Brexit and its impact on EU financial markets

October 2025

Abstract

We investigate the impact of Brexit on volatility spillovers across the EU countries. We introduce a Brexit intensity measure that assigns an intensity score reflective of the financial markets' reaction to the events that occurred as Brexit negotiations began to unfold. We find that Brexit related events have contributed towards increased volatility transmission within the EU. Country-wise investigations show that throughout the Brexit timespan, France is the key volatility transmitter within the Union. By contrast, the UK is evidenced as a volatility transmitter during the early stages of Brexit negotiations, under Theresa May as the prime minister. Out of the smallest stock markets of the block, Ireland, Portugal, and Spain have been amongst those particularly affected.

Keywords: Brexit, financial markets, volatility spillover, connectedness, Brexit intensity measure

JEL classification: G15, C24

Declarations of interest: None

1. Introduction

In this paper we investigate the impact of Brexit on volatility spillovers across the EU countries. We develop a Brexit intensity measure for that purpose. Brexit is not a one-off event but rather a process and our intensity score reflects the financial markets' reaction on the events that occurred during this process as Brexit negotiations began to unfold. The United Kingdom (UK) held a referendum on the 23rd of June 2016 and 51.89% of voters handed the Brexit decision, in which the UK was to leave the European Union (EU). The UK has been an essential and critical part of European integration since the late 1950s. The decision to leave was unexpected, so much so that the then Prime Minister David Cameron resigned immediately. On March 29, 2017, the new Theresa May government notified the European Union about its intention to leave, triggering Article 50 (of the Lisbon Treaty) that allows withdrawal negotiations up to two years. The deal Theresa May's government made with the EU was rejected three times by the parliament resulting in her resignation and the election of Boris Johnson as the new prime minister. The Brexit process ended in December 2020 following the suspension of parliament and a volatile political process of negotiations with the EU and disagreements in the parliament about the happening of Brexit as well as the nature of the deal that was to follow and govern the subsequent relations between the UK and the rest of the EU.

The Brexit process is the first attempt after the Second World War, for de-globalization in Europe. UK withdrawing from the EU has not only political but also economic consequences as barriers will be erected between the UK and the rest of the EU, a market of approximate population of five hundred million in the exchange of goods, services, and people. In this paper we investigate the first major disintegration event after a long period of world integration, by focusing on immediate economic consequences of Brexit related events upon financial markets.

To investigate how Brexit has affected volatility spillovers across the EU countries we rely on stock market equity indices that span the 4/1/2000–4/5/2021 period. We use the Diebold and Yilmaz (2009) (henceforth DY) volatility spillovers approach with conditional volatility estimates from an asymmetric GARCH specification. The DY approach allows us to obtain a dynamic estimate of spillover intensity across the EU countries. Besides, it provides estimates of the net directional spillovers, which distinguish the volatility transmitters to volatility receivers. In a second stage analysis we examine the drivers of net directional spillovers using an array of macroeconomic and financial controls in line with the financial contagion literature, and our novel Brexit intensity measure.

One econometric challenge of Brexit relates to the multitude of events and the heterogeneity of political responses and attention across time. Utilizing a traditional event study analysis is challenging as Brexit events are often overlapping, while there is no single criterion on which basis to select the most influential.

Contrarily, specifying a set time assumes that Brexit turmoil has the same *intensity* across time. To circumvent these challenges, we create a novel Brexit intensity measure. Our measure utilizes all Brexit related events from a comprehensive list, to which an intensity score is assigned.

In our analysis, we investigate the transmission of Brexit-related shocks to EU financial markets via news-based channels that reflect both policy uncertainty and economic expectations. Specifically, we focus on the news channel as the core mechanism through which Brexit affects volatility spillovers. To operationalize this, we construct a novel Brexit Intensity Measure, which captures market responses to 500 events dated from 17/12/2015 (i.e., the referendum pledge) until 31/12/2020 (i.e., the formal exit from the EU). These events capture the eight phases that the Brexit process unfolded, each reflecting significant shifts in political context, institutional developments, and market uncertainty. The first phase, Pre-Referendum Campaign and Political Lead-Up (January 2013 – April 2016), began with David Cameron's announcement of an EU referendum and included early debates and legislative steps leading to the vote. The second phase, Referendum and Immediate Aftermath (June 2016 – May 2017), captured the political shock of the Leave vote, David Cameron's resignation, and the emergence of Theresa May's leadership, which initially aimed to unify a divided country. The third phase, First Negotiation Phase and Political Realignments (June 2017 – July 2021), was marked by the UK's formal triggering of Article 50, the beginning of EU-UK negotiations, and the 2017 general election that weakened May's mandate. The fourth phase, EU (Withdrawal) Act Period – Institutional Frameworks (December 2017 – June 2018), saw the legislative groundwork being laid, as the UK Parliament passed the EU (Withdrawal) Act to prepare domestic law for Brexit. The fifth phase, Meaningful Votes and Legislative Challenges (June 2018 – June 2019), was characterized by repeated parliamentary rejections of the withdrawal deal, creating deep political gridlock and market anxiety. The sixth phase, Parliamentary Gridlock and Leadership Change (January 2019 – July 2019), intensified political uncertainty, ultimately leading to Theresa May's resignation and Boris Johnson's rise to power. The seventh phase, Johnson Premiership and Exit Day (July 2019 – January 2020), featured renegotiation of the withdrawal agreement and the UK's formal exit from the EU on January 31, 2020. Finally, the eighth phase, Transition Period and EU–UK Trade Talks (February 2020 – December 2020), included the complex process of negotiating the future trade relationship under intense time pressure, concluding with the EU–UK Trade and Cooperation Agreement. Each phase corresponds to specific clusters of events and political shifts, providing a chronological lens to understand the evolving impact of Brexit on financial markets and investor sentiment. These events collectively capture five transmission channels: (i) UK Brexit Policy Channel – captures policy announcements, government white papers, legal acts, and the official negotiation stance of the UK. This reflects regulatory and policy uncertainty, directly affecting investor expectations; (ii) EU Brexit Policy Channel – reflects the EU's reaction and counter-strategy. These announcements shape market expectations about the future trade

relationship and regulatory divergence, impacting cross-border investment and volatility; (iii) UK Political Channel – captures leadership changes, general elections, and court rulings. This represents the political risk channel, where leadership uncertainty or judicial intervention increases perceived systemic risk; (iv) Voting/Institutional Process Channel – includes all key parliamentary votes and institutional decisions. These events determine the legal and procedural certainty of Brexit, affecting markets' perception of the timeline and credibility of the process; (v) Industry & Market Sentiment Channel – includes corporate and financial sector responses, such as credit rating actions or relocation plans. This reflects the real economy and confidence channel, where firms adjust investment based on perceived future risk.

The intensity score reflects the financial markets' reaction on each particular event, and we use the following measures: i) FTSE 100 logarithmic returns; ii) FTSE 100 conditional volatility; iii & iv) GBP/EUR and GBP/USD logarithmic change; v) VIX implied volatility. We are aware that some events may have varying reflections on financial markets. For example, business-oriented events may have a more pronounced impact on stock market, while more policy-related measures may affect the foreign exchange rate. Arguably, the most important events (i.e., the referendum result) would have market-wide impact. The Brexit intensity variable is continuous and ranges between zero and one, with higher values indicating an event of a higher magnitude.

A preview of our results shows that largest stock markets by market capitalization are more likely to be volatility transmitters; relatedly the UK transmits 32.5 percentage points more volatility than it receives. An unprecedented in speed and magnitude drop in volatility spillovers within the EU-15 is evidenced following the Brexit referendum, suggestive of plummeting financial integration. A determinants of volatility transmission analysis shows that Brexit related events have contributed towards increased volatility transmission. Country-wise investigations show that throughout the Brexit timespan, France is the key volatility transmitter within the Union. By contrast, the UK is evidenced as a volatility transmitter during the early stages of Brexit negotiations, under Theresa May as the prime minister. Regarding the smaller stock markets of the block, Ireland, Portugal and Spain have been amongst those particularly affected.

Our contribution is threefold. *First*, we construct a novel Brexit Intensity Measure that overcomes the limitations of traditional event studies. Rather than treating Brexit as a single binary event or focusing on a handful of announcements, our measure captures over 500 Brexit-related events, each weighted for its market relevance and organized into eight phases that reflect shifting political and economic contexts. This methodology allows us to quantify the heterogeneous and evolving nature of Brexit shocks and provides a more accurate lens to study their financial market impact. *Second*, we offer the first investigation of the determinants of net directional volatility spillovers. These spillovers, defined as the difference between

volatility imports and exports of a country, offer an intuitive measure of financial interdependence and risk transmission that is highly relevant for policymakers and regulators. *Third*, we conduct a comprehensive analysis of how EU stock markets responded to Brexit shocks across time. By linking our intensity measure with financial and macroeconomic data in a Diebold-Yilmaz spillover framework, we show how Brexit uncertainty transmitted across borders and evolved through different stages of the withdrawal process.

The remainder of the paper is organized as follows. Section 2 presents a concise literature review, while section 3 presents the data used. Section 4 lays out the econometric methodology used together with the mechanics of the Brexit intensity variable. Section 5 presents and discusses the empirical results. Robustness tests are provided in Section 6. A final section concludes.

2. Related Literature

2.1 Brexit

Following the June 2016 referendum, the pound depreciated sharply and by the end of June 2017 was 12 percent lower against the dollar before the vote (Sampson, 2017). Dhingra et al., (2016) argue that Brexit is likely to have a negative impact on inward FDI. They document that leaving the EU will reduce FDI inflows to the UK by around 22%. Such losses of investment will damage UK productivity and could lower real incomes by 3.4%. Bloom et al., (2019) document three key findings. They find that Brexit has generated a long-lasting increase in uncertainty. They also anticipate that Brexit investment would reduce by about 11% and forecast a reduced UK productivity by between 2%and 5% over the three years after the referendum. McGrattan and Waddle (2017) estimate the impact of tightening regulations on foreign producers following Brexit. They find that the impact on investment, production, and welfare depends on whether the UK acts unilaterally to block EU FDI or jointly with EU nations to establish cross-border barriers on each other's FDI. Sampson (2017) argues that Brexit will lead to a reduction in economic integration between the United Kingdom and its main trading partner, the EU. These findings and discussions correspond to the findings of Bekaert et al., (2013) who find that EU membership reduces equity market segmentation between member countries and that market integration of EU would lead to greater benefits. Kenourgios et al., (2020) examine the reaction of European stock markets after the UK's EU membership referendum ("Brexit"). They use an event study approach to analyze the impact of the referendum on stock markets, and find that the financial sector experienced a negative effect. Similarly, Kim et al., (2024) find that Brexit had a spontaneous adverse effect on the liquidity of UK and EU stocks. They conclude that the Brexit' impact lasted longer for UK stocks than other EU stocks. On the other hand,

US stocks show higher sensitivity to Brexit-related news than non-US stocks. Ben Ameur and Louhichi (2022) study Brexit's impact on European market co-movements using the Diebold and Yilmaz (2012) connectedness framework, treating Brexit as a single discrete event with binary pre- and post-referendum indicators.

2.2 Financial Contagion

According to Forbes and Rigobon (2002), financial contagion is defined as follows: "a significant increase in cross-market linkages after a shock to one country (or group of countries)". This definition implies that it is necessary to find a large and significant impact in one market after an event has occurred in another market to determine whether there is a contagion effect. Moreover, it is imperative that the markets show few or no co-movements before the disturbance, else it cannot be considered financial contagion. A plethora of literature focuses on the connectedness amongst the various financial assets. For example, Ayadi et al., (2021) document evidence of contagion in the equity markets including the USA, Western Europe and the BRICS; and sixteen categories of commodities during four crises, namely, the global financial crisis, the Irish banking crisis and the European debt crisis and Brexit. BenMim and BenSaïda (2019) examine the dependence dynamics between major American and European stock markets by distinguishing the effects during crisis periods such as the European debt crisis and the Brexit vote and find evidence of financial contagion. In another study, BenSaïda and Litimi (2020) find very strong evidence of contagion amongst the G10 markets during global financial crisis and the European sovereign debt crisis but find low connectedness after the British referendum to leave the EU. They argue that this is because the European community has taken early measures to limit harmful shock transmission.

In this paper, we classify Brexit as a financial contagion since the UK is a key player in global financial markets and any major event that occurs in the UK will have serious transmission implications to global markets especially in the European financial markets. Using daily closing price indices from 31 stock exchanges, including in the UK, Escribano and Íñiguez (2021) analyze the impact of the Brexit process in the main European and non-European financial markets. The study period covers from the Prime Minister's announcement of the date of the referendum. They document that financial contagion on the main European and international economies consistent with the effect of the Brexit referendum results. They adopt the framework of contagion tests based on correlation and coskewness. Aristeidis and Kampouris (2018) use dependence dynamics through copulas with regime switching and find financial contagion from the referendum results.

Kose (2011) notes that studies often face challenges in precisely dating a crisis. This issue is especially pronounced when no single event date can be identified. To overcome this problem, several papers propose contagion tests that is not reliant on dates established exogenously (see, e.g., Forbes and Rigobon, 2002; Fry et al., 2010; Tabak et al., 2016; Diebold and Yilmaz, 2014; Bostanci and Yilmaz, 2020).

For this paper, we use the framework of contagion tests by applying the connectedness methodology developed by Diebold and Yilmaz (2014). We apply the methodology of Diebold and Yilmaz (2014) to measure the intensity of the spillover effects from the shocks arising from Brexit to each of the country. Following Engle et al., (1990), the Diebold -Yilmaz model investigates return and volatility spillovers using a vector autoregressive (VAR) model, but concentrate on variance decompositions. This procedure hence gives one measure of spillover based on spillovers from several markets.

This is especially important as the connectedness among various asset classes, portfolios, and the stocks of institutions are critical whilst examining financial markets. The model allows for variance decompositions that are weighted and directional to explicitly show the connectedness across assets, portfolio, markets and countries. Diebold and Yilmaz (2015) show the existence of global business cycle connectedness and that it is economically significant and time-varying. Their results also reveal that that the U.S. has disproportionately high connectedness to the rest of the world, and that pairwise country connectedness is inversely related to bilateral trade surpluses. In a study on connectedness of sovereign credit default swaps, Bostanci and Yilmaz (2020) find that countries in the emerging markets have played a crucial role in the transmission of sovereign credit risk, while developed countries and developing countries with high debt levels have played marginal roles. They also show that both trade and capital flows are determinants of pairwise connectedness across countries. Using a measure referred to as a spillover index, Diebold and Yilmaz (2009) document interdependence for the asset returns and volatilities of 19 global equity markets for the period January 1992 to November 2007. They note that the interdependence between markets is also time-varying, and that the pattern of spill overs differed. Sumner et al., (2010) extend the work of Diebold and Yilmaz (2009) using a spill over index methodology to examine whether gold returns and volatilities can predict U.S. stock and bond market movements or vice versa. Demirer et al., (2018) extend the Diebold and Yilmaz model to a high dimensional environment by incorporating LASSO estimation. Their results show that global bank equity connectedness has a strong geographic component, whereas sovereign bond connectedness does not.

Diebold and Yilmaz (2012) develop a framework to study the daily volatility spillovers across US stock, bond, foreign exchange and commodities markets, from January 1999 to January 2010. They find that cross-

market volatility spillovers were quite limited until the global financial crisis in 2007. Umar et al., (2020) use the Diebold Yilmaz framework to examine the connectedness between major ESG equity indices. Their results indicate that developed markets are the shock transmitters to Asian and other emerging markets. Furthermore, they find that the Eurozone crisis and COVID-19 pandemic enhance further the connectedness among the markets.

Belke et al., (2016) assess the effect of policy uncertainty on volatility in financial markets resulting from Brexit. They use the Diebold and Yilmaz (2009, 2012) approach based on VAR variance decompositions. They find that policy uncertainty will continue to cause instability in key financial markets and it has the potential to damage the real economies of both the UK and other European countries. Lucey et al., (2014) adopt the Diebold and Yilmaz (2009) model to investigate the degree to which London, New York, Shanghai and Tokyo gold markets are connected, and which markets are the net senders or recipients of information. In terms of volatility and return spillovers, they find that Shanghai remains isolated as a market.

Kenourgios (2014) investigate the implied volatility contagion during the global and Euro zone crises. His findings reveal that contagion in cross-market volatilities, with the initial phase of the Global Financial Crisis as the most contagious as well as the later period of the Euro crisis. Kenourgios *et al.,* (2011) use both a multivariate regime-switching Gaussian copula model and the asymmetric generalized dynamic conditional correlation (AG-DCC) approach to capture financial contagion in the BRIC (Brazil, Russia, India, China) countries and two developed markets, namely UK and US during finance crises. They find that a contagion effect from the crisis country to all other countries.

3. Data

The data comprise daily closing prices for the aggregate equity indices for EU-15 countries and cover the period from 4/1/2000–4/5/2021. All indices are value-weighted and exclude dividends. The data source is Bloomberg. For every index, we compute the continuously compounded percentage return as $r_t = \ln(p_t/p_{t-1}) \times 100$, where p_t is the closing price at day t. Table 1 presents key descriptive statistics of the equity indices under investigation. All returns exhibit the stylised facts of skewness and excess kurtosis. Luxembourg exhibits the highest mean returns, while Greece is the most volatile. Across the full period, the UK is the largest stock market in terms of market capitalisation, followed by France and Germany. By contrast, Portugal and Greece are among the smallest.

<Table 1 descriptive statistics>

We use daily data to capture the high-frequency dynamics of equity market responses, particularly around Brexit-related events. Brexit events happen on a day-to-day basis. Daily observations allow us to measure immediate volatility spillovers and market reactions to individual events, which could be smoothed over by lower-frequency (e.g., weekly or monthly) data. Lower frequency data by its very nature would include information other than the Brexit events that we focus on. This choice is consistent with the literature highlighting the importance of data frequency in financial hypothesis testing (Narayan and Sharma, 2015; Narayan et al., 2015), and is supported by Narayan and Bannigidadmath (2016), who argue that daily data are preferable when the goal is to extract maximal information from market movements. Moreover, daily data are essential for constructing the Brexit intensity variable, which aggregates stock returns, volatility, exchange rates, and VIX measures daily to reflect market reactions with fine granularity.

4. Methodology

4.1 Estimation of conditional volatility

We estimate conditional volatility for each index using a GJR-GARCH specification that allows for asymmetric effects[1] in the volatility process, given as $r_t = \theta_0 + \varphi_1 r_{t-1} + u_t, u_t \sim N(0, h_t)$ with $h_t^2 = \omega_0 + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}^2 + \gamma_1 u_{t-1}^2 I_{t-1}$ where $I_{t-1} = 1$ if $u_t < 0$ and zero otherwise.

4.2 Volatility spillover connectedness

We introduce only the most relevant notation to our analysis and direct the reader to the Diebold and Yilmaz (2014) for a complete exposition. Of key interest for the construction of the connectedness measures are the forecast error variance decompositions from an N-dimensional covariance stationary VAR system, denoted as: $d_{ij}^H \; \forall \; i, j = 1, \dots, N$. The inequality $i \neq j$ is used to disentangle between "own" and "cross" (or spillover) effects. The main output is the connectedness table that features the "variance decomposition matrix", denoted as $D^H = [d_{ij}^H]$, with elements $C_{i \leftarrow j}^H \equiv d_{ij}^H$ and $C_{j \leftarrow i}^H \equiv d_{ji}^H$ denoting the *directional spillovers* to asset i from asset j, and to asset j from asset i respectively. As the method is asymmetric, it follows that $d_{ij}^H \neq d_{ji}^H$. The connectedness table also includes the off-diagonal column-sums and row-sums, defined as $C_{i \leftarrow \bullet}^H \equiv \sum_{j=1; j \neq i}^N d_{ij}^H$ and $C_{\bullet \leftarrow \mathrm{j}}^H \equiv \sum_{i=1; i \neq j}^N d_{ij}^H$, denoted as the "From" and "To" *total directional spillovers* respectively. These quantities reflect the share of the forecast error variance for each asset i *from*

[1] That investors care more about negative returns are central to behavioral finance (with arguments on prospect theory and loss aversion, see Kahneman and Tversky (1979), while asset pricing studies dating back to Roy (1952) and Markowitz (1959) concur.

all other assets and for each asset j *to* all other assets, respectively. We also define the *net total directional spillovers* as $C_i^H = C_{i\leftarrow\bullet}^H - C_{\bullet\leftarrow \mathrm{j}}^H$ where positive (negative) values indicate a spillover receiver (transmitter) respectively. Finally, the *total spillover index* is defined as the sum of the off-diagonal entries of D^H averaged over the N-assets, namely $C^H = N^{-1}\sum_{i,j=1;i\neq j}^N d_{ij}^H$. Moving from a static to a dynamic analysis turns the connectedness table containing the pre-discussed metrics into a series of dynamic plots. In our setup, we implement the dynamic analysis with a 2-year rolling estimation window (w=500).[2]

Having outlined the technical construction of the DY connectedness measures, we now discuss why our methodology is particularly suited to study Brexit. Compared to other advanced contagion techniques such as dynamic copulas, asymmetric DCC specifications, or wavelet coherence analysis, the DY spillover framework offers several advantages for the purposes of this study. First, it provides a clear identification of volatility transmitters and receivers, something less transparent in copula or wavelet-based methods. For instance, Kenourgios et al. (2013) investigate financial contagion using an asymmetric generalized DCC model, emphasizing correlation asymmetry rather than directional spillovers. Similarly, BenSaïda and Litimi (2021) employ a copula approach across G10 stock markets to study tail dependence, while Samitas et al. (2022) analyze the role of policy uncertainty in real-economy contagion using copulas. Second, the DY methodology is explicitly dynamic and can be linked directly with macro-financial variables, which makes it particularly suitable for our second-stage analysis that relates spillover transmission to Brexit intensity. Third, unlike copula or wavelet approaches that often require pairwise analysis, the DY framework can simultaneously handle a large panel of markets in a system-wide setting, which is crucial for understanding EU-wide integration and fragmentation during Brexit. Finally, while DCC-type models capture time-varying correlations, they do not directly quantify directional volatility flows, which is the central focus of our study. Thus, the DY approach balances tractability, interpretability, and system-level insight, making it particularly well-suited to our research objectives.

4.3 Second-stage analysis

[2] In our analysis we focus on daily conditional volatility spillovers using a second-order VAR in the generalized variance decomposition framework of Koop et al., (1996) and Pesaran and Shin (1998). Conditional correlations are estimated via GJR-GARCH(1,1,1) models akin to the univariate analysis of the main paper. For robustness we also conduct the same analysis with logarithmic returns Diebold and Yilmaz (2009) and the results remain qualitatively similar. Data limitations prohibit us from using realized volatility as in Diebold and Yilmaz (2014). Our choice of forecast horizon is set to H=10 days, and we also run robustness with horizons between 2 and 14 days. In the dynamic analysis we opt for a three-year rolling estimation window to allow sufficient smoothing in the connectedness process, which we roll by a day. We have also experimented with a 1-year window and a 3-year window and a different stepping period; while these results are not presented for brevity, we confirm that they are qualitatively similar.

We perform a second stage analysis to shed light on the dynamics of net spillovers. The following model is estimated using pooled OLS with robust standard errors.

$$C_{i,t}^{H} = \beta_0 + \beta X + kCrisis + gBREXIT + \varepsilon_{i,t} \quad (1)$$

where $C_{i,t}^{H}$ denotes the *net total directional spillovers* of country i at time t (see section 4.2); X is a vector of the economic controls; $Crisis$ is each of the crisis dummy variables assigned to the specific sub-periods; BREXIT is a dummy variable assigned to Brexit related events; $\varepsilon_{i,t}$ is the error term; β_0, β, k, g are parameters to be estimated.

Changing economic conditions are accounted via the use of the logarithmic change in the interest rate term spread, proxied by the 10-Year US Government bond rate minus the 3-Month US Treasury bill rate. In a similar manner, we account for the change in corporate risk via the logarithmic change in the corporate bond yields spread, proxied by the AAA Corporate bond yield minus the BAA Corporate bond yield. To capture the overall stock market performance, we use the MSCI World Index. We account for the performance of commodities and real estate as alternative investments, via the S&P GSCI Commodity Index and the DJ REIT Index respectively. The logarithm of the US TED Spread is used to account for the credit risk in the economy; the Libor is used as a key benchmark for short-term interest rates; the logarithm of the Economic Policy Uncertainty (EPU) to account for the economic uncertainty. The CBOE VIX index is a forward-looking measure of stock market volatility, derived from index options, and is included as a measure of market sentiment. The exchange rate used is expressed as the Euro amount required to purchase one British pound; hence higher values indicate an appreciation of the pound. The source of these data is Datastream/US Fred and Table 2 presents summary statistics.[3]

<Table 2 macro variables statistics>

Given that our sample spans several turbulent periods—including the dot-com bubble, the Global Financial Crisis (GFC), the European Sovereign Debt Crisis (ESDC), and the Covid-19 pandemic—it is important to account for their potential impact on volatility spillovers. To this end, we include crisis-specific dummy variables in our second-stage regressions. These dummies allow us to isolate the effect of each crisis on net directional spillovers, ensuring that the estimated impact of Brexit-related events is not confounded by other major market disruptions. Moreover, incorporating these controls enables us to examine how volatility transmission varies across different market conditions and to assess whether Brexit-related shocks exert an incremental influence beyond the background turbulence in financial markets.

[3] Several alternative measures have been used as robustness checks, including the interest rate spread between the 10-Year and the 3-Month German bonds, the 3-month Euribor rate, the MSCI REIT Index. The qualitative nature of our results remains similar.

Each of the crisis variables (DTCM, GFC, ESDC, COVID-19) take the value 1 during the respective crisis, zero otherwise with crisis timings outlined as follows: The dotcom crisis is assumed to range from March 11, 2000 to October 9, 2002, which corresponds to the peak and trough of the NASDAQ index. The official timelines separate the GFC into four phases (BIS, 2009; Federal Reserve Board of St. Louis, 2009). Phase 1 spans from 1st August 2007 until 15th September 2008 and is defined as "initial financial turmoil". Phase 2 is described as "sharp financial market deterioration" and covers the period from 16th September 2008 until 31st December 2008. Phase 3 is defined as "macroeconomic deterioration" (1st January 2009 - 31st March 2009), while Phase 4 is a phase of "stabilization and tentative signs of recovery" (1st April - 1st November 2009). Therefore, the core of the crisis can be defined from 16th September 2008 until 31st March 2009, covering the second and third phases. The identification of the ESDC is based on information sourced by the European Central Bank (ECB) and Reuters. We construct a timeline of the crisis by merging the events and dates from the two sources as follows. The ESDC begins shortly before the Greek bailout in May 2010 (23rd April 2010), when the Greek Prime Minister announced that the austerity packages were not enough and requested a bailout plan from the Eurozone and the IMF. The poor performance of the European banking system and the spread of the crisis to other European economies led to fears of a potential "Grexit" and a breakdown of the Eurozone. Thus, the ESDC extends from April 2010 until the exit of Cyprus from the economic adjustment program in the March 2016. During the Covid-19 exogenous shock the Dow Jones and the SP500 plunged 35% withing 6 weeks. On the 9th of March 2020 stock markets plunged with a magnitude comparable in scale to what was observed after the Lehman Brothers' collapse in 2008, while trading was halted in NYSE. We assume that the Covid-19 financial crisis between February 2020 and July 2020.

4.4 The Brexit intensity variable

Our initial pool for Brexit related events is drawn from the Brexit timeline published by the House of Commons Library (Walker, 2021). The list contains approximately 500 events dated from 17/12/2015 (i.e., the referendum pledge) until 31/12/2020 (i.e., the formal exit from the EU), arranged into eight phases. The most important events are identified as "key events" in the same document, and this latter list forms the basis of our analysis. Table 3 presents these key events alongside market reaction information in regard to stock market and foreign exchange rates.

<Table 3 Brexit events>

Both lists are extensive and challenging to handle econometrically. One way in dealing with Brexit events econometrically would be to consider all events of equal importance via a Brexit binary variable spanning the entire Brexit timeline. However, this would constrain all events to have equal impact on net directional

spillovers, and it may incorrectly classify time periods as related to Brexit when in fact no events may be present. By contrast, having a binary variable for each event ensures that marginal effects are individual but at the expense of interpretability of results.

To deal with these issues we take a different approach. Our approach retains the ease of interpretation of a single Brexit variable but dispenses with the constraint of all events carrying a similar magnitude on net directional spillovers. To do so we weigh each event by its importance upon financial markets using the following daily measures: i) FTSE 100 logarithmic returns; ii) FTSE 100 conditional volatility; iii & iv) GBP/EUR and GBP/USD logarithmic change; v) VIX implied volatility. We are aware that some events may have varying reflections on financial markets. For example, business-oriented events may have a more pronounced impact on stock market, while more policy-related measures may affect the foreign exchange rate. Arguably, the most important events (i.e., the referendum result) would have market-wide impact.

We measure the intensity of the events as follows: We construct a set of binary variables each taking the value one for each of the key events in our sample, zero otherwise. For events that occur on a weekend, the following business day is used instead. We regress the entire set of binary variables on each of the five market measures using robust regressions. As the interpretability of volatility is inverse to the rest of the market measures, we make the coefficients of the two volatility measures comparable to those of the rest by multiplying them with minus one. In this way higher values in any of the five market measures implies an abrupt event. For each event we assign the value one if the value corresponding to each market measure is below the respective sample median, zero otherwise. We aggregate them up into a *categorical Brexit Intensity* variable, which takes integer values between zero and five; the former corresponding to muted event, while the latter would identify the most pronounced events. Further, we substitute the sample median with a percentile approach, which allows for fine tuning to the market responses in regard to events. On this occasion we construct a *continuous Brexit Intensity* variable on the basis of the mean percentile across the five market measures. To mitigate the impact of outliers in any of the measures, we also do a robustness check with the median percentile.

Table 4 shows the construction of these measures using a sample of the events, and reports the Brexit intensity scores (expressed in percentage terms), which quantify the strength of financial market reactions to key events. We observe that the day following the announcement (i.e., 24/06/2016) has had a particularly strong reaction by all market indicators, with a Brexit intensity score of 95.22%. By contrast, the call for a general election (i.e., 18/04/2017) has had a rather subdued market reaction, with a Brexit intensity score of 40.01%. The formal departure of the UK from the EU has had a pronounced market reaction by the markets, with a Brexit intensity score of 58.91%, plausibly as supply chains were disrupted to a larger extent that was anticipated.

<Table 4 Brexit intensity measures>

5. Results

5.1 Conditional volatility estimation results

Table 5 reports the estimated coefficients, robust standard errors, goodness-of-fit statistics for the conditional volatility estimation of each index. To accommodate the presence of skewness and kurtosis in the financial returns we have used the quasi-maximum likelihood method of Bollerslev and Wooldridge (1992) to covariances and standard errors that are robust to conditional non-normality. The significance and magnitude of the φ_1 coefficient suggest the presence of autocorrelation in the periphery stock markets. The volatility of most of the indices displays high persistence with the sum of the estimated ARCH and GARCH $(\alpha_1 + \beta_1)$ coefficients in each case being close to unity. The leverage terms γ_1 are positive and statistically significant, suggesting that the volatility of all equity indices exhibits asymmetric responses to good and bad news.

<Table 5 univariate estimation results >

5.2 Volatility spillover connectedness results

Table 6 presents the volatility spillover connectedness results over the entire sample period. Each entry in the main part of the table is a directional spillover from country i (arranged column-wise) to country j (arranged row-wise). For instance, Belgium receives 2.8% from Denmark's volatility, while Belgium contributes 5.0% to Denmark's volatility. The column labelled "FROM", and the row labelled "TO" display the total directional spillovers for each country, while the row labelled "NET" presents the difference (i.e., FROM-TO). Net total directional spillovers are important as they quantify the extent to which a particular country acts as a volatility receiver (NET>0) or transmitter (NET<0). The number at the intersection of columns FROM and TO is the total spillover index, which offers a quantifiable way of measuring the importance of volatility spillovers in the sample of countries.

A cursory inspection of the net directional spillovers suggests that it is negatively correlated ($\rho = -0.739$) with the market capitalization of the stock markets. In other words, the largest stock markets tend to be volatility transmitters. Throughout the period of examination, the UK has been the largest volatility transmitter, while at the other end of the spectrum is Luxembourg.

The economic implication of these estimates is important too. The volatility spillover index at 75.80% suggests that over three-quarters of volatility is interchangeable across countries, suggesting a high level of financial integration amidst the EU-15 economies. For comparison, on a non-EU mix of developed and emerging economies the Diebold and Yılmaz (2009) study records a volatility spillover index of around 40%. The net directional spillovers are conveniently interpreted as difference in percentage points between

the volatility imports and exports of a country. Where the UK transmits 32.5 percentage points more volatility than it receives, Luxembourg receives approximately 34.1 percentage points more.

<Table 6 connectedness table>

Figure 1 plots the total spillover index when the analysis is conducted dynamically. A cursory inspection reveals that in the period leading to the 2008 global financial crisis the index moves upwards, reaching 85% at the time of the Lehman collapse; thus confirming earlier findings (Diebold and Yılmaz, 2014). In the following years the connectedness stabilizes for a short period before the European sovereign debt crisis starts to unravel, which would decrease the index in late 2010, and the 2014–15 Oil crisis that would further decrease spillovers. A major drop in volatility spillovers is evidenced after the Brexit referendum and following Brexit negotiations, where this drop is unprecedented both in terms of magnitude and in speed as the index drops from 80% to 60% within approximately two months.

<Figure 1 volatility spillover index>

Figure 2 plots the net total directional volatility spillovers for the three largest (UK, France, Germany) and two smallest (Portugal, Greece) stock markets by market capitalization in the EU-15.[4] The reported net directional spillovers are estimated over the full sample using a 2-year rolling estimation window, with robustness checks for 1-year and 3-year rolling windows.[5] A pattern emerges whereby the largest stock markets are initially large volatility transmitters, although this tends to be mitigated towards the recent years. By contrast, small stock markets start off as volatility receivers but shift to a transmitter status over time.

<Figure 2 net directional volatility spillovers>

5.3 Second-stage results

We estimate equation 1 using pooled robust least squares with country fixed effects on weekly aggregated data to reduce the impact of noisy daily measures. For comparability across the Brexit intensity variables, we recode the categorical Brexit intensity within the [0,1] range; the continuous Brexit intensity variables are by definition within the same range. Table 7 presents the results.

<Table 7 second stage pooled OLS results>

A brief inspection shows that net directional spillovers are inversely affected by a depreciating Euro, suggesting that stock markets, on average, become volatility transmitters in such conditions. Contrarily,

[4] For brevity we only report the extreme stock markets by market capitalisation and confirm that the remaining display similar dynamics. Full results are available upon request.
[5] These results are qualitatively similar and are omitted for brevity but are available upon request.

under dire economic conditions as suggested by a decreasing term spread, or an increasing implied volatility, or an increasing policy uncertainty, net directional spillovers increase; thus, stock markets, on average, become volatility receivers. Net directional spillovers appear immune to financial crisis (i.e., dotcom, 2008 global financial crisis, Covid-19). However, they are significantly reduced during prolonged economic recessions, such as the European sovereign debt crisis. Brexit has decreased net directional spillovers, suggesting that EU countries, on average, have contributed towards increased volatility transmission.

Table 8 presents the second-stage results for country-wise estimations. The estimated coefficients and robust t-statistics of the Brexit intensity variable are reported alongside goodness of fit statistics; the rest of the control variables are identical to those used in Table 7 but are not reported for brevity.

<Table 8 second stage by country>

Not all EU countries were affected equally by Brexit. While the UK and France have been at the epicenter of the Brexit crisis, Germany has not been significantly affected. Throughout the Brexit timespan, France records the largest negative net total directional spillover, suggestive that the French stock market being the key volatility transmitter within the Union. By contrast, the UK is evidenced as a volatility receiver throughout the same period, as documented by the positive net total directional spillover. In regard to the smaller stock markets of the block, Ireland, Portugal and Spain have been the particularly affected. The magnitude of the coefficient suggests the former to be the second largest volatility transmitter (after France), while the latter two are classified as the top volatility receivers in the sample. Estimated marginal effects suggest that France transmits around 17 percentage points more volatility in the EU-15 stock markets ceteris paribus. By contrast, during the Brexit process the UK, Portugal and Spain absorb around 10-13 percentage points more volatility.

5.4 The impact of political periods

We investigate whether Brexit intensity has been mitigated through a series of administration changes in the UK. We focus on political changes within the country and disregard similar changes both at the rest of the EU member countries and the European commission level for two reasons. First, the Brexit decision was initiated from the UK; thus, the UK government has been the driving force for these changes, while the rest of the EU block has been in a responsive position. Secondly, during these negotiations there is not a single equivalent to the UK PM in the rest of the EU block as the discussions have been led by a mix of the European Commission (with Ursula von der Leyen succeeding Jean-Claude Junker), the "Task Force for Relations with the United Kingdom" (UKTF) headed by Michel Barnier, and the respective EU country governments.

We focus on the changes of prime minister (PM) during the period covered by the Brexit related events whether accompanied by a general election or via a stepping down of the incumbent PM. In particular, we define the following five PM periods: i) David Cameron following the 2015 General election (i.e., 7/5/2015 – 12/7/2016); ii) Theresa May succession (i.e., 13/7/2015 – 7/6/2017); iii) Theresa May following the 2017 General election (i.e., 8/6/2017 – 23/7/2019); iv) Boris Johnson succession (i.e., 24/7/2019 – 11/12/2019); v) Boris Johnson following the 2019 General election (i.e., 12/12/2019 – 4/5/2021). We re-estimate equation 11 while interacting the Brexit intensity variables with each of the five PM periods.

The results of this analysis are presented in Table 9. For brevity, we only report those models that include the Brexit intensity variable, that is models IV-XII, while we do not report the rest of the control variables from. We confirm that they are in line with earlier results presented in Table 7. The results are suggestive that the volatility transmission increased significantly, on average across the countries, during the second period of Theresa May being the PM.

<Table 9 Political periods>

In Table 10 we break down the results by country, and for brevity we report only the three largest stock markets by market capitalization. These results suggest that during the period of David Cameron being the PM, France and Germany were acting as volatility transmitters and receivers respectively. With Theresa May succeeding, the UK becomes the largest volatility transmitter as the early stages of Brexit negotiations unravel. Nevertheless, in the period following the 2017 General election, the UK switches to a volatility receiver, while the largest volatility transmission is originating from the France and Germany.

<Table 10 political periods by country>

5.5. Economic interpretation and implications for policy makers and managers

Our empirical results reveal distinct patterns in volatility transmission across European financial markets during the Brexit period. Large and liquid markets—particularly the UK, France, and Germany—consistently acted as primary volatility transmitters, reflecting their central role in regional capital flows and investor expectations. Smaller and more open markets, such as Ireland, Portugal, and Greece, primarily absorbed volatility, highlighting their higher sensitivity to cross-border shocks.

Transmission dynamics also varied across political periods. During Theresa May's early premiership, the UK emerged as a key volatility exporter as Brexit negotiations intensified. In later stages, the UK shifted toward absorbing volatility, while France and Germany assumed stronger transmitter roles. Periods of heightened Brexit-related uncertainty coincided with amplified spillovers, demonstrating that political and informational shocks can temporarily reshape financial integration within the EU. These findings link

quantitative results to underlying economic mechanisms: market size, liquidity, and the evolving nature of political events jointly drive volatility contagion.

The findings carry several practical implications. First, political events in one country can generate measurable economic effects elsewhere, requiring governments, regulators, and corporations to monitor foreign political developments. Second, our event-based methodology translates day-to-day political news into quantifiable market impacts, providing a tool for both policy surveillance and corporate risk management. Third, for managers, the results highlight the importance of building resilience through diversification and contingency planning, integrating risk management into financial strategy, and maintaining agility during political uncertainty. Adapting business models and innovation strategies is critical in an evolving political and economic climate. Finally, Brexit is part of a broader trend of disintegration and policy realignment. Recent geopolitical tensions, rising fiscal pressures in major economies, the retrenchment within national borders, and trade wars further underscore the relevance of understanding how political processes unfold over time and propagate through markets. Our framework can be applied to future episodes where political processes unfold over time, helping both policymakers and managers understand and anticipate cross-border market impacts.

6. Robustness

6.1 SUR estimation

For robustness we re-estimate equation 11 using the Seemingly Unrelated Regression (SUR) approach (Zellner, 1962). In this system of equations, a separate equation is specified for each of the EU-15 countries, while allowing contemporaneous correlation information among error terms of the equations. The latter is the key advantage of using this estimation technique in our context, as it allows for simultaneity between the dependent variables (i.e., the net directional spillovers). Table 11 presents estimated coefficients and robust t-statistics, average across the EU-15 countries, and goodness of fit statistics. A cursory inspection shows that these results are in line with the main results reported in the main section of the paper. In particular, the Brexit intensity variables maintain their negative sign, suggesting that Brexit has, on average, increased volatility transmission.

<Table 11 SUR estimations>

7. Conclusions

Following the June 23, 2016 referendum and subsequent negotiations, the United Kingdom formally left the European Union after 47 years of membership. This is the first attempt after the Second World War, for

de-globalization in Europe. This paper investigates the impact of Brexit-related events on EU-15 financial markets.

The main methodological challenge in studying Brexit is the multitude of overlapping events and the heterogeneity of political responses and market attention across time. A traditional event study analysis is limited as Brexit events are often overlapping, while there is no single criterion on which basis to select the most influential. Contrarily, specifying a set time assumes that Brexit turmoil has the same intensity across time. Our approach overcomes both difficulties by providing a granular, news-based measure of Brexit intensity.

We introduce a novel Brexit Intensity Measure, which weights over 500 Brexit-related events by financial markets' reactions. This continuous measure ranges from zero to one, with higher values indicating events of greater market significance. In the second stage, we use this measure to examine the drivers of volatility spillovers across countries, controlling for a rich set of macroeconomic and financial variables.

The results reveal how Brexit-related events influenced volatility transmission and financial integration across EU-15 stock markets. Conditional volatility estimates confirm strong persistence and asymmetry in returns, with equity markets responding more sharply to negative shocks. The Diebold–Yilmaz connectedness analysis shows that the largest markets—particularly the UK, France, and Germany—were major volatility transmitters, while smaller markets such as Luxembourg, Ireland, Portugal, and Greece acted mainly as volatility receivers. The overall spillover index indicates a high level of financial integration, though it dropped sharply and rapidly immediately after the 2016 Brexit referendum, signaling reduced market interdependence and lessened financial integration. Subsequent events related to the Brexit negotiations have contributed towards increased volatility transmission. Country-wise investigations show that throughout the Brexit timespan, France is the key volatility transmitter within the Union. By contrast, the UK is evidenced as a volatility transmitter during the early stages of Brexit negotiations, under Theresa May as the prime minister. Regarding the smaller stock markets of the block, Ireland, Portugal and Spain have been amongst those particularly affected.

These findings have practical implications, as policymakers can better anticipate systemic risks, while managers can use this framework to enhance resilience through diversification, risk management, and adaptable business strategies during periods of political uncertainty. Future studies could apply this methodology to examine the long-term effects of other global market disintegration events as they unfold.

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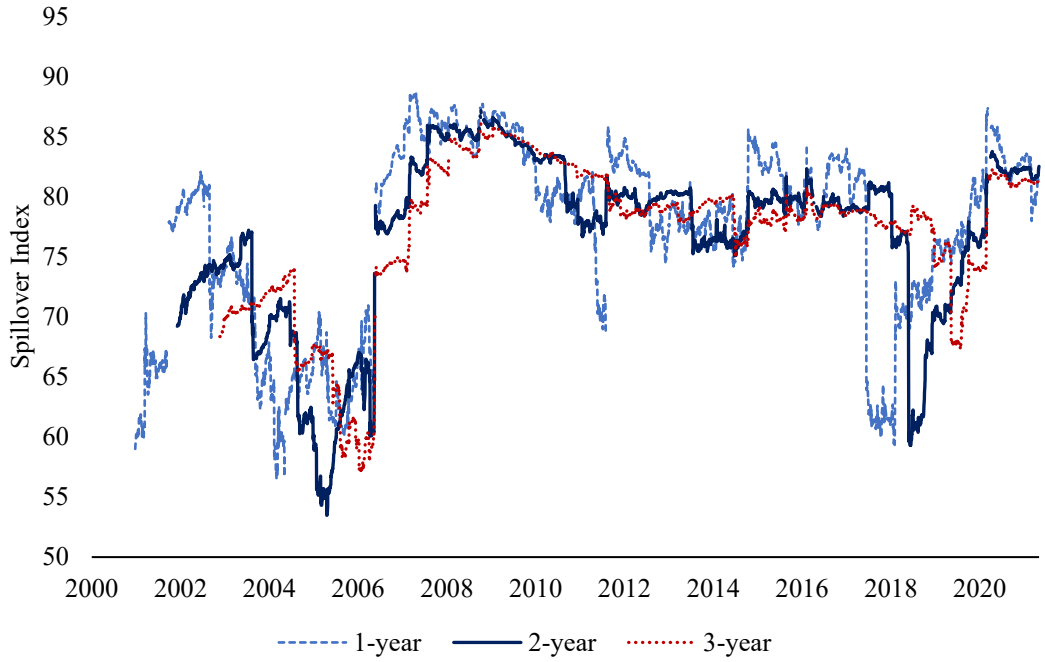
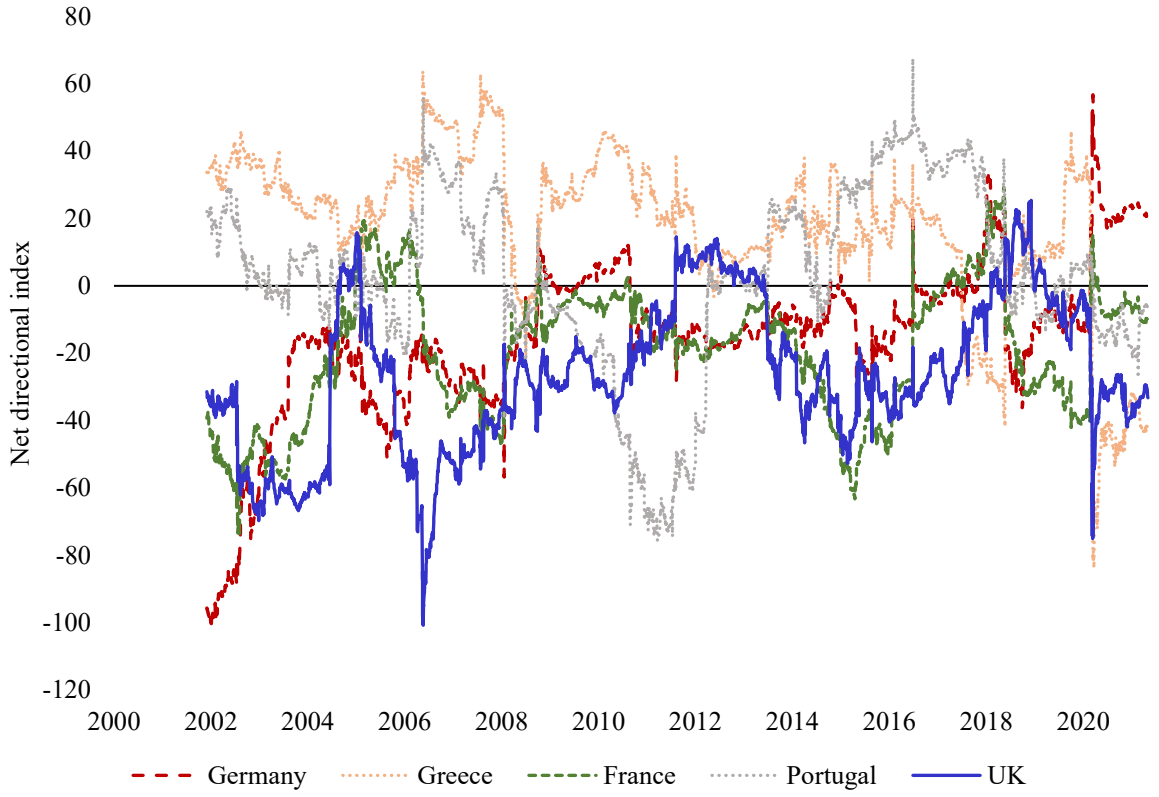
Figure 1. Volatility spillover index.



Notes: The figure shows the total volatility spillover index for EU-15 countries over the full sample period, using a 2-year rolling estimation window (with robustness for 1-year and 3-years).

Figure 2. Net directional volatility spillovers.



Notes: The figure shows the net total directional volatility spillovers for the three largest (UK, France, Germany) and two smallest (Portugal, Greece) stock markets by market capitalization in the EU-15. Net directional spillovers are estimated over the full sample using a 2-year rolling estimation window.

Table 1
Equity indices descriptive statistics.

Country	Mean	Rank	Annualized volatility	Rank	Min	Max	Skewness	Kurtosis	MCAP
Austria	0.031	2	19.65	4	-14.52	12.02	-0.52	12.39	11.26
Belgium	-0.035	11	15.06	14	-11.17	7.75	-0.63	11.04	12.58
Denmark	-0.004	5	17.15	10	-11.72	9.50	-0.24	9.10	12.33
Finland	-0.027	8	21.62	2	-17.42	14.56	-0.30	12.31	12.50
France	-0.028	9	16.88	11	-8.32	7.28	-0.20	7.86	14.13
Germany	-0.005	6	18.41	8	-9.10	11.14	0.02	8.80	13.80
Greece	-0.038	13	25.46	1	-17.71	13.43	-0.46	11.28	11.22
Ireland	0.024	3	19.24	6	-13.96	9.73	-0.69	11.49	11.65
Italy	-0.046	14	19.90	3	-17.00	9.06	-0.74	12.82	13.21
Luxembourg	0.037	1	19.26	5	-11.18	9.01	0.20	9.08	12.53
Netherlands	-0.028	10	15.63	13	-9.06	9.24	-0.22	10.29	13.27
Portugal	-0.053	15	14.86	15	-8.03	8.50	-0.37	7.65	11.13
Spain	-0.037	12	18.37	9	-9.68	13.34	-0.08	8.95	13.25
Sweden	-0.006	7	18.65	7	-8.90	9.87	0.01	8.08	13.10
UK	0.007	4	16.51	12	-11.51	9.38	-0.33	10.92	14.71

Notes: The table reports descriptive statistics for the equity indices used in the analysis over the full sample period. The Rank columns provide ranking positions of each index relatively to the mean percentage return and percentage annualized volatility. Annualized volatility is estimated from a GJR-GARCH model. MCAP is the average market capitalization (in natural logs).

Table 2

Financial variables summary statistics.

Variable	Mean	SD	Max	Min	Obs
Δ(AAA-BAA)×100	0.017	2.068	38.612	-20.946	4,978
Δ(T10Y3M) ×100	0.046	6.560	74.000	-52.000	4,975
FXRATE (GBP/EUR)	1.314	0.178	1.752	1.020	5,392
FXRATE (GBP/USD)	1.570	0.212	2.108	1.149	5,392
Δ(MXWO) ×100	0.011	1.034	9.096	-10.441	5,419
Δ(DJREIT) ×100	0.036	1.834	17.381	-22.018	5,419
Δ(SPGSCITR) ×100	-0.009	1.475	7.617	-12.522	5,090
TED spread	0.417	0.398	4.580	0.090	5,236
Libor	2.372	1.763	7.501	0.344	5,273
VIX	19.874	8.924	82.690	9.140	5,420
EPU	109.116	83.047	822.640	3.320	5,566

Notes: Data sources are Datastream and FRED. Δ denotes the logarithmic difference. EPU is the Economic policy uncertainty index.

Table 3

List of Brexit key events and market reaction.

Date	Event	Volatility	Return	GBP/EUR	GBP/USD	VIX
17/12/2015	The European Union Referendum Act receives Royal Assent, providing for a referendum on the UK's future membership of the EU.	0.271	0.673	0.209	-0.821	-1.084
22/02/2016	The Prime Minister announces the EU referendum date – 23 June 2016.	0.423	1.453	-0.198	-0.920	-0.644
23/06/2016	UK holds referendum on its membership of the EU, with the majority of voters choosing to leave the EU (51.9% of the vote versus 48.1% voting to remain).	-0.001	1.214	0.166	0.755	-2.774
24/06/2016	**Prime Minister David Cameron announces his intention to resign.**	**-0.046**	**-3.204**	**-6.204**	**-8.286**	**5.736**
13/07/2016	Theresa May becomes the new UK Prime Minister	0.156	-0.161	-0.045	0.222	-6.984
03/10/2016	In her Party Conference speech, Theresa May announces a 'Great Repeal Bill' and confirms Article 50 will be triggered before the end of March 2017.	-0.305	1.206	-1.004	-1.214	-6.454
03/11/2016	High Court gives its judgment in the Gina Miller case, finding in favour of the claimants. The Government announces it will appeal against the decision.	-0.223	-0.812	1.341	1.133	2.056
17/01/2017	Prime Minister gives her Lancaster House speech, setting out the Government's 'Plan for Britain' and the priorities that the UK will use to negotiate Brexit.	-0.590	-1.474	1.817	2.620	-8.154
24/01/2017	Supreme Court rejects the Government's appeal of the Gina Miller case.	-0.306	-0.019	0.125	0.146	-8.954
26/01/2017	Government publishes European Union (Notification of Withdrawal) Bill.	-0.352	-0.048	0.532	-0.125	-9.394
02/02/2017	Government publishes its Brexit White Paper, formally setting out its strategy for the UK to leave the EU.	-0.346	0.458	-1.374	-0.927	-8.094
16/03/2017	European Union (Notification of Withdrawal) Act received Royal Assent.	-0.558	0.633	0.196	1.190	-8.814
29/03/2017	Prime Minister triggers Article 50 of the Treaty on European Union	-0.443	0.405	0.092	-1.000	-8.604
30/03/2017	Government publishes the Great Repeal Bill White Paper.	-0.458	-0.064	0.790	0.629	-8.484
18/04/2017	**Prime Minister calls a General Election – to be held on 8 June 2017.**	**-0.475**	**-2.495**	**0.422**	**0.652**	**-5.604**
08/06/2017	General Election results in a hung Parliament, with the Conservatives winning the most seats and Theresa May forming a government	-0.463	-0.391	0.292	-0.090	-9.864
19/06/2017	First round of UK-EU exit negotiations begin	-0.431	0.797	-0.039	-0.334	-9.654
21/06/2017	State Opening of Parliament – Queen's Speech includes a 'Great Repeal Bill'	-0.400	-0.341	0.234	0.366	-9.274
13/07/2017	Government introduces the European Union (Withdrawal) Bill, commonly referred to as the 'Great Repeal Bill'.	-0.442	-0.054	0.491	0.335	-10.124
12/09/2017	EU Withdrawal Bill passes Second Reading in the House of Commons.	-0.403	-0.181	0.856	0.607	-9.444
22/09/2017	Prime Minister delivers her key Brexit speech in Florence, setting out the UK's position on moving the Brexit talks forward	-0.296	0.635	-0.489	-0.116	-10.434
19/10/2017	European Council meeting to assess progress on the first phase of Brexit negotiations	-0.541	-0.270	-0.389	0.245	-9.974
20/10/2017	European Council meeting to assess progress on the first phase of Brexit negotiations	-0.535	-0.004	0.453	-0.096	-10.054
13/11/2017	Government outlines plans for a Withdrawal Agreement and Implementation Bill	-0.382	-0.247	-0.854	-0.818	-8.524
27/11/2017	At a special meeting of the European Council, EU27 leaders endorse the Withdrawal Agreement and approve the political declaration on future EU-UK relations	-0.490	-0.355	0.059	-0.080	-10.154
08/12/2017	UK and EU publish a Joint Report on progress made during Phase 1 of negotiations. This concludes Phase 1 of negotiations and both sides move to Phase 2.	-0.383	0.988	0.023	-0.304	-10.444
11/12/2017	Prime Minister updates Parliament on Brexit negotiations	-0.405	0.795	-0.470	-0.102	-10.684
18/01/2018	The European Union (Withdrawal) Bill has its First Reading in the House of Lords	-0.536	-0.324	0.376	0.349	-7.804
02/03/2018	Prime Minister gives a speech at Mansion House on the UK's future economic partnership with the European Union	-0.113	-1.491	-0.743	0.322	-0.434
14/03/2018	The European Parliament endorses a resolution laying out a possible association agreement framework for future EU-UK relations after Brexit	-0.123	-0.092	-0.004	-0.298	-2.794
19/03/2018	The amended Draft Withdrawal Agreement is published	-0.222	-1.713	0.401	0.797	-1.004
16/05/2018	The European Union (Withdrawal) Bill finishes its House of Lords stages and goes into parliamentary ping pong	-0.543	0.138	0.540	-0.087	-6.604
26/06/2018	The European Union (Withdrawal) Bill receives Royal Assent and becomes an Act of Parliament: the European Union (Withdrawal) Act	0.183	0.366	-0.092	-0.269	-4.104
06/07/2018	The Cabinet meets at Chequers to agree a collective position for the future Brexit negotiations with the EU.	-0.071	0.183	-0.048	0.410	-6.654
09/07/2018	David Davis resigns as Secretary of State for Exiting the European Union and is replaced by Dominic Raab.	-0.109	0.912	-0.146	-0.126	-7.334
24/07/2018	Government publishes White Paper on future UK-EU relations	-0.262	0.686	0.326	0.330	-7.614
23/08/2018	The government publishes the first collection of technical notices providing guidance on how to prepare for a no-deal Brexit.	-0.221	-0.152	-0.373	-0.580	-7.614
19/09/2018	EU leaders hold an informal summit in Salzburg.	-0.302	0.415	0.254	-0.021	-8.274
20/09/2018	EU leaders hold an informal summit in Salzburg.	-0.327	0.486	0.058	0.790	-8.224
29/10/2018	Budget Day, the last Budget before the UK leaves the EU	-0.037	1.236	-0.288	-0.115	4.676
14/11/2018	The Withdrawal Agreement is agreed and published	-0.251	-0.290	-0.195	0.056	1.226

15/11/2018	Brexit Secretary resigns as Secretary of State for Exiting the European Union and is replaced by Stephen Barclay the following day.	-0.270	0.053	-1.802	-1.720	-0.044
04/12/2018	MPs begin the first of five days of Brexit debates, leading up to the 'Meaningful Vote' on 11 December	-0.282	-0.570	-0.111	-0.076	0.716
05/12/2018	Government publishes the Attorney General's legal advice to Cabinet on the Protocol to the Withdrawal Agreement on Ireland and Northern Ireland.	-0.272	-1.454	0.183	0.089	0.716
10/12/2018	CJEU issues its judgment on the Wightman case, finding unilateral revocation of Article 50 TEU is a sovereign right for any Member State to pursue	0.454	-0.845	-1.597	-1.761	2.616
11/12/2018	Theresa May wins a vote of confidence in her leadership of the Conservative Party	0.427	1.256	0.376	-0.070	1.736
08/01/2019	Report Stage and Third Reading of Finance (No. 3) Bill: in a defeat for the Prime Minister, MPs approve an amendment limiting the Government's financial powers in the event of a no-deal Brexit	-0.111	0.735	-0.121	-0.319	0.446
09/01/2019	As five days of Brexit debates begin – leading to a 'Meaningful Vote' on 15 January – an amendment to the business motion is passed,	-0.148	0.647	-0.490	0.096	-0.044
15/01/2019	The Prime Minister loses the 'Meaningful Vote' and the Leader of the Opposition tables a motion of no confidence in the Government	-0.176	0.575	-0.538	-0.791	-1.424
16/01/2019	The Prime Minister wins a vote of confidence in the Government	-0.209	-0.477	0.788	0.400	-0.984
21/01/2019	Theresa May presents the government's 'Plan B' Brexit deal.	-0.265	0.026	-0.083	-0.083	-2.224
29/01/2019	MPs debate the Prime Minister's 'Plan B' deal, which is then approved following two amendments	-0.166	1.272	0.135	-0.051	-0.894
14/02/2019	The government's Brexit plan suffers a defeat in the House of Commons	-0.345	0.079	-0.690	-0.754	-3.804
26/02/2019	The Prime Minister promises MPs a vote on ruling out a no-deal Brexit or delaying Brexit if she loses the second 'meaningful vote' next month	-0.370	-0.462	1.205	1.317	-4.854
12/03/2019	The Prime Minister loses the 'Meaningful Vote 2'.	-0.365	0.281	-0.424	0.018	-6.254
13/03/2019	In a defeat for the Prime Minister, MPs vote to rule out a 'no-deal Brexit'.	-0.385	0.106	0.700	0.997	-6.614
14/03/2019	MPs approve the amended government's motion, instructing the government to seek permission from the EU to extend Article 50.	-0.404	0.359	0.457	0.410	-6.524
20/03/2019	The Prime Minister writes to European Council President Donald Tusk, asking to extend Article 50 until 30 June 2019	-0.471	-0.458	-0.604	-0.542	-6.114
21/03/2019	Following a meeting of the European Council, EU27 leaders agree to grant an extension comprising two possible dates:	-0.454	0.871	-0.963	-0.904	-6.394
27/03/2019	The Commons debates and votes on eight indicative votes, in an attempt to find a Brexit plan that wins the support of the majority of MPs	-0.117	-0.036	0.099	-0.172	-4.874
29/03/2019	The Prime Minister loses the 'Meaningful Vote 3'.	-0.187	0.611	-0.365	-0.442	-6.314
01/04/2019	In the second day of indicative votes, all four of the selected options are defeated	-0.219	0.516	0.923	0.851	-6.624
02/04/2019	The Prime Minister announces she will seek a further extension to the Article 50 process and offers to sit down with the Leader of the Opposition,	-0.249	0.996	-0.577	-0.838	-6.664
05/04/2019	Theresa May formally writes to Donald Tusk, requesting a further extension to the Article 50 process to the end of June 2019	-0.323	0.598	-0.614	-0.542	-7.204
10/04/2019	The European Council meets. The UK and EU27 agree to extend Article 50 until 31 October 2019	-0.372	-0.056	0.548	0.347	-6.724
21/05/2019	The Prime Minister unveils her new Brexit deal.	-0.302	0.240	0.277	0.410	-5.074
23/05/2019	The UK votes in the European Parliament elections	-0.350	-1.423	0.137	0.081	-3.104
23/07/2019	Boris Johnson wins the Conservative Party leadership race	-0.480	0.550	0.176	-0.479	-7.414
24/07/2019	Boris Johnson formally takes over as Prime Minister.	-0.493	-0.743	0.550	0.491	-7.954
25/07/2019	Prime Minister Johnson makes a statement in the House of Commons and commits to the October date for Brexit and – while hoping for a renegotiation of the Withdrawal Agreement – refuses to rule out the possibility of a 'no-deal' Brexit.	-0.426	-0.172	-0.182	-0.030	-7.284
04/09/2019	With the Commons passing Hilary Benn's European Union (Withdrawal) (No. 6) Bill, the Prime Minister moves a motion to hold an early General Election. The motion is defeated	-0.176	0.584	0.186	0.826	-2.694
09/09/2019	The Benn bill becomes law: the European Union (Withdrawal) (No. 2) Act 2019 and parliament prorogues.	-0.239	-0.648	0.166	0.254	-4.754
24/09/2019	The Supreme Court passes a unanimous judgment that the decision to prorogue Parliament was unlawful. The Speaker of the House of Commons announces that the House will sit again the next day.	-0.401	-0.481	0.376	0.396	-2.974
03/10/2019	The Prime Minister delivers a statement to the Commons, outlining the Government's proposals for a new Brexit deal	0.409	-0.639	0.467	0.836	-0.904
08/10/2019	The Government publishes the No-Deal Readiness Report, detailing the UK's preparedness ahead of Brexit on 31 October	0.245	-0.770	-0.514	-0.870	0.256
21/10/2019	The European Union (Withdrawal Agreement) Bill is introduced to Parliament	-0.080	0.176	0.591	0.651	-6.024
22/10/2019	The EU (Withdrawal Agreement) Bill passes its second reading, but the programme motion setting out the timetable is defeated. The PM pauses the legislation.	-0.118	0.673	-0.442	-0.577	-5.564
28/10/2019	EU Ambassadors agree to a Brexit extension to 31 January 2020. The Prime Minister confirms the UK's agreement to this extension	-0.251	0.086	0.178	0.205	-6.914
30/10/2019	The Government introduces the Early Parliamentary General Election Bill, which sets the date for a General Election to take place on 12 December. The Bill completes its Commons stages.	-0.291	0.328	-0.297	-0.254	-7.694

12/12/2019	General Election results in Conservative Party majority. The Prime Minister pledges "to get Brexit done" by 31 January 2020	-0.192	0.783	-0.721	-0.439	-6.084
19/12/2019	The Government publishes the European Union (Withdrawal Agreement)	-0.343	0.431	-0.233	-0.335	-7.524
23/01/2020	The European Union (Withdrawal Agreement) Act 2020 becomes law, having received Royal Assent	-0.423	-0.859	0.106	-0.173	-7.044
31/01/2020	At 11pm the UK leaves the European Union	0.097	-1.315	0.232	0.603	-1.184
15/06/2020	The Prime Minister meets EU leaders and asks them to "put a tiger in the tank" of stalled talks	0.948	-0.672	-0.040	0.162	14.376
30/06/2020	The deadline to request an extension to the transition period, currently due to conclude at the end of December, passes	0.599	-0.911	0.863	0.741	10.406
09/09/2020	The UK Internal Market Bill is introduced and receives criticism from EU.	0.157	1.375	-0.340	-0.205	8.786
16/09/2020	The European Commission President warns the UK Government against reneging on the Brexit deal.	-0.075	-0.451	1.233	1.178	6.016
29/09/2020	The UK Internal Market Bill passes its Third Reading in the House of Commons and moves to the House of Lords.	0.343	-0.521	-0.741	0.002	6.246
01/10/2020	The European Commission President announces the EU will initiate legal proceedings to prevent the UK from trying to use domestic legislation to override aspects of the Brexit Withdrawal Agreement.	0.258	0.220	-0.532	-0.416	6.676
17/12/2020	The UK Internal Market Bill receives Royal Assent and enters UK law.	-0.325	-0.309	0.231	0.711	1.906
24/12/2020	The Brexit deal (the EU-UK Trade and Cooperation Agreement) is sealed.	-0.145	0.091	0.428	0.489	1.506
30/12/2020	Parliament is recalled to pass the European Union (Future Relationship) Bill	-0.275	-0.719	0.376	0.844	2.746
31/12/2020	**The transition period ends at 11pm and the UK leaves the EU single market and customs union**	**-0.247**	**-1.471**	**0.501**	**0.303**	**2.726**

Notes: The table presents key events along the Brexit timeline as published by the House of Commons Library (Walker, 2021) alongside market reaction indicators. Volatility and returns refer to the GJR-GARCH conditional volatility and logarithmic returns of the FTSE 100 equity index respectively, expressed in percentages. GBP/EUR and GBP/USD refer to the logarithmic percentage change in the respective exchange rates. VIX is implied volatility. To gauge market reaction, we construct a set of binary variables each taking the value one for each of the key events in our sample, zero otherwise. We regress the entire set of binary variables on each of the five market measures using robust regressions. As the interpretability of volatility is inverse to the rest of the market measures, we make the coefficients of the two volatility measures comparable to those of the rest by multiplying them with minus one. In this way higher values lower values in any of the five market measures implies an abrupt event. We report these signed marginal effects. Events in **bold** are our choice for the explanation of Brexit intensity variable.

Table 4

Brexit intensity measures

Date	Event	Market measures					Brexit intensity variables		
		Volatility	Return	GBP/EUR	GBP/USD	VIX	Categorical	Continuous (Mean)	Continuous (Median)
24/06/2016	Prime Minister David Cameron announces his intention to resign.	-0.046	-3.204	-6.204	-8.286	5.736	5	95.22	100.00
	Percentiles	*82.61*	*100.00*	*100.00*	*100.00*	*93.48*			
18/04/2017	Prime Minister calls a General Election – to be held on 8 June 2017.	-0.475	-2.495	0.422	0.652	-5.604	2	40.01	22.83
	Percentiles	*9.78*	*98.91*	*22.83*	*16.31*	*52.17*			
31/12/2020	The transition period ends at 11pm and the UK leaves the EU single market and customs union	-0.247	-1.471	0.501	0.303	2.726	3	58.91	57.61
	Percentiles	*57.61*	*94.57*	*16.31*	*35.87*	*90.22*			
Sample Medians		*0.272*	*0.026*	*0.099*	*-0.021*	*6.084*			

Notes: The table shows the construction of our Brexit intensity measures for a sample of three Brexit key events. For each event we report the following fives market measures: i) FTSE 100 daily logarithmic returns; ii) FTSE 100 daily conditional volatility; iii & iv) GBP/EUR and GBP/USD daily logarithmic change; v) VIX daily implied volatility. We report the signed marginal effects, see Notes in Table 3 for more details.

Table 5
Univariate estimation results.

	θ_0		φ_1		ω_0		α_1		β_1		γ_1		BIC	T
Austria	0.047***	(0.015)	0.097***	(0.015)	0.035***	(0.005)	0.015*	(0.008)	0.139***	(0.016)	0.891***	(0.009)	3.090	5,565
Belgium	0.013	(0.010)	0.042***	(0.015)	0.019***	(0.003)	0.029**	(0.012)	0.137***	(0.020)	0.880***	(0.014)	2.538	5,565
Denmark	0.014	(0.013)	0.044***	(0.014)	0.040***	(0.008)	0.042***	(0.013)	0.091***	(0.018)	0.879***	(0.015)	2.898	5,565
Finland	-0.010	(0.014)	0.069***	(0.015)	0.007***	(0.003)	0.023***	(0.009)	0.065***	(0.014)	0.941***	(0.008)	3.174	5,565
France	-0.008	(0.011)	-0.021	(0.015)	0.015***	(0.002)	-0.001	(0.008)	0.126***	(0.014)	0.923***	(0.007)	2.790	5,565
Germany	0.004	(0.012)	0.007	(0.014)	0.016***	(0.003)	0.010	(0.008)	0.120***	(0.014)	0.917***	(0.008)	2.942	5,565
Greece	-0.005	(0.017)	0.082***	(0.023)	0.024***	(0.006)	0.076***	(0.021)	0.073***	(0.034)	0.887**	(0.009)	3.580	5,565
Ireland	0.048***	(0.014)	0.068***	(0.015)	0.033***	(0.006)	0.050***	(0.013)	0.106***	(0.019)	0.876***	(0.010)	3.050	5,565
Italy	-0.032**	(0.013)	-0.039**	(0.016)	0.019***	(0.003)	0.041***	(0.015)	0.109***	(0.019)	0.895***	(0.009)	3.105	5,565
Luxembourg	0.018	(0.012)	0.063***	(0.015)	0.015***	(0.004)	0.091***	(0.019)	0.056***	(0.019)	0.880***	(0.014)	3.005	5,565
Netherlands	-0.008	(0.010)	-0.009	(0.014)	0.010***	(0.002)	-0.001	(0.007)	0.128***	(0.013)	0.925***	(0.008)	2.585	5,565
Portugal	-0.010	(0.011)	0.081***	(0.015)	0.016***	(0.002)	0.034***	(0.009)	0.103***	(0.018)	0.896***	(0.009)	2.559	5,565
Spain	-0.015	(0.013)	0.023	(0.015)	0.017***	(0.003)	0.015**	(0.007)	0.116***	(0.014)	0.915***	(0.008)	2.970	5,565
Sweden	-0.001	(0.013)	0.001	(0.014)	0.015***	(0.003)	0.013	(0.009)	0.114***	(0.013)	0.919***	(0.007)	2.990	5,565
UK	0.002	(0.011)	-0.003	(0.014)	0.018***	(0.003)	-0.002	(0.010)	0.158***	(0.016)	0.905***	(0.008)	2.724	5,565

Notes: The table reports estimated coefficients and Bollerslev and Wooldrige (1992) robust standard errors in brackets for the univariate GJR-GARCH models of section 4.1. BIC denotes the Schwartz information criterion. ***, **, * denote statistical significance at the 1, 5 and 10% significance level respectively.

Table 6
Volatility spillover connectedness.

	Belgium	Denmark	Germany	Greece	France	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	UK	Austria	Finland	Sweden	**FROM**
Belgium	17.0	2.8	8.8	1.3	10	4.6	7.5	1.7	11.0	5.9	7.8	8.6	5.0	1.7	6.3	**83.0**
Denmark	5.0	28.8	5.8	1.7	5.6	5.5	3.5	1.8	7.0	6.5	4.2	7.7	4.3	3.3	9.3	**71.2**
Germany	9.1	3.3	17	0.8	12.3	3.0	6.7	0.8	11.2	5.2	8.3	8.4	3.2	3.0	7.7	**83.0**
Greece	2.6	2.8	2.0	47.6	2.8	4.6	5.9	3.7	2.9	4.9	4.3	6.2	6.4	0.9	2.5	**52.4**
France	9.9	2.7	11.4	1.0	15.3	3.0	7.2	0.9	12.2	6.1	9.3	8.1	3.4	2.5	7.1	**84.7**
Ireland	6.4	3.8	4.3	3.6	5.2	23.8	6.4	4.3	6.0	4.3	4.9	9.6	8.5	2.2	6.7	**76.2**
Italy	7.2	2.4	7.6	2.9	8.7	4.1	19.4	2.0	7.6	6.1	10.2	8.6	6.1	1.9	5.1	**80.6**
Luxembourg	4.7	3.0	3.3	3.5	3.7	7.1	5.0	38.2	4.5	3.6	3.3	7.8	6.7	1.0	4.8	**61.8**
Netherlands	10.7	3.0	10.6	0.9	12.4	3.4	6.3	1.1	17.2	5.4	7.7	8.6	3.3	2.3	7.0	**82.8**
Portugal	7.9	3.7	6.2	2.4	8.4	3.9	6.5	1.6	7.7	24.5	8.2	6.6	4.4	2.3	5.6	**75.5**
Spain	8.3	2.6	8.5	1.9	10.6	3.5	10.5	1.2	9.2	7.1	17.9	7.0	4.1	2.2	5.4	**82.1**
UK	7.8	3.9	7.8	2.0	8.3	6.1	6.2	2.5	8.6	4.8	5.7	19.3	6.8	2.4	7.9	**80.7**
Austria	6.6	3.6	4.5	4.1	5.5	7.9	7.1	3.8	5.5	4.8	5.4	10.5	22.3	1.9	6.5	**77.7**
Finland	4.4	3.6	6.9	0.7	7.0	3.2	4.1	0.8	6.3	4.1	4.6	6.2	2.8	35.9	9.4	**64.1**
Sweden	6.5	5.7	8.5	1.2	8.5	5.9	5.9	1.6	7.8	4.9	6.0	9.2	5.2	4.2	19.0	**81.0**
TO	**97.1**	**46.7**	**96.2**	**28.0**	**108.8**	**65.7**	**88.8**	**27.7**	**107.4**	**73.6**	**90.0**	**113.2**	**70.2**	**32.0**	**91.4**	**75.80%**
NET	**-14.1**	**24.5**	**-13.2**	**24.4**	**-24.1**	**10.5**	**-8.2**	**34.1**	**-24.6**	**1.9**	**-7.9**	**-32.5**	**7.5**	**32.1**	**-10.4**	—

Notes: The connectedness table presents the full-sample (2000-2021) directional conditional volatility spillovers, the total directional spillovers (FROM/TO) and the net total directional spillovers (NET). Conditional volatility is estimated via a GJR-GARCH(1,1,1). For the connectedness we have used a second order VAR with generalized variance decomposition; forecasting horizon is set to 10 days.

Table 7

Second stage estimation results.

Model	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Constant	0.070	0.060	0.062	0.149	0.155	0.549	0.154	0.161	0.554	0.166	0.172	0.568
	[0.479]	[0.407]	[0.417]	[0.848]	[0.884]	[1.899]	[0.874]	[0.910]	[1.911]	[0.943]	[0.978]	[1.963]
DLOG(AAA-BAA)	-0.291	-0.289	-0.356	-0.263	-0.213	-0.328	-0.263	-0.214	-0.328	-0.256	-0.206	-0.322
	[-0.648]	[-0.641]	[-0.800]	[-0.602]	[-0.482]	[-0.750]	[-0.603]	[-0.483]	[-0.750]	[-0.589]	[-0.466]	[-0.737]
FXRATE_EUR(-1)	-0.134	-0.114	-0.116	-0.193	-0.194	-0.281	-0.196	-0.197	-0.284	-0.204	-0.205	-0.294
	[-1.180]	[-1.107]	[-1.117]	[-1.564]	[-1.575]	[-2.123]	[-1.579]	[-1.589]	[-2.134]	[-1.658]	[-1.668]	[-2.215]
VIX(-1)	0.004	0.004	0.004	0.006	0.006	0.009	0.006	0.006	0.009	0.006	0.006	0.009
	[2.529]	[2.289]	[2.290]	[2.408]	[2.270]	[2.875]	[2.375]	[2.238]	[2.846]	[2.392]	[2.255]	[2.866]
D(T10Y3M)	-0.274	-0.275	-0.271	-0.288	-0.286	-0.290	-0.287	-0.285	-0.289	-0.288	-0.286	-0.290
	[-2.005]	[-2.012]	[-2.033]	[-2.158]	[-2.094]	[-2.159]	[-2.152]	[-2.090]	[-2.154]	[-2.161]	[-2.097]	[-2.162]
LOG(LIBOR(-1))	0.011											
	[0.419]											
LOG(TEDRATE(-1))		0.006	0.004	-0.017	-0.016	-0.025	-0.017	-0.016	-0.025	-0.018	-0.017	-0.027
		[0.227]	[0.145]	[-0.558]	[-0.519]	[-0.809]	[-0.558]	[-0.519]	[-0.808]	[-0.605]	[-0.566]	[-0.858]
DLOG(MXWO)	0.271	0.261			0.121			0.145			0.130	
	[0.228]	[0.221]			[0.104]			[0.124]			[0.111]	
DLOG(DJREIT)	0.684	0.686			0.701			0.687			0.701	
	[0.871]	[0.877]			[0.884]			[0.868]			[0.884]	
DLOG(SPGSCITR)	-0.386	-0.378			-0.433			-0.442			-0.430	
	[-0.622]	[-0.608]			[-0.702]			[-0.717]			[-0.699]	
LOG(EPU(-1))						-0.077			-0.077			-0.078
						[-1.701]			[-1.698]			[-1.711]
DTCM				-0.089	-0.081	-0.071	-0.088	-0.080	-0.070	-0.088	-0.080	-0.071
				[-0.906]	[-0.827]	[-0.717]	[-0.897]	[-0.816]	[-0.708]	[-0.901]	[-0.822]	[-0.711]
GFC				-0.127	-0.108	-0.140	-0.126	-0.107	-0.138	-0.128	-0.109	-0.140
				[-1.081]	[-0.909]	[-1.184]	[-1.068]	[-0.899]	[-1.172]	[-1.086]	[-0.912]	[-1.191]
ESDC				-0.088	-0.089	-0.083	-0.089	-0.090	-0.084	-0.092	-0.092	-0.086
				[-2.246]	[-2.265]	[-2.135]	[-2.257]	[-2.277]	[-2.145]	[-2.333]	[-2.351]	[-2.224]
BREXIT Intensity (Cat)				-0.223	-0.226	-0.220						
				[-2.030]	[-2.054]	[-2.015]						
BREXIT Intensity (Cont-Mean)							-0.246	-0.250	-0.244			
							[-2.003]	[-2.030]	[-1.986]			

BREXIT Intensity (Cont-Med)										-0.277	-0.280	-0.276
										[-2.352]	[-2.380]	[-2.353]
CVD19				-0.057	-0.050	-0.019	-0.055	-0.049	-0.017	-0.053	-0.046	-0.014
				[-0.564]	[-0.500]	[-0.186]	[-0.547]	[-0.484]	[-0.169]	[-0.547]	[-0.484]	[-0.169]
Adjusted R-squared	0.4343	0.4343	0.4344	0.4342	0.4341	0.4342	0.4342	0.4341	0.4342	0.4342	0.4341	0.4342
F-statistic	516.61	516.61	598.31	473.50	420.80	454.53	473.50	420.80	454.53	473.50	420.80	454.53
Observations	14,775	14,775	14,775	14775	14775	14775	14,775	14,775	14,775	14,775	14,775	14,775
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents estimated coefficients and robust t-statistics in brackets. Dependent variable is the net spillovers for EU-15 countries. Full-sample (2000-2021) estimation is reported on weekly observations. Brexit intensity variables are denoted as (Cat), (Cont-Mean) and (Cont-Med) for the categorical, continuous/mean and continuous/median specifications respectively.

Table 8

Second stage estimation results by country.

	BREXIT Intensity								
	Categorical			Continuous (Mean)			Continuous (Median)		
Country	Coefficient	t-Statistic	Adj-R2	Coefficient	t-Statistic	Adj-R2	Coefficient	t-Statistic	Adj-R2
Austria	12.47	2.03	0.39	13.71	2.01	0.39	13.12	1.97	0.39
Belgium	-9.23	1.64	0.46	-10.33	1.69	0.46	-9.65	1.64	0.46
Denmark	-2.71	0.61	0.54	-2.03	0.41	0.54	-2.95	0.62	0.54
Finland	-6.96	2.14	0.60	-7.34	2.08	0.59	-7.65	2.33	0.60
France	-17.13	3.69	0.34	-19.56	3.90	0.34	-18.25	3.80	0.34
Germany	-2.98	1.02	0.76	-3.15	1.02	0.76	-2.91	0.94	0.76
Greece	-6.00	0.89	0.38	-6.14	0.81	0.38	-6.90	0.92	0.38
Ireland	-14.48	3.24	0.51	-17.28	3.40	0.51	-13.94	2.79	0.51
Italy	10.11	1.81	0.19	10.41	1.70	0.18	11.02	1.96	0.19
Luxembourg	10.60	2.87	0.48	11.95	2.89	0.48	10.90	2.69	0.48
Netherlands	-5.81	1.33	0.42	-6.36	1.33	0.42	-6.16	1.35	0.42
Portugal	13.63	2.35	0.29	16.61	2.56	0.29	14.43	2.38	0.29
Spain	12.38	2.16	0.18	12.65	2.02	0.17	13.24	2.29	0.18
Sweden	-4.67	0.89	0.35	-4.75	0.84	0.35	-5.55	1.08	0.35
UK	10.73	3.33	0.43	11.57	3.04	0.43	11.23	3.08	0.43

Notes: The table presents estimated coefficients and robust t-statistics in brackets for the Brexit intensity variable. For each of the three variants the full set of control variables is included but not reported for brevity. Dependent variable is the net spillovers for EU-15 countries. Full-sample (2000-2021) estimation is reported on weekly observations.

Table 9

Political periods.

Model	IV	V	VI	VII	VIII	IX	X	XI	XII
BREXIT Intensity (Cat)_DC	-0.044	-0.056	-0.064						
	[-0.126]	[-0.162]	[-0.181]						
BREXIT Intensity (Cat)_TM_I	-0.235	-0.236	-0.196						
	[-0.554]	[-0.559]	[-0.461]						
BREXIT Intensity (Cat)_TM_II	-0.268	-0.271	-0.268						
	[-2.161]	[-2.169]	[-2.152]						
BREXIT Intensity (Cat)_BJ_I	0.048	0.052	0.044						
	[0.170]	[0.184]	[0.158]						
BREXIT Intensity (Cat)_BJ_II	-0.252	-0.254	-0.240						
	[-0.921]	[-0.937]	[-0.876]						
BREXIT Intensity (Cont-Mean)_DC				-0.027	-0.042	-0.048			
				[-0.074]	[-0.111]	[-0.126]			
BREXIT Intensity (Cont-Mean)_TM_I				-0.166	-0.166	-0.131			
				[-0.415]	[-0.415]	[-0.325]			
BREXIT Intensity (Cont-Mean)_TM_II				-0.334	-0.335	-0.333			
				[-2.273]	[-2.270]	[-2.262]			
BREXIT Intensity (Cont-Mean)_BJ_I				0.011	0.015	0.007			
				[0.034]	[0.045]	[0.022]			
BREXIT Intensity (Cont-Mean)_BJ_II				-0.268	-0.273	-0.256			
				[-1.017]	[-1.049]	[-0.968]			
BREXIT Intensity (Cont-Med)_DC							0.017	0.004	-0.002
							[0.055]	[0.011]	[-0.007]
BREXIT Intensity (Cont-Med)_TM_I							-0.471	-0.469	-0.436
							[-1.114]	[-1.111]	[-1.036]
BREXIT Intensity (Cont-Med)_TM_II							-0.352	-0.353	-0.352
							[-2.546]	[-2.532]	[-2.541]
BREXIT Intensity (Cont-Med)_BJ_I							0.014	0.018	0.011
							[0.046]	[0.057]	[0.035]

BREXIT Intensity (Cont-Med)_BJ_II							-0.289	-0.293	-0.281
							[-1.160]	[-1.195]	[-1.127]
Adjusted R-squared	0.4341	0.4340	0.4341	0.4341	0.4340	0.4341	0.4341	0.4340	0.4341
F-statistic	405.75	366.41	391.73	405.75	366.41	391.73	405.75	366.41	391.73
Observations	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents estimated coefficients and robust t-statistics in brackets. Dependent variable is the net spillovers for EU-15 countries. Full-sample (2000-2021) estimation is reported on weekly observations. Brexit intensity variables are denoted as (Cat), (Cont-Mean) and (Cont-Med) for the categorical, continuous/mean and continuous/median specifications respectively. Control variables are included in the estimation but not reported for brevity; see Table 7 for more details. We define the following five PM periods: i) David Cameron following the 2015 General election (i.e., 7/5/2015 – 12/7/2016); ii) Theresa May succession (i.e., 13/7/2015 – 7/6/2017); iii) Theresa May following the 2017 General election (i.e., 8/6/2017 – 23/7/2019); iv) Boris Johnson succession (i.e., 24/7/2019 – 11/12/2019); v) Boris Johnson following the 2019 General election (i.e., 12/12/2019 – 4/5/2021).

Table 10

Political periods by country.

	BREXIT intensity								
	Categorical			Continuous (Mean)			Continuous (Median)		
Country	France	Germany	UK	France	Germany	UK	France	Germany	UK
BREXIT Intensity (Cat)_DC	-10.015	6.003	-4.586	-10.861	6.175	-4.906	-9.945	5.755	-4.078
	[-2.257]	[2.315]	[-1.379]	[-2.425]	[2.270]	[-1.437]	[-2.304]	[2.268]	[-1.238]
BREXIT Intensity (Cat)_TM_I	3.988	5.685	-33.503	3.872	5.805	-33.069	2.743	5.685	-35.632
	[0.560]	[1.061]	[-5.255]	[0.557]	[1.108]	[-4.714]	[0.366]	[0.974]	[-4.665]
BREXIT Intensity (Cat)_TM_II	-13.800	-7.300	24.304	-15.793	-7.971	27.666	-15.167	-7.877	26.801
	[-1.938]	[-1.587]	[6.471]	[-2.090]	[-1.631]	[6.611]	[-2.108]	[-1.682]	[6.870]
BREXIT Intensity (Cat)_BJ_I	-44.034	-7.039	3.935	-49.379	-7.568	4.684	-45.834	-6.967	4.499
	[-8.227]	[-1.742]	[0.899]	[-9.285]	[-1.799]	[0.997]	[-9.671]	[-1.775]	[1.008]
BREXIT Intensity (Cat)_BJ_II	-11.344	3.592	4.413	-14.361	2.584	5.165	-9.967	2.963	3.255
	[-1.080]	[0.343]	[0.633]	[-1.226]	[0.234]	[0.705]	[-1.057]	[0.307]	[0.536]
Adjusted R-squared	0.351	0.763	0.444	0.353	0.763	0.445	0.352	0.763	0.445
Observations	985	985	985	985	985	985	985	985	985
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents estimated coefficients and robust t-statistics in brackets. Dependent variable is the net spillovers for EU-15 countries. Full-sample (2000-2021) estimation is reported on weekly observations. Control variables are included in the estimation but not reported for brevity; see Table 7 for more details. We define the following five PM periods: i) David Cameron following the 2015 General election (i.e., 7/5/2015 – 12/7/2016); ii) Theresa May succession (i.e., 13/7/2015 – 7/6/2017); iii) Theresa May following the 2017 General election (i.e., 8/6/2017 – 23/7/2019); iv) Boris Johnson succession (i.e., 24/7/2019 – 11/12/2019); v) Boris Johnson following the 2019 General election (i.e., 12/12/2019 – 4/5/2021).

Table 11

Robustness results.

Model	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Constant	0.070	0.060	0.062	0.148	0.155	0.548	0.155	0.160	0.554	0.165	0.171	0.568
	[14.798]	[14.463]	[14.487]	[12.546]	[12.578]	[9.130]	[12.509]	[12.542]	[9.118]	[12.559]	[12.592]	[9.130]
DLOG(AAA-BAA)	-0.291	-0.289	-0.356	-0.263	-0.213	-0.328	-0.263	-0.214	-0.328	-0.256	-0.206	-0.322
	[1.412]	[1.320]	[1.464]	[1.446]	[1.338]	[1.350]	[1.445]	[1.338]	[1.350]	[1.446]	[1.338]	[1.351]
FXRATE_EUR(-1)	-0.134	-0.114	-0.116	-0.193	-0.194	-0.281	-0.196	-0.197	-0.284	-0.204	-0.205	-0.293
	[18.382]	[18.113]	[18.166]	[15.726]	[15.768]	[14.892]	[15.694]	[15.738]	[14.871]	[15.736]	[15.779]	[14.894]
VIX(-1)	0.004	0.004	0.004	0.006	0.006	0.009	0.006	0.006	0.009	0.006	0.006	0.009
	[6.061]	[7.479]	[7.423]	[7.173]	[7.210]	[5.780]	[7.164]	[7.200]	[5.772]	[7.173]	[7.210]	[5.781]
D(T10Y3M)	-0.274	-0.275	-0.271	-0.287	-0.286	-0.290	-0.287	-0.285	-0.289	-0.288	-0.286	-0.290
	[0.934]	[0.926]	[0.906]	[1.051]	[1.053]	[1.062]	[1.052]	[1.052]	[1.062]	[1.052]	[1.054]	[1.063]
LOG(LIBOR(-1))	0.011											
	[7.700]											
LOG(TEDRATE(-1))		0.006	0.004	-0.017	-0.016	-0.025	-0.017	-0.016	-0.025	-0.018	-0.017	-0.026
		[6.729]	[6.769]	[5.088]	[5.090]	[5.044]	[5.089]	[5.091]	[5.045]	[5.078]	[5.080]	[5.033]
DLOG(MXWO)	0.270	0.261			0.122			0.145			0.129	
	[1.366]	[1.233]			[0.945]			[0.950]			[0.947]	
DLOG(DJREIT)	0.683	0.686			0.701			0.687			0.701	
	[1.548]	[1.302]			[1.185]			[1.189]			[1.186]	
DLOG(SPGSCITR)	-0.386	-0.378			-0.433			-0.442			-0.430	
	[1.635]	[1.578]			[1.153]			[1.149]			[1.153]	
LOG(EPU(-1))						-0.077			-0.077			-0.078
						[2.878]			2.879			2.876
DTCM				-0.089	-0.081	-0.071	-0.088	-0.080	-0.070	-0.088	-0.080	-0.070
				[5.243]	[5.193]	[5.222]	[5.239]	[5.188]	[5.218]	[5.245]	[5.195]	[5.223]
GFC				-0.127	-0.108	-0.140	-0.126	-0.107	-0.138	-0.128	-0.109	-0.140
				[2.354]	[2.241]	[2.257]	[2.355]	[2.242]	[2.258]	[2.354]	[2.241]	[2.257]
ESDC				-0.088	-0.089	-0.083	-0.089	-0.090	-0.084	-0.092	-0.092	-0.086
				[8.407]	[8.443]	[8.367]	[8.389]	[8.426]	[8.348]	[8.412]	[8.448]	[8.373]
BREXIT Intensity (categorical)				-0.223	-0.226	-0.220						
				[2.641]	[2.640]	[2.652]						
BREXIT Intensity (continuous)							-0.246	-0.250	-0.244			
							[2.598]	[2.597]	[2.608]			

BREXIT Intensity (continuous)										-0.277	-0.280	-0.276
										[2.661]	[2.662]	[2.674]
CVD19				-0.057	-0.050	-0.019	-0.055	-0.049	-0.017	-0.053	-0.046	-0.014
				[4.440]	[4.309]	[4.460]	[4.442]	[4.309]	[4.461]	[4.445]	[4.312]	[4.465]
Adjusted R-squared	0.322	0.307	0.304	0.419	0.420	0.426	0.419	0.420	0.426	0.419	0.421	0.426
Observations	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775	14,775
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents estimated coefficients and robust t-statistics in brackets, averaged across the EU-15 countries. Dependent variable is the net spillovers for EU-15 countries. Full-sample (2000-2021) estimation is reported on weekly observations. The seemingly unrelated regression is used which allows for contemporaneous correlation among error terms of the equations. Brexit intensity variables are denoted as (Cat), (Cont-Mean) and (Cont-Med) for the categorical, continuous/mean and continuous/median specifications respectively.