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Political referenda and investment: evidence from Scotland

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Abstract

We present evidence that referenda have a significant, detrimental outcome on investment. Employing an unsupervised machine learning algorithm over the period 2008-2017, we construct three important uncertainty indices underlying reports in the Scottish news media: *Scottish independence (IndyRef)*-related uncertainty; *Brexit*-related uncertainty; and *Scottish policy*-related uncertainty. Examining the relationship of these indices with investment on a longitudinal panel of 3,589 Scottish firms, the evidence suggests that Brexit-related uncertainty associates more strongly than *IndyRef*-related uncertainty to investment. Our preferred specification suggests that a one standard-deviation increase in Brexit uncertainty foreshadows a reduction in investment by 8% on average in the following year. Besides we find that the uncertainty associated with the Scottish referendum for independence while negligible at the aggregate level, relates more strongly with the investment of listed firms as well as those operating on the border with England. In addition, we present evidence of greater sensitivity to these indices among firms that are financially constrained or whose investment is to a greater degree irreversible.

keywords— Political uncertainty, investment, machine learning, textual-data

JEL classifications: C80, D80, E22, E66, G18, G31

Non-technical summary

Scotland has recently experienced two significant episodes when political uncertainty might have been especially pronounced: the Scottish referendum on independence in September 2014 (secession from the United Kingdom) and the Brexit referendum in June 2016 (on the UK leaving the European Union). Both of these events were preceded by extensive and intensive periods of national debate. These debates were often fractious and resulted in many claims that a 'Leave' vote (for Scotland to leave the UK or for the UK to leave the EU) would result in widespread economic uncertainty as they would usher in possibly protracted periods of political wrangling until trading regimes and the wider business environment were resolved.

The central aim of this paper is to quantify these two political uncertainty shocks, and to study their relationship with investment. To measure political uncertainty, we use an unsupervised machine learning algorithm to subdivide overall economic uncertainty reported in the news-media into different topics or themes. The unsupervised machine learning algorithm called Latent Dirichlet Allocation (LDA) studies the co-occurrences of words in news-media articles to frame two distributions: a distribution of words composing a topic and a distribution of topics for each document (news article). One can then track through time the evolution of the topics describing the uncertainty measures of interest. In other words, the LDA approach allows one to decompose economic policy uncertainty into endogenously determined sub-indices, without need to read the individual newspaper articles and apportion their content across pre-determined sub-indices. Nonetheless, given that the topics uncovered by this approach are simply described by a set of words, it is left to the researcher to justify the labelling of each topic. However, it turns out that the LDA approach recovers indices that naturally comprise distinct political sources of uncertainty.

For example, in analyzing the Scottish press we label as '*IndyRef*' (Independence Referendum) that index whose most representative words given by the LDA algorithm include: *independence*, *SNP* [Scottish National Party], *referendum*, *party*, *vote*, *minister*, *Scotland* and *election*. This index increased steadily from the moment when the UK Parliament approved the Scottish referendum for independence (January 2012), until its actual occurrence in September 2014, rising again around mid-2016. Additionally, we label 'Brexit uncertainty' that index whose most representative words include: *EU*, *Brexit*, *European*, *UK*, *negotiations*, *leave*, *country*, *membership*, *single* and *trade*. That index peaked during the Brexit referendum in June 2016, and at the general election in June 2017. In addition, once we compare these two referendum-related uncertainty indices, *IndyRef* and *Brexit*, with the proportion of individuals that Google searched *"Scottish Independence"* and *"Brexit"* in Scotland, we observe strong similarities: 0.78 and 0.81 correlation respectively. This reassured us that we are capturing uncertainty, understood as the second moment.

We then examine the relationship between the indices just described and firm investment by applying a standard investment regression to a longitudinal panel dataset of 3,589 Scottish firms during the period 2008-2017. Our baseline results suggest that a one standard-deviation increase in Brexit uncertainty foreshadows a reduction in investment by 8% on average in the following year. Besides we find that the uncertainty associated with the Scottish referendum for independence while negligible for the overall firm network, relates more strongly with the investment of listed and border companies (those operating on the border with England).

We subject our baseline results to a battery of robustness tests. First, we incorporate a wide range of familiar variables into the empirical model that aims to explain the investment behaviour, such as cash-flows, sales growth rates, and GDP growth rates. Second, we add into the model alternative measures of uncertainty, such as the implied volatility index (VFTSE), election year dummies of various sorts, and an overall measure of UK Economic Policy Uncertainty index (EPU). Additionally, we ensure that the results are robust to several econometric approaches, including simple panel regressions both with and without fixed effects, a first-difference specification, as well as dynamic panel specifications estimated using a System GMM estimator.

To study the most plausible mechanisms through which uncertainty impacts investment, we investigate whether investment across different types of companies respond equally to uncertainty. First, we distinguish between non-manufacturing and manufacturing firms. The *Decision Maker Panel* survey reported that firms in the manufacturing sector are the most likely to move part of their operations outside the UK due to the uncertainty produced by Brexit. Nonetheless, more recent evidence suggests that business confidence from the manufacturing sector has actually increased after Brexit. We find evidence supporting this latter behaviour: Scottish manufacturing companies have been less negatively affected by political uncertainty.

