119	.0347697	-0.87	0.386	-.0982664	.0380284
_cons	.0005361	.0002289	2.34	0.019	.0000874	.0009848
ARCH_UKf						
arch						
L1.	.0814205	.0126053	6.46	0.000	.0567145	.1061264
garch						
L1.	.8847139	.0192925	45.86	0.000	.8469013	.9225265
_cons	3.59e-06	1.04e-06	3.45	0.001	1.55e-06	5.63e-06
Euf						
UKf						
L1.	-.1122139	.0519918	-2.16	0.031	-.2141161	-.0103118
L2.	-.0563765	.051677	-1.09	0.275	-.1576616	.0449086
L3.	-.063223	.051534	-1.23	0.220	-.1642279	.0377818
L4.	-.0599488	.0514927	-1.16	0.244	-.1608727	.0409751
L5.	.0192678	.0516129	0.37	0.709	-.0818916	.1204272
Euf						
L1.	.0910554	.0443803	2.05	0.040	.0040717	.1780391
L2.	.0165479	.043827	0.38	0.706	-.0693515	.1024473
L3.	.0566336	.0437259	1.30	0.195	-.0290676	.1423347
L4.	-.0457731	.0439776	-1.04	0.298	-.1319676	.0404213
L5.	-.0441599	.0434378	-1.02	0.309	-.1292964	.0409766
_cons	.0006427	.0002825	2.27	0.023	.0000889	.0011964
ARCH_Euf						
arch						
L1.	.0635089	.0094011	6.76	0.000	.0450831	.0819348
garch						
L1.	.912846	.0135735	67.25	0.000	.8862424	.9394495
_cons	3.93e-06	1.14e-06	3.44	0.001	1.69e-06	6.17e-06
corr(UKf,Euf)	.8271357	.0113476	72.89	0.000	.8048948	.8493766
Adjustment						
lambda1	.0327252	.0130715	2.50	0.012	.0071056	.0583448
lambda2	.895018	.0579518	15.44	0.000	.7814345	1.008602

Figure 78: Garch Financials

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 20.64
Log likelihood = 11131.67 — Prob > chi2 = 0.4187

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKh						
UKh						
L1.	.0040815	.0342769	0.12	0.905	-.0630999	.071263
L2.	.021841	.0340534	0.64	0.521	-.0449025	.0885845
L3.	.0565591	.0340552	1.66	0.097	-.0101879	.1233062
L4.	.0196898	.0342536	0.57	0.565	-.0474459	.0868255
L5.	.0020752	.0340014	0.06	0.951	-.0645663	.0687167
Euh						
L1.	-.0293227	.0285586	-1.03	0.305	-.0852965	.0266512
L2.	-.0170481	.02838	-0.60	0.548	-.0726719	.0385758
L3.	.0179452	.0286639	0.63	0.531	-.0382349	.0741253
L4.	-.014789	.0288352	-0.51	0.608	-.071305	.0417269
L5.	-.0100248	.0284365	-0.35	0.724	-.0657594	.0457097
_cons	.0005775	.0002047	2.82	0.005	.0001763	.0009787
ARCH_UKh						
arch						
L1.	.0324859	.0078081	4.16	0.000	.0171824	.0477895
garch						
L1.	.9272761	.0192662	48.13	0.000	.889515	.9650372
_cons	2.88e-06	1.00e-06	2.87	0.004	9.15e-07	4.84e-06
Euh						
UKh						
L1.	-.0138426	.0370507	-0.37	0.709	-.0864606	.0587755
L2.	.0636255	.037365	1.70	0.089	-.0096085	.1368595
L3.	.0135459	.0373684	0.36	0.717	-.0596948	.0867867
L4.	.0130363	.0375261	0.35	0.728	-.0605135	.0865861
L5.	-.00887	.0372671	-0.24	0.812	-.0819122	.0641723
Euh						
L1.	-.0283263	.0335612	-0.84	0.399	-.0941051	.0374525
L2.	-.04342	.0336033	-1.29	0.196	-.1092813	.0224414
L3.	.0274859	.0336533	0.82	0.414	-.0384733	.0934451
L4.	-.0350766	.033936	-1.03	0.301	-.10159	.0314368
L5.	-.0379894	.0333317	-1.14	0.254	-.1033183	.0273395
_cons	.0008255	.0002307	3.58	0.000	.0003734	.0012776
ARCH_Euh						
arch						
L1.	.0549495	.0115826	4.74	0.000	.032248	.077651
garch						
L1.	.9094204	.0196218	46.35	0.000	.8709625	.9478784
_cons	3.40e-06	1.01e-06	3.37	0.001	1.42e-06	5.38e-06
corr(UKh,Euh)	.6722755	.0162625	41.34	0.000	.6404017	.7041494
Adjustment						
lambda1	.0559398	.0201397	2.78	0.005	.0164668	.0954128
lambda2	.6709416	.1089079	6.16	0.000	.457486	.8843972

Figure 79: Garch Health Care

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 42.09
Log likelihood = 11809.58 — Prob > chi2 = 0.0027

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKi						
UKi						
L1.	-.0427788	.0428157	-1.00	0.318	-.1266961	.0411385
L2.	-.0706355	.0426575	-1.66	0.098	-.1542427	.0129716
L3.	.0060681	.0421473	0.14	0.886	-.0765391	.0886752
L4.	.0013066	.0416021	0.03	0.975	-.0802321	.0828453
L5.	.0331951	.0414819	0.80	0.424	-.0481079	.1144981
Eui						
L1.	.0389602	.0298334	1.31	0.192	-.0195122	.0974326
L2.	.010868	.0306504	0.35	0.723	-.0492057	.0709417
L3.	-.0024735	.0302992	-0.08	0.935	-.0618588	.0569118
L4.	-.0853708	.0301885	-2.83	0.005	-.1445391	-.0262025
L5.	-.0384275	.030305	-1.27	0.205	-.0978241	.0209691
_cons	.0007086	.000168	4.22	0.000	.0003794	.0010378
ARCH_UKi						
arch						
L1.	.1064975	.0180118	5.91	0.000	.071195	.1417999
garch						
L1.	.7471266	.0492145	15.18	0.000	.6506679	.8435852
_cons	7.26e-06	1.87e-06	3.89	0.000	3.60e-06	.0000109
Eui						
UKi						
L1.	-.0287617	.0564924	-0.51	0.611	-.1394848	.0819614
L2.	-.1201777	.0564983	-2.13	0.033	-.2309123	-.0094432
L3.	.0024178	.056394	0.04	0.966	-.1081124	.112948
L4.	-.0583313	.0563573	-1.04	0.301	-.1687895	.052127
L5.	.0273106	.0559318	0.49	0.625	-.0823137	.136935
Eui						
L1.	.0163778	.0425551	0.38	0.700	-.0670286	.0997841
L2.	.0638991	.042588	1.50	0.134	-.0195718	.14737
L3.	.0123986	.0426117	0.29	0.771	-.0711188	.095916
L4.	-.0639666	.04254	-1.50	0.133	-.1473434	.0194102
L5.	-.0582377	.0422859	-1.38	0.168	-.1411166	.0246412
_cons	.0009625	.0002311	4.16	0.000	.0005095	.0014155
ARCH_Eui						
arch						
L1.	.0835049	.0132919	6.28	0.000	.0574531	.1095566
garch						
L1.	.8465049	.0243671	34.74	0.000	.7987462	.8942636
_cons	6.79e-06	1.52e-06	4.46	0.000	3.81e-06	9.77e-06
corr(UKi,Eui)	.813914	.0122353	66.52	0.000	.7899332	.8378947
Adjustment						
lambda1	.0433106	.0121763	3.56	0.000	.0194456	.0671757
lambda2	.8627139	.0364676	23.66	0.000	.7912389	.934189

Figure 80: GARCH Industrials

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 24.37
Log likelihood = 10689.08 — Prob > chi2 = 0.2265

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKit						
UKit						
L1.	-.0301302	.0336773	-0.89	0.371	-.0961364	.0358761
L2.	-.0044561	.033224	-0.13	0.893	-.0695739	.0606617
L3.	.0288371	.0327011	0.88	0.378	-.035256	.0929301
L4.	-.0066381	.0325174	-0.20	0.838	-.070371	.0570949
L5.	.0426901	.0317361	1.35	0.179	-.0195116	.1048917
Euit						
L1.	.0343189	.0294407	1.17	0.244	-.0233838	.0920215
L2.	-.0469189	.0294569	-1.59	0.111	-.1046533	.0108155
L3.	.0375456	.0294307	1.28	0.202	-.0201376	.0952288
L4.	-.0282909	.0296038	-0.96	0.339	-.0863133	.0297316
L5.	-.0468094	.0291296	-1.61	0.108	-.1039024	.0102835
_cons	.0012203	.0002425	5.03	0.000	.0007449	.0016956
ARCH_UKit						
arch						
L1.	.1056999	.0213583	4.95	0.000	.0638383	.1475615
garch						
L1.	.7694112	.0460695	16.70	0.000	.6791167	.8597056
_cons	.0000126	3.15e-06	4.00	0.000	6.43e-06	.0000188
Euit						
UKit						
L1.	.0223402	.0337021	0.66	0.507	-.0437146	.0883951
L2.	-.0039182	.0334531	-0.12	0.907	-.0694851	.0616488
L3.	.0212186	.0335415	0.63	0.527	-.0445216	.0869588
L4.	-.0035071	.0333136	-0.11	0.916	-.0688005	.0617863
L5.	.037367	.0335359	1.11	0.265	-.0283621	.1030961
Euit						
L1.	-.0093179	.0328606	-0.28	0.777	-.0737234	.0550877
L2.	-.037998	.0327266	-1.16	0.246	-.102141	.026145
L3.	.0005344	.0329585	0.02	0.987	-.0640632	.0651319
L4.	-.0510172	.0324506	-1.57	0.116	-.1146192	.0125848
L5.	-.0444705	.0324736	-1.37	0.171	-.1081175	.0191765
_cons	.0010237	.0002559	4.00	0.000	.000522	.0015253
ARCH_Euit						
arch						
L1.	.0626543	.0118475	5.29	0.000	.0394336	.0858751
garch						
L1.	.8818918	.0238105	37.04	0.000	.8352241	.9285595
_cons	6.40e-06	1.82e-06	3.52	0.000	2.84e-06	9.97e-06
corr(UKit,Euit)	.6489447	.0185515	34.98	0.000	.6125843	.685305
Adjustment						
lambda1	.0481304	.0172451	2.79	0.005	.0143306	.0819303
lambda2	.7862917	.0817791	9.61	0.000	.6260076	.9465757

Figure 81: GARCH Information Technologies

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 28.11
Log likelihood = 10775.18 — Prob > chi2 = 0.1068

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKm						
UKm						
L1.	-.0070206	.0329924	-0.21	0.831	-.0716846	.0576434
L2.	.0262923	.032589	0.81	0.420	-.0375809	.0901655
L3.	.039323	.0328554	1.20	0.231	-.0250723	.1037183
L4.	-.0396921	.0327038	-1.21	0.225	-.1037903	.0244061
L5.	.0078703	.0328255	0.24	0.811	-.0564665	.0722071
Eum						
L1.	.0118398	.0459086	0.26	0.796	-.0781393	.101819
L2.	-.0673767	.0457436	-1.47	0.141	-.1570325	.022279
L3.	-.0546104	.0463386	-1.18	0.239	-.1454323	.0362115
L4.	-.0505473	.0460827	-1.10	0.273	-.1408678	.0397732
L5.	-.0549832	.0457611	-1.20	0.230	-.1446733	.0347069
_cons	.0005175	.0002833	1.83	0.068	-.0000377	.0010727
ARCH_UKm						
arch						
L1.	.0386599	.0067365	5.74	0.000	.0254566	.0518631
garch						
L1.	.9493204	.0092925	102.16	0.000	.9311075	.9675334
_cons	1.76e-06	6.71e-07	2.62	0.009	4.44e-07	3.07e-06
Eum						
UKm						
L1.	-.0205595	.0221362	-0.93	0.353	-.0639457	.0228266
L2.	.0162695	.0220456	0.74	0.461	-.026939	.059478
L3.	-.0105064	.0220515	-0.48	0.634	-.0537266	.0327139
L4.	-.0280046	.0219715	-1.27	0.202	-.0710679	.0150587
L5.	-.0078758	.0221291	-0.36	0.722	-.0512481	.0354966
Eum						
L1.	.0525264	.0334007	1.57	0.116	-.0129377	.1179905
L2.	-.0618686	.0334403	-1.85	0.064	-.1274104	.0036732
L3.	.0167807	.0336576	0.50	0.618	-.0491871	.0827484
L4.	-.0479332	.033471	-1.43	0.152	-.1135351	.0176687
L5.	-.0427942	.0333068	-1.28	0.199	-.1080744	.022486
_cons	.0006878	.0001978	3.48	0.001	.0003001	.0010755
ARCH_Eum						
arch						
L1.	.0559107	.0120124	4.65	0.000	.0323667	.0794546
garch						
L1.	.9151584	.0191123	47.88	0.000	.877699	.9526179
_cons	2.06e-06	6.61e-07	3.11	0.002	7.63e-07	3.35e-06
corr(UKm,Eum)	.6580976	.0315592	20.85	0.000	.5962427	.7199524
Adjustment						
lambda1	.0361866	.0080817	4.48	0.000	.0203467	.0520265
lambda2	.9353581	.0156952	59.60	0.000	.9045961	.96612

Figure 82: GARCH Materials

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 26.56
Log likelihood = 10839.42 — Prob > chi2 = 0.1480

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKes						
UKes						
L1.	-.0211453	.0318308	-0.66	0.506	-.0835324	.0412419
L2.	-.0126179	.0314434	-0.40	0.688	-.0742458	.04901
L3.	-.0294762	.0315152	-0.94	0.350	-.0912448	.0322925
L4.	-.0267131	.0301664	-0.89	0.376	-.0858381	.032412
L5.	.0132387	.0301324	0.44	0.660	-.0458198	.0722972
Eues						
L1.	-.0180473	.0273265	-0.66	0.509	-.0716062	.0355116
L2.	.0045258	.0275474	0.16	0.870	-.049466	.0585177
L3.	.0274299	.027313	1.00	0.315	-.0261027	.0809624
L4.	-.0502393	.0272537	-1.84	0.065	-.1036556	.0031769
L5.	.0066961	.0268568	0.25	0.803	-.0459423	.0593345
_cons	.0007079	.0002143	3.30	0.001	.000288	.0011278
ARCH_UKes						
arch						
L1.	.1525155	.0208678	7.31	0.000	.1116154	.1934156
garch						
L1.	.7645753	.0309268	24.72	0.000	.7039598	.8251907
_cons	8.75e-06	1.85e-06	4.72	0.000	5.12e-06	.0000124
Eues						
UKes						
L1.	.0644621	.0293985	2.19	0.028	.006842	.1220821
L2.	.006233	.0286189	0.22	0.828	-.0498591	.062325
L3.	-.0005361	.028746	-0.02	0.985	-.0568773	.0558051
L4.	.0279939	.028232	0.99	0.321	-.0273398	.0833277
L5.	.0326615	.0282503	1.16	0.248	-.022708	.088031
Eues						
L1.	-.0779167	.0307889	-2.53	0.011	-.1382618	-.0175715
L2.	-.0020692	.0307364	-0.07	0.946	-.0623114	.0581729
L3.	.0130296	.030424	0.43	0.668	-.0466004	.0726595
L4.	-.0749988	.0302728	-2.48	0.013	-.1343324	-.0156651
L5.	-.0248699	.0298945	-0.83	0.405	-.083462	.0337223
_cons	.0008787	.000228	3.85	0.000	.0004317	.0013256
ARCH_Eues						
arch						
L1.	.0540107	.0127519	4.24	0.000	.0290175	.079004
garch						
L1.	.91381	.0215696	42.37	0.000	.8715343	.9560857
_cons	3.26e-06	1.20e-06	2.71	0.007	9.03e-07	5.61e-06
corr(UKes,Eues)	.6548749	.0326718	20.04	0.000	.5908393	.7189105
Adjustment						
lambda1	.0013101	.0022653	0.58	0.563	-.0031298	.00575
lambda2	.9927019	.0037206	266.81	0.000	.9854096	.9999941

Figure 83: Sector: GARCH Real Estate

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 14.65
Log likelihood = 10370.44 — Prob > chi2 = 0.7963

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKt						
UKt						
L1.	-.0563797	.0331669	-1.70	0.089	-.1213857	.0086263
L2.	.0025298	.0321114	0.08	0.937	-.0604074	.065467
L3.	.0262007	.0320953	0.82	0.414	-.0367049	.0891064
L4.	-.0137188	.0318333	-0.43	0.666	-.0761108	.0486732
L5.	.0583827	.0312938	1.87	0.062	-.002952	.1197175
Eut						
L1.	.0390412	.0339151	1.15	0.250	-.0274311	.1055135
L2.	-.0354345	.0331805	-1.07	0.286	-.1004671	.029598
L3.	.0006533	.0332348	0.02	0.984	-.0644857	.0657922
L4.	-.0005771	.0328999	-0.02	0.986	-.0650597	.0639054
L5.	-.0649552	.0330993	-1.96	0.050	-.1298287	-.0000817
_cons	.0005377	.0002776	1.94	0.053	-6.39e-06	.0010818
ARCH_UKt						
arch						
L1.	.0750136	.019852	3.78	0.000	.0361045	.1139227
garch						
L1.	.7477136	.0798078	9.37	0.000	.5912932	.9041341
_cons	.0000242	9.12e-06	2.65	0.008	6.30e-06	.0000421
Eut						
UKt						
L1.	-.03093	.0256888	-1.20	0.229	-.0812792	.0194192
L2.	-.0051642	.0254365	-0.20	0.839	-.0550188	.0446905
L3.	.0342722	.0256775	1.33	0.182	-.0160548	.0845992
L4.	.0056703	.0255686	0.22	0.824	-.0444433	.0557839
L5.	.010356	.0251944	0.41	0.681	-.0390242	.0597362
Eut						
L1.	.0322545	.0309702	1.04	0.298	-.028446	.0929549
L2.	.0083646	.0305606	0.27	0.784	-.0515331	.0682624
L3.	-.0072912	.0307722	-0.24	0.813	-.0676035	.0530211
L4.	-.0177729	.0306948	-0.58	0.563	-.0779337	.0423879
L5.	-.0146231	.0302803	-0.48	0.629	-.0739715	.0447253
_cons	.0004278	.00024	1.78	0.075	-.0000426	.0008982
ARCH_Eut						
arch						
L1.	.0714613	.0124075	5.76	0.000	.047143	.0957796
garch						
L1.	.8967851	.0190454	47.09	0.000	.8594569	.9341133
_cons	3.61e-06	1.10e-06	3.27	0.001	1.45e-06	5.78e-06
corr(UKt,Eut)	.5944811	.0349152	17.03	0.000	.5260485	.6629137
Adjustment						
lambda1	.0390063	.0110966	3.52	0.000	.0172573	.0607552
lambda2	.9254062	.0215137	43.01	0.000	.88324	.9675723

Figure 84: GARCH Telecommunication Services

Dynamic conditional correlation MGARCH model

Sample: 1 - 1691, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 32.18
Log likelihood = 11023.74 — Prob > chi2 = 0.0414

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKu						
UKu						
L1.	.0019081	.0309571	0.06	0.951	-.0587667	.0625829
L2.	.0156482	.030698	0.51	0.610	-.0445189	.0758152
L3.	-.0127386	.030472	-0.42	0.676	-.0724626	.0469853
L4.	.0258618	.0309035	0.84	0.403	-.0347079	.0864315
L5.	.0375019	.0304098	1.23	0.217	-.0221002	.0971041
Euu						
L1.	-.0080344	.0277232	-0.29	0.772	-.0623708	.046302
L2.	-.0558243	.0275943	-2.02	0.043	-.1099081	-.0017406
L3.	.0492193	.0277667	1.77	0.076	-.0052023	.103641
L4.	-.0845173	.027871	-3.03	0.002	-.1391435	-.0298912
L5.	-.0371751	.0279923	-1.33	0.184	-.092039	.0176888
_cons	.0004759	.0002074	2.29	0.022	.0000694	.0008823
ARCH_UKu						
arch						
L1.	.0443488	.0160172	2.77	0.006	.0129556	.0757421
garch						
L1.	.9291281	.0340584	27.28	0.000	.8623749	.9958812
_cons	2.12e-06	1.52e-06	1.40	0.162	-8.53e-07	5.09e-06
Euu						
UKu						
L1.	.0189694	.0308996	0.61	0.539	-.0415928	.0795315
L2.	.0244874	.0311341	0.79	0.432	-.0365343	.085509
L3.	.0002668	.0308339	0.01	0.993	-.0601664	.0607001
L4.	-.0302458	.0309912	-0.98	0.329	-.0909875	.0304959
L5.	.028954	.030779	0.94	0.347	-.0313717	.0892797
Euu						
L1.	.0133486	.0307451	0.43	0.664	-.0469106	.0736079
L2.	-.0062388	.0309832	-0.20	0.840	-.0669647	.054487
L3.	.0327455	.0312271	1.05	0.294	-.0284584	.0939495
L4.	-.0299973	.0308728	-0.97	0.331	-.0905069	.0305122
L5.	-.0474189	.0308784	-1.54	0.125	-.1079395	.0131017
_cons	.0005213	.0002174	2.40	0.017	.0000951	.0009475
ARCH_Euu						
arch						
L1.	.0551571	.0099675	5.53	0.000	.0356212	.074693
garch						
L1.	.9152027	.0156625	58.43	0.000	.8845048	.9459007
_cons	2.66e-06	8.29e-07	3.20	0.001	1.03e-06	4.28e-06
corr(UKu,Euu)	.6103167	.036042	16.93	0.000	.5396758	.6809577
Adjustment						
lambda1	.0299152	.0080467	3.72	0.000	.014144	.0456864
lambda2	.9455148	.0160933	58.75	0.000	.9139726	.9770571

Figure 85: GARCH Utilities

Focus

Dynamic conditional correlation MGARCH model

Sample: 1 - 1647, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 28.20
Log likelihood = 11453.35 — Prob > chi2 = 0.1048

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UKfocus						
UKfocus						
L1.	.0393913	.0356774	1.10	0.270	-.030535	.1093177
L2.	.0080231	.0350737	0.23	0.819	-.0607201	.0767663
L3.	-.0149599	.0344678	-0.43	0.664	-.0825155	.0525956
L4.	.0250847	.0342243	0.73	0.464	-.0419936	.092163
L5.	.0132083	.0341161	0.39	0.699	-.0536579	.0800746
European						
L1.	-.0194648	.028813	-0.68	0.499	-.0759373	.0370076
L2.	-.0578549	.0283306	-2.04	0.041	-.1133818	-.002328
L3.	.0294847	.028827	1.02	0.306	-.0270151	.0859846
L4.	-.0786831	.0282568	-2.78	0.005	-.1340653	-.0233008
L5.	-.0340448	.0288465	-1.18	0.238	-.0905828	.0224932
_cons	.0009909	.0001813	5.47	0.000	.0006356	.0013463
ARCH_UKfocus						
arch						
L1.	.1081787	.0129856	8.33	0.000	.0827275	.1336299
garch						
L1.	.8519808	.0180269	47.26	0.000	.8166488	.8873127
_cons	2.76e-06	6.57e-07	4.19	0.000	1.47e-06	4.04e-06
European						
UKfocus						
L1.	.0053755	.0358283	0.15	0.881	-.0648467	.0755977
L2.	-.0087839	.0354618	-0.25	0.804	-.0782878	.06072
L3.	-.0231338	.0352099	-0.66	0.511	-.0921439	.0458764
L4.	.0016103	.0351159	0.05	0.963	-.0672156	.0704362
L5.	.0180954	.0350623	0.52	0.606	-.0506255	.0868163
European						
L1.	-.0129197	.0348159	-0.37	0.711	-.0811576	.0553182
L2.	-.0210655	.0343416	-0.61	0.540	-.0883737	.0462428
L3.	.0361807	.0350065	1.03	0.301	-.0324308	.1047922
L4.	-.0601128	.0342854	-1.75	0.080	-.127311	.0070853
L5.	-.0597441	.0346879	-1.72	0.085	-.127731	.0082429
_cons	.0008626	.0002111	4.09	0.000	.0004489	.0012762
ARCH_European						
arch						
L1.	.0598035	.0094139	6.35	0.000	.0413526	.0782545
garch						
L1.	.9170483	.013815	66.38	0.000	.8899714	.9441252
_cons	2.06e-06	6.01e-07	3.43	0.001	8.84e-07	3.24e-06
corr(UKfocus,European)	.7343302	.0270261	27.17	0.000	.6813601	.7873003
Adjustment						
lambda1	.0528939	.0096674	5.47	0.000	.0339461	.0718417
lambda2	.9114726	.0172152	52.95	0.000	.8777313	.9452138

Figure 86: Focus: Results of the baseline regression

Dynamic conditional correlation MGARCH model

Sample: 1 - 1647, but with gaps — Number of obs = 1,612
Distribution: Gaussian — Wald chi2(20) = 45.97
Log likelihood = 11255.99 — Prob > chi2 = 0.0008

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Foreignfocus						
Foreignfocus						
L1.	-.0419189	.0369909	-1.13	0.257	-.1144197	.0305819
L2.	.024477	.0369902	0.66	0.508	-.0480225	.0969765
L3.	.0917061	.0366368	2.50	0.012	.0198993	.1635128
L4.	-.0303854	.0366092	-0.83	0.407	-.1021381	.0413673
L5.	-.0392483	.0368072	-1.07	0.286	-.111389	.0328924
European						
L1.	.0340622	.0356143	0.96	0.339	-.0357405	.1038649
L2.	-.0590706	.0355785	-1.66	0.097	-.1288031	.010662
L3.	-.0680935	.035624	-1.91	0.056	-.1379153	.0017283
L4.	-.0528079	.0353748	-1.49	0.135	-.1221413	.0165254
L5.	.0231746	.0357097	0.65	0.516	-.0468152	.0931643
_cons	.0005685	.0002146	2.65	0.008	.0001479	.0009891
ARCH_Foreignfocus						
arch						
L1.	.0463216	.0079076	5.86	0.000	.030823	.0618202
garch						
L1.	.9338897	.0124721	74.88	0.000	.9094448	.9583346
_cons	1.69e-06	5.75e-07	2.93	0.003	5.58e-07	2.81e-06
European						
Foreignfocus						
L1.	-.0690426	.0360761	-1.91	0.056	-.1397505	.0016653
L2.	-.0273295	.0366165	-0.75	0.455	-.0990964	.0444375
L3.	.0194263	.0364203	0.53	0.594	-.0519561	.0908088
L4.	-.0792037	.0364859	-2.17	0.030	-.1507147	-.0076927
L5.	.0044623	.0361877	0.12	0.902	-.0664642	.0753888
European						
L1.	.043393	.0371812	1.17	0.243	-.0294807	.1162668
L2.	-.0079138	.0373469	-0.21	0.832	-.0811124	.0652847
L3.	-.0253538	.0375102	-0.68	0.499	-.0988723	.0481648
L4.	-.0249003	.0373572	-0.67	0.505	-.098119	.0483184
L5.	-.048933	.0370782	-1.32	0.187	-.121605	.0237389
_cons	.0008388	.0002138	3.92	0.000	.0004197	.0012579
ARCH_European						
arch						
L1.	.0691627	.0105459	6.56	0.000	.0484932	.0898322
garch						
L1.	.9088441	.0142481	63.79	0.000	.8809183	.9367699
_cons	2.10e-06	5.92e-07	3.55	0.000	9.40e-07	3.26e-06
corr(Foreignfocus,European)	.7515999	.0248835	30.20	0.000	.7028292	.8003707
Adjustment						
lambda1	.0389956	.009491	4.11	0.000	.0203935	.0575977
lambda2	.932589	.0180296	51.73	0.000	.8972515	.9679264

Figure 87: Focus: Foreign-focused companies: Baseline Regression