Second, we distinguish between listed and non-listed companies. Listed companies may be less likely to suffer from financing constraints than their non-listed counterparts to the extent that asymmetric information is less of a problem to them. That said, they may face more risk due to having a larger share of operations abroad, thus making them especially vulnerable to referendum uncertainties. We observe that investment from listed companies present greater sensitivity with political uncertainty, especially that uncertainty arising from the Scottish referendum for independence.

To further investigate to what extent the financing constraints channel is behind these results, we construct two financing constraints proxy variables commonly used in the literature. Thus, we use company size and age to reflect the possible impact of external financial constraints whilst the 'coverage ratio' and 'cash-flows' to quantify the possible intensity of internal financial constraints. We find evidence that those firms that are more likely to be financially constrained display higher drops in investment in the presence of uncertainty. This holds principally for firms with either internal or external financing constraints and Brexit uncertainty. Finally, we study firms with potentially high degrees of irreversible investment. Consistent with priors, we find a stronger negative relationship between firms whose investment is more likely irreversible and political uncertainty.

The resulting policy implications may be important, in particular to the current economic climate. Referenda are becoming a popular tool for politicians, yet their consequences as a source of uncertainty often escape the political debate. In this paper, we show not only that referenda are a significant source of political and policy uncertainty but also that they affect private investment independently of their outcome.

1 Introduction

There is growing acknowledgement that economic policy uncertainty can have a significant impact on economies, and in particular on firms' investment decisions. Scotland has recently experienced two significant episodes where such uncertainty might have been especially pronounced: the Scottish referendum on independence in September 2014 (secession from the United Kingdom) and the Brexit referendum in June 2016 (on the UK leaving the European Union). Both of these events were preceded by extensive and intensive periods of national debate. These debates were often fractious and resulted in many claims that a 'Leave' vote[1] (for Scotland to leave the UK or for the UK to leave the EU) would result in widespread economic uncertainty as they would usher in possibly protracted periods of political wrangling until trading regimes and the wider business environment were resolved.

As Figure 1 shows, the Brexit referendum campaign started off more finely balanced than the independence referendum campaign in Scotland. However, as the dates of both referenda drew near, the polls narrowed, in some measure as undecided voters decided which way to vote. The solid lines in the figure are a linear extrapolation of the Remain and Leave votes recorded in various polls through the campaigns (other extrapolative techniques tell the same story). That apparent convergence in the votes, may itself have been an additional source of uncertainty and we shall examine that possible effect later. Of course, in the end, Scotland voted to remain in the UK (55% to 45%) whilst the UK voted to leave the European Union (52% to 48%).

In the case of the Scottish referendum, it may be the case that much of the political (independence-related) uncertainty has resolved, or is at least somewhat diminished. On the other hand, significant changes to 'devolved fiscal policy' (in particular to income tax raising powers) were introduced following the referendum and so policy uncertainty, *a priori*, need not have diminished. In other words, fiscal policy in Scotland may now diverge

[1] In the Scottish Independence Referendum (*IndyRef* for short) the question posed to voters was: 'Should Scotland be an independent country?' The political campaigns were organized around a Yes or No vote. For the EU Referendum the question was: 'Should the United Kingdom remain a member of the European Union or leave the European Union?' The political campaigns were organized around a vote to Remain or Leave. It is convenient simply to refer to Leave or Remain votes for either referendum.

from rUK (the rest of the UK, excluding Scotland) in potentially significant ways. And, of course, it is not clear that a second Scottish referendum on independence is off the political agenda. We will try to examine the extent to which this political (i.e., referendum-related) uncertainty has been resolved. As far as the EU referendum is concerned, it appears that much uncertainty, both political and policy related remains. The central aim of this paper is to attempt to identify the underlying sources of economic policy uncertainty (EPU) and to see which are more deleterious to investment: Are referenda an independent source of EPU and, if so, how costly are they? In doing this, we build on recent research which has established that economic policy itself can create an uncertain investment environment.

The principal challenge in extending the literature on policy uncertainty is isolating an appropriate measure of political/referenda-related uncertainty. In the literature, the overall economic uncertainty faced by a country has been measured using a variety of proxy variables, such as the dispersion in the forecast of GDP growth, implied volatility indices, or survey-based firm reports of investment uncertainty. A seminal development has been the news-based Economic Policy Uncertainty index developed by Baker, Bloom, and Davis (2016). Such indices describe primarily uncertainty concerning *which* or *when* economic policies the government will implement. However, measuring the portion of uncertainty attributable to the political system and in particular applicable to Scottish issues alone is rather challenging using their approach.

To fill this gap, we use an unsupervised machine learning algorithm to subdivide overall economic uncertainty reported in the news-media into different topics following the approach of Azqueta-Gavaldón (2017). The unsupervised machine learning algorithm called Latent Dirichlet Allocation (Blei, Ng, and Jordan (2003)) studies the co-occurrences of words in news-media articles to frame two distributions: a distribution of words composing a topic and a distribution of topics for each document (news article). One can then track through time the evolution of the topics describing the uncertainty measures of interest. In other words, the LDA approach allows one to decompose economic policy uncertainty into endogenously determined sub-indices, whilst the unsupervised machine algorithm makes the analysis feasible. Hence, there is no need to read the individual newspaper articles and apportion their content across pre-determined sub-indices. Nonetheless, given that the topics uncovered by this approach are simply described by a set of words, it is left to the researcher to justify the labelling of each topic. However, as we describe briefly now, and in more detail below, it turns out that the LDA approach recovers indices that naturally comprise distinct political and policy sources of uncertainty.

For example, in analyzing the Scottish press we label as '*IndyRef*' that index whose most representative words given by the LDA algorithm include: *independence*, *SNP* [Scottish National Party], *referendum*, *party*, *vote*, *minister*, *Scotland* and *election*. This index increased steadily from the moment when the UK Parliament approved the Scottish referendum for independence (January 2012), until its actual occurrence in September 2014, rising again around mid-2016. Additionally, we label '*Brexit uncertainty*' that index whose most representative words displayed by the algorithm include *EU*, *Brexit*, *European*, *UK*, *negotiations*, *leave*, *country*, *membership*, *single* and *trade*. That index peaked during the Brexit referendum in June 2016, and at the general election in June 2017.

In addition, once we compare these two referendum-related uncertainty indices with the proportion of individuals that Google searched *"Scottish Independence"* and *"Brexit"* in Scotland, we observe strong similarities: 0.78 and 0.81 correlation respectively. The similarity between our referendum-related uncertainty indices and Google searches implies two things: i) *IndyRef* and *Brexit* indeed capture relevant events related to these two referenda; ii) given that internet users look for online information when they are uncertain (Castelnuovo and Tran (2017)), it reassured us that we are capturing uncertainty, understood as the second moment, and not just the first moment of beliefs. Furthermore, we label the index '*Scottish policy uncertainty*' whose most representative words include: *Scotland*, *Scottish*, *government*, *budget*, *public*, *education*, *need*, *fund*, *report* and *tax*. That index peaks when the Scottish Parliament approved the SNP's administration's budget at the second time of asking (Feb 2009); the Scottish public-sector strikes (November 2011) and Brexit (June 2016).

We then examine the relationship between the indices just described and firm investment by applying a standard investment regression to a longitudinal panel dataset of 3,589 Scottish firms. Our baseline results suggests that a one standard deviation increase in

Brexit uncertainty foreshadows a reduction in investment by 8% on average in the following year. Besides we find that the uncertainty associated with the Scottish referendum for independence, while negligible for the overall firm network, had a negative and significant outcome on the investment of listed and border companies (those operating on the border with England).

Our results appear significant and consistent with some important recent findings in the literature. For example, Gulen and Ion (2015), in examining US firms over the period 1987:Q1-2013:Q4, found that a one standard deviation increase in policy uncertainty is associated with an average decrease in quarterly investment rates of 6%. In addition, Azzimonti (2018), studying the period 1987:Q1-2017:Q4, found that a one standard deviation increase in her Partisan Conflict index over the period led to a drop in quarterly US investment of 13% of the sample mean. Regarding political uncertainty, Jens (2017) found that gubernatorial elections in the United States depresses investment by 5% on average while Dibiasi et al. (2018) found that the economic policy uncertainty induced by the 2014 referendum vote on Mass Immigration in Switzerland reduced irreversible investment by as much as 25-30% in exposed firms. In line with the Brexit referendum, Born et al. (2019) found that the Brexit vote caused a reduction in GDP by approximately 2% by the second quarter of 2018 and policy uncertainty accounts for 30% of this effect.

We subject our baseline results to a battery of robustness tests. First, we incorporate a wide range of familiar variables into the empirical model that aims to explain investment behaviour such as cash-flows, sales growth rates, and GDP growth rates. Second, we add into the model alternative measures of uncertainty, such as the implied volatility index (VFTSE), election year dummies of various sorts, and an overall measure of UK Economic Policy Uncertainty index (EPU). Additionally, we ensure that the results are robust to several econometric approaches, including simple panel regressions both with and without fixed effects, a first-difference specification, as well as dynamic panel specifications estimated using a System GMM estimator.

To study the most plausible mechanisms through which uncertainty relates to investment, we investigate whether investment across different types of companies respond equally to uncertainty. First, we distinguish between non-manufacturing and manufacturing firms. The *Decision Maker Panel* survey reported that firms in the manufacturing sector are the most likely to move part of their operations outside the UK due to the uncertainty produced by Brexit (Bloom, Bunn, et al. (2017)). Nonetheless, more recent evidence suggests that business confidence from the manufacturing sector has actually increased after Brexit (see Born et al. (2019)). We find evidence supporting this latter behaviour: investment from Scottish manufacturing companies appear less sensitive to political uncertainty.

Second, we distinguish between listed and non-listed companies. Listed companies may be less likely to suffer from financing constraints than their non-listed counterparts to the extent that asymmetric information is less of a problem (Carpenter and B. C. Petersen (2002)). That said, they may face more risk due to having a larger share of operations abroad, thus making them especially vulnerable to referendum uncertainties. We observe that investment from listed companies appears more sensitive to political uncertainty (in a negative way), especially to that arising from the Scottish referendum for independence.

To further investigate to what extent the financing constraints channel is behind these results, we construct two financing constraints proxy variables commonly used in the literature. Thus, we use company size and age to reflect the possible impact of external financial constraints whilst the 'coverage ratio' and 'cash-flows' to reflect the possible intensity of internal financial constraints (see Guariglia (2008)). We find evidence that those firms that are more likely to be financially constrained also display higher drops in investment in the presence of uncertainty. This holds principally for firms with either internal or external financing constraints and Brexit uncertainty.

Finally, we study firms with potentially high degrees of irreversible investment. Drawing on Chirinko and Schaller (2009), we use depreciation rates to proxy for investment irreversibility. This proxy is motivated by the fact that, in addition to selling capital, firms can reduce their capital stock through depreciation. Therefore, firms with low depreciation rates face higher risks when making capital purchases under uncertainty. Consistent with priors, we find a stronger negative relationship between firms whose investment is more likely irreversible and political uncertainty.

This paper relates to at least three strands of literature. The first is research on the impact of uncertainty on investment. Theoretical work on this topic dates back to Bernanke (1983) who reveal that high uncertainty gives firms an incentive to delay investment when investment projects are costly to undo.[2] Recent empirical literature (and which we closely follow) is Gulen and Ion (2015) who examine the impact of economic policy uncertainty on US firms investment over the period 1987:Q1-2013:Q4. They found a significantly stronger effect of uncertainty on investment for firms with a higher degree of investment irreversibility and for firms that are more financially constrained. Other empirical studies connecting political risk/uncertainty and economic activity are Azzimonti (2018) and Jens (2017).

Second, there are interesting studies examining explicitly the impact of referenda on the economy. Using a time-dummy approach (1 for when the referendum took place and 0 otherwise), Dibiasi et al. (2018) found that the economic policy uncertainty induced by the 2014 referendum vote on Mass Immigration in Switzerland reduced irreversible investment by as much as 25-30% in exposed firms. Also using a timeline approach, Darby and Roy (2019) examined the impact of the Scottish referendum on stock market volatility. They observed increases in the relative volatility of Scottish companies' stock returns compared to the rest of the UK when polls suggested the referendum result was too close to call. Finally, using a synthetic control method, Born et al. (2019) found that the Brexit vote caused a reduction in UK's GDP by approximately 2% by the second quarter of 2018 and that policy uncertainty accounts for 30% of this effect.

Finally, there is a rapidly growing literature on textual methods to measure a variety of outcomes. In their seminal contribution, Baker, Bloom, and Davis (2016) used newspaper coverage frequency and simple dictionary techniques to measure Economic Policy Uncertainty (EPU).[3] Hansen, McMahon, and Prat (2017) used Latent Dirichlet Allocation on the Federal Open Market Committee talks to study communication patterns. Using simple text-mining techniques, Hassan et al. (2019) built a political risk measure as the share of

[2] R. K. Dixit and Pindyck (1994) offer a detailed review of the early theoretical literature.

[3] EPU indices have been replicated with more advanced methods (see Azqueta-Gavaldón (2017) or Saltzman and Yung (2018)).

firm-quarterly conference calls that are devoted to the political risk for the USA.[4] They found that increases in their firm-level measure of political risk are associated with significant increases in firm-specific stock return volatility as well as with significant decreases in firms' investment, planned capital expenditures, and hiring. More recently, combining word-embedding and LDA algorithms, Azqueta-Gavaldon et al. (2020) built several EPU indicators for Spain, Italy, France and Germany.

The rest of the paper proceeds as follows: Section 2 describes the algorithm and news-media data used to produce the specific uncertainty indices for Scotland. Section 3 presents the data and econometric framework to study the effects of uncertainty on private investment. Section 4 shows the empirical findings of the average effect of uncertainty on investment. Section 5 displays the analysis of cross-sectional firm heterogeneity under political uncertainty. Section 6 contains robustness tests and Section 7 concludes.

2 Political and policy uncertainty in Scotland

2.1 LDA model

To obtain the distinctive narratives of political uncertainty embedded in the news media, we use the approach described in Azqueta-Gavaldón (2017). This approach applies an unsupervised machine learning algorithm to all news articles describing economic uncertainty (all news articles containing any form of the words *economy* and *uncertainty*) in order to unveil the wide range of themes or topics described on it. The unsupervised machine learning algorithm, called Latent Dirichlet Allocation (LDA) and developed by Blei, Ng, and Jordan (2003), reveals the themes across articles without the need for prior knowledge about their content. Intuitively, the algorithm studies the co-occurrences of words per articles to frame each topic as a composition of the most likely words (more likely to appear together) while each article is framed as a distribution of topics.

In other words, LDA is a generative probabilistic model that infers the distribution

[4] To come up with political topics, they first filter political topics by correlating them to sources with *a priori* political vocabulary e.g. political sciences textbooks. They then count the number of instances in which these political-related words appear together with synonyms of *risk* or *uncertainty*.

of words that defines a topic, while simultaneously characterizing each article with a distribution of topics. The model recovers these two distributions by obtaining the model parameters that maximize the probability of each word appearing in each article given the total number of topics K. The probability of word w_i occurring in an article is:

$$P(w_i) = \sum_{j=1}^{K} P(w_i|z_i = j)P(z_i = j) \tag{1}$$

where z_i is a latent variable indicating the topic from which the ith word was drawn and $P(w_i|z_i = j)$ is the probability of word w_i being drawn from topic j. Moreover, $P(z_i = j)$ is the probability of drawing a word from topic j in the current article, which will vary across different articles. Intuitively, $P(w|z)$ indicates which words are important to a topic, whereas $P(z)$ is the prevalence of those topics within an article. The goal is therefore to maximize $P(w_i|z_i = j)$ and $P(z_i = j)$ from equation (1). However, direct maximization turns out to be susceptible of finding local maxima and showing slow convergence (Griffiths and Steyvers (2004)). To overcome this issue, we use *online variational Bayes* as proposed by Hoffman, Bach, and Blei (2010). This method approximates the posterior distribution of $P(w_i|z_i = j)$ and $P(z_i = j)$ using an alternative and simpler distribution: $P(z|w)$, and associated parameters.[5]

2.2 New article Data

We apply the LDA algorithm to three of the most read Scottish newspapers: *The Herald* (UK coverage and based in Glasgow), *The Scotsman* (UK coverage and based in Edinburgh), and *The Aberdeen Press and Journal* (largely Scottish coverage). Because we are interested in building an aggregate political uncertainty index, that is, to what extent the general public (and in particular firms' CEOs) got exposed to news portraying the various sources of political wrangling, we do not differentiate between political position or sympathy across these news outlets. For example, one could imagine that more conservative news outlets would tend to describe political uncertainty around Brexit to a lower degree than more liberal ones would. Nevertheless, provided that these news outlets are among the most read ones in Scotland, we are confident that they serve our purpose.

[5]For more details about the implementation see Rehurek and Sojka (2010).

We use *Nexis*, an online database of journalistic documents to gather all news articles containing any form of the words ‘economy’ and ‘uncertainty’ from these three newspapers.[6] The total number of news articles associated with any form of these two words from January 1998 to June 2017 (inclusive) was 18,125. In this *corpus*, the aggregate of all articles, there are over one million words. Following usual practice in the literature, we preprocess the data (words). Stopwords are removed: that is, words that do not contain informative details about an article: e.g., *that* or *me*. All words are converted to lower case, and each word is converted to its root (known as ‘stemming’). Finally, to find the most likely number of topics K, we use a *likelihood* maximization method. This method consists of estimating empirically the likelihood of the probability of words for a different number of topics $P(w|K)$. This probability cannot be directly estimated since it requires summing over all possible assignments of words to topics but can be approximated using the harmonic mean of a set of values of $P(w|z, K)$, when z is sampled from the posterior distribution (Griffiths and Steyvers (2004)). This method indicates that the most likely number of topics in this corpus is $K = 20$ (see Table 1).

Table 2 displays all the 20 topics identified by the LDA algorithm in our corpus. Column 3 shows the most representative words for each topic given by the algorithm (in lower cases and root format). A useful method to further scrutinize how well LDA captures the essence of the corpus is to apply a visual representation of the sizes and distances between topics in the two-dimensional space. We use the *LDAvis* method developed by Sievert and Shirley (2014) to accomplish this task. Figure 2 represents each topic as a disc whose area denotes that topic’s prevalence in the corpus; essentially, the bigger the disk, the more important the topic in the corpus. Furthermore, the inter-topic-distances between topics describe the similarities between them. These distances are given by the Jensen-Shannon divergence and are scaled by Principal Components in the two-dimensional space (see Sievert and Shirley (2014)); the closer the disks, the more the topics (words with a high probability of belonging to that topic) overlap. Furthermore, one observes that most of the information in this corpus lies within the top right-hand quadrant (top-right corner of Figure 2), indicating a

[6]Recall that news articles containing any form of the words *economy* and *uncertainty* describe overall economic uncertainty (see Baker, Bloom, and Davis (2016)).

degree of similarity between most of the topics, as one would expect given that our corpus was constructed to focus on economic uncertainty. Recall, our interest is not so much in overall economic policy uncertainty, but in the constituent components of that uncertainty (policy uncertainty, Brexit, and so on). As we will discuss in more detail below, that quadrant is indeed mostly populated by policy uncertainty related topics.

One observes in Figure 2 that the two referendum topics (Topics 1 and 12) appear very close together and even overlap. Nonetheless, even though they are related by some of the most characteristics words associated with each topic, they are still distinct from each other according to the LDA (two different discs). Whether that distinctiveness is statistically or econometrically significant in explaining investment is, of course, of central importance. Also closely aligned are the topics related to Scottish policy uncertainty (Topic 6), monetary policy uncertainty (Topic 4) and agricultural policies (Topic 13). More distant to the core topics, but still of some significance in the overall corpus and still connected with Scottish policy uncertainty, we find topics reflecting labour policies (Topic 9), financial regulation (Topic 10), and North Sea oil (Topic 8). From all these topics, we choose the three topics centrally related to political and Scottish policy uncertainty:[7]

- **IndyRef:** *independ, snp, mr, referendum, parti, vote, labour, minist, scotland, elect, campaign, would, sturgeon*
- **Brexit Uncertainty:** *eu, brexit, european, britain, europ, union, uk, negoti, leav, countri, membership, singl, trade, brussel*
- **Scottish Policy Uncertainty:** *scotland, scottish, govern, budget, busi, univers, public, educ, need, fund, council, report, tax*

[7] Although there are other topics related to Scottish policy uncertainty we choose Topic 6 for our study for two reasons. First, it is the largest of the topics describing Scottish policy uncertainty (9% of the total news describing economic uncertainty) and, second, it is the closest to the two referendum Topics. Also note that while the topic Preferences (Topic 3) seems related to the two referendums, we do not take it into account for two reasons. In the first instance, its meaning is highly ambiguous and hence difficult to map to observable economic variables. In addition, once transformed into a time series, see next paragraph, Topic 3 is only weakly correlated with the two referenda uncertainty indices: -0.01 with *IndyRef* and 0.17 with Brexit uncertainty.

Building each time series requires a few extra steps. First, we label each article according to its most representative topic (the topic with the highest percentage in the article). Next, we produce a raw count of the number of news articles for every topic each month (20 *raw time-series*). Finally, since the number of news articles is not constant over time, we divide each *raw time-series* by the total number of news articles containing the word *today* each month (the proxy for the total number of news articles, see Azzimonti (2018)).

2.3 Uncertainty indices

Figure 3 shows the evolution of *IndyRef*, Brexit uncertainty and Scottish policy uncertainty indices from Jan 2008 through June 2017. *IndyRef* covers around 10 per cent of all news articles describing economic uncertainty. It shows spikes when the UK Government legally approved the Scottish referendum for independence (Jan 2012); when the chancellor of the Exchequer George Osborne argued that a 'Yes' vote meant Scotland giving up the pound (Feb 2014)[8]; the Scottish referendum for independence (Sept 2014); and Brexit (June 2016). 'Brexit uncertainty' (4 percent of all economic uncertainty news) shows its peak at the time of the Brexit referendum (June 2016); it also rises in the run-up to the general election of June 2017. Lastly, Scottish policy uncertainty (9 percent of all economic uncertainty news) peaks when the SNP budget was approved following initial rejection (Feb 2009); Scottish public sector strikes (Nov 2011)[9], and, most notably in the run up to the Brexit vote (June 2016).

To validate that these indices are capturing periods of high uncertainty, we compare each uncertainty index with the implied volatility index of the FTSE (VFTSE) and Google searches. On the one hand, the VFTSE index uses implied option volatilities information which represents the market consensus of future UK stock market volatility. This index is based on market data, is forward-looking and is often referred to as the *investor fear gauge*; the higher the index, the greater the fear (Whaley (2000)). Significantly, implied volatility indices are often used as a proxy for overall uncertainty (see for example Baker, Bloom, and Davis (2016) and Gulen and Ion (2015)).

[8] See http://www.bbc.co.uk/news/uk-scotland-scotland-politics-26166794.

[9] See http://www.bbc.co.uk/news/uk-scotland-scotland-politics-15938970.

Setting the financial and European debt crises aside (where the VFTSE shows its two most prominent peaks), the implied volatility index and the uncertainty indices display some similarities in the run up to the Scottish referendum for independence and *Brexit*. However, it is interesting to note that after *Brexit* the implied volatility index, in contrast to the three uncertainty indices, did not rise but remained somewhat subdued. This indicates that uncertainty perceived by financial markets after *Brexit* was not as high as the one apparently being picked up by our three political/policy uncertainty indices. An interesting question, therefore, is whether these three measures of uncertainty are able to contribute in explaining investment whilst controlling for the VFTSE and other more standard measures of uncertainty.

To further validate these uncertainty indices, we compare them with Google searches available via *Google Trends*. The data provided by *Google Trends* is freely available in real time and it has been used before to construct uncertainty indicators. For example, Castelnuovo and Tran (2017) use words associated to uncertainties about future economic conditions such as "bankruptcy", "stock markets", "economic reforms" or "debt stabilization" to construct an uncertainty index for the United States and Australia. The assumption is that economic agents, represented by internet users, look for online information when they are uncertain (Castelnuovo and Tran (2017)). This assumption implies that an increase in the frequency of terms associated to future, uncertain events results from high periods of uncertainty. With this in mind, we compare the proportion of individuals who searched "*Scottish Independence*" and "*Brexit*" in Scotland via Google with our political news-based uncertainty indices.

As can be seen by the discontinuous red line in Figure 4, developments in the proportion of individuals who searched "*Scottish Independence*" via Google closely resembles the *IndyRef* uncertainty index (0.78 correlation). The first notable increase in this particular Google search occurred when the UK Government legally approved the Scottish referendum for independence (Jan 2012). In addition, just like in the *IndyRef* index, the second most prominent spike takes place when the chancellor of the Exchequer George Osborne argued that a 'Yes' vote meant Scotland giving up the pound (Feb 2014) while the most prominent spike occurs during the Scottish referendum for independence (Sept 2014). Even though the *No* won the Scottish referendum, there are two important spikes in the Google search and in the *IndyRef* in the aftermath of the referendum. The first one occurs in the month of Brexit: shortly after the Brexit referendum results, the SNP advocated for another Scottish independence vote on the justification that Scotland voted in favour of the UK staying in the EU by 62% to 38%. The second one takes place in March 2017; when the Scottish parliament voted to demand a second independence referendum (69 to 59 votes).[10] Nonetheless, this proposition was rejected by the U.K. Prime Minister Theresa May and therefore a second Scottish independence referendum scheduled for Autumn 2018 was cancelled.

Besides, the dynamics in the proportion of individuals who searched "*Brexit*" in Scotland via Google and the Brexit uncertainty index are also very similar (0.81 correlation); both spiking in the month of the referendum and displaying high levels in the aftermath. Note, however, that the uncertainty indices created *via* the conventional press are preferred over those built using Google Trends for four main reasons. Firstly, we do not need to impose any query and therefore risking *ad hocness*. Secondly, the conventional press-media is likely to lead Google searches since agents react to what they read in the news by searching for additional information online. Thirdly, one can only retrieve Google Trends data as far back as 2004, limiting the time span. Finally, Google Trends does not provide an exact measure of the number of times a given query was formulated but offers a re-scaled time series from 0 to 100. In this regard, we do not know whether "*Scottish Independence*" was searched by 2 million people at its peak (September 2014) or only a few thousands. In both cases, it would display a maximum peak of 100.

3 Firm level data and methodology

3.1 Data

To perform the analysis, we extract the data from the profit and loss and balance sheet section assembled by the Bureau Van Dijk Electronic Publishing, and available in the *Fi-*

[10]See ttps://www.ft.com/content/195d9986-13d1-11e7-80f4-13e067d5072c.

nancial Analysis Made Easy (FAME) dataset. This dataset provides yearly information on British and Irish companies for the period 2008-2017. To be consistent with the uncertainty measures, we include in the analysis only companies with registered office address or primary trading address in Scotland. The companies selected perform in a wide range of economic sectors: agriculture, forestry and mining; manufacturing; construction; retail and wholesales; hotels and restaurants; and business and other services.[11]

We measure the investment rate as the purchase of fixed tangible assets by the firm over its capital stock at $t-1$. Investment is the difference between the book value of tangible fixed assets at the end of year t and the end of year $t-1$, plus depreciation at t, whilst the capital stock is fixed tangible assets at $t-1$.[12] The other two variables of interest are cash-flows (CF) which is computed as the sum of firm's after-tax profits and depreciation, and sales growth rates (SG).

Finally, we exclude firms that do not have complete records on investment, cash-flows, or sales growth rates, as well as those companies with less than three years of observations. Also, to control for the potential influence of outliers, we exclude observations in the 1% tails for each of the regression variables. These rules are common in the literature and also aid comparability with previous work (Guariglia (2008); Gulen and Ion (2015)). The final data used in the estimation comprises 3,589 companies or 22,769 firm-year observations. Of these firms, 800 operate in the manufacturing sector and 43 are listed companies (see Table 3). Comparing column 1 and column 2 in Table 3, we can see that even after imposing these filters on the data, the final sample is similar to the entire FAME universe for Scottish firms. On average over the period 2009 to 2017 our sample of companies account annually for around 40% of the total workforce of interest (total employment less those employed in banking and financial services and the public sector).[13]

[11]For standard reasons, we exclude companies operating in the financial and regulated sectors.

[12]Sometimes, the normalizing variable is not the capital stock but the replacement value of the capital stock calculated using the perpetual inventory formula (Blundell, Bond, et al. (1992)). In our short sample, the replacement value of the capital stock produced a significant downward trend in the overall investment (see Chirinko and Schaller (2009) for discussion). It is for this reason that we prefer using the capital stock.

[13]Specifically, our firms employed annually on average over the sample 524,680 individuals (after removing outliers). The aggregate employment level in the economy, less that in banking and financial services and the public sector, during the same time period was on average (annually) 1,342,422, see

3.2 Econometric framework

To study the relationship between investment and uncertainty, we employ the classical investment regression augmented to include political and policy uncertainty measures and a set of macroeconomic variables:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \beta_1 PU_{t-1} + \beta_2 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_3 SG_{i,t} + \beta_4 M_{i,t-1} + \beta_5 D_{t-1} + \epsilon_{i,t} \tag{2}$$

where $i = 1, 2, ..., N$ indexes the cross-section dimension and $t = 1, 2, ..., T$ the time series dimension. $I_{i,t}/K_{i,t-1}$ is the ratio between investment in fixed tangible assets and the capital stock at the beginning of the period; α_i is a firm fixed effect which captures firm-specific time-invariant omitted variables; PU_{t-1} indicates the yearly average news uncertainty indices; $CF_{i,t}/K_{i,t-1}$ corresponds to cash-flows scaled by the capital stock at the beginning of the period and $SG_{i,t}$ stands for sales growth rates. D_{t-1} and M_{t-1} contain a set of yearly dummy and macroeconomic variables meant to control for possible seasonality and other time-dependent factors of investment. Finally, standard errors are clustered at the firm level to correct for potential cross-sectional and serial correlation in the error term ϵ_{it} (M. A. Petersen (2009)).

Because the uncertainty indices are firm invariant, *time-fixed* effects cannot be incorporated into this basic econometric framework since doing so would entirely absorb the coefficients of our uncertainty indices. So, to address concerns that results might be driven by time-dependent factors such as business cycles or year-specific effects, we include a battery of macroeconomic variables (M_{t-1}) to account for such effects. An important concern in the literature when studying the impact of uncertainty on investment comes in the form of countercyclical behaviour of political/policy uncertainty: *"during bad economic outcomes, policy-makers often feel increasing pressure to make policy changes"* (Gulen and Ion (2015)). To this end, we use Scottish GDP growth rates[14] to control for business cycles (in line with Azzimonti (2018); Gulen and Ion (2015); Baker, Bloom, and Davis (2016)). Unfortunately,

https://www.gov.scot/Topics/Statistics/Browse/Labour-Market/Local-Authority-Tables.

[14] Available at http://www.gov.scot/Topics/Statistics/Browse/Economy/PubGDP.

GDP growth rates during the sample are positively correlated with the *IndyRef* index, see Table 4. For this reason, we need to be particularly cautious when interpreting the coefficient of *IndyRef* and this is why both results, with and without GDP growth rates, are discussed.[15]

There are a number of other issues which we try to address/control for in the subsequent analysis. These issues are largely concerned with whether or not our political and policy uncertainty indices are really justified in being so labelled. For example, our political uncertainty indices might be recording risk derived to a greater or lesser extent from election years, when investment tends to drop (see for instance Julio and Yook (2012)). In this case, we add a dummy variable which takes the value 1 if during that year a Scottish parliamentary election occurred and 0 otherwise (in line with Gulen and Ion (2015)).

Finally, note that we include the natural logarithm of the implied volatility index (VFTSE obtained from Bloomberg) which serves as a proxy for overall uncertainty. Recall that a graphical comparison of the three measures of uncertainty and the VFTSE suggested that after the Brexit referendum these measures diverged somewhat (see Figure 3). The uncertainty indices we construct indicate heightened uncertainty, in apparent contrast to the VFTSE.

It is worth mentioning that controlling for cash-flows and sales growth rates aim at capturing expected profitability/investment opportunities, that is, the first moment effects (Gulen and Ion (2015)). In the case that these first moment effects are not properly accounted for by these variables, the firm fixed effects as well as other macroeconomic variables, we might have biased coefficients. Nonetheless, since we always use lagged values of the uncertainty variable with respect to the dependent variable, omitted variables bias is unlikely. This is because our uncertainty measures are predetermined, which means that their effects are estimated consistently in our specifications (see Hayashi (2000), p. 109). In addition, this lagging technique also helps to alleviate any reverse causality concerns.[16]

[15]We also tried different measures to control for business cycles such as dummy variables for when GDP growth rates are positive/negative, and for the UK's GDP growth rates. Worth is mentioning that using these alternative specifications, the results remain unchanged.

[16]Note that the cash-flows and sales growth rates variables are not lagged while the uncertainty measures

4 The Average effect of Political Uncertainty on Investment

Table 5 shows our baseline empirical results from estimating equation (2). To facilitate interpretation, each uncertainty coefficient has been normalized by its sample standard deviation. Therefore, each coefficient may be interpreted as the change in the investment rate associated with a one standard deviation increase in uncertainty. Panel A shows the results without controlling for business cycles while Panel B adds Scottish GDP growth rates to control for them. Overall, our results show that each of the three uncertainty indices is estimated to impact investment negatively and highly significantly when entered separately. However, when we include the uncertainty indices jointly, the explanatory power becomes centred on Brexit uncertainty.

Columns (1) through (3) include only one of the three uncertainty indices. Column (1) reports the results including only *IndyRef* uncertainty. There we observe that a one standard deviation increase in uncertainty implies a decrease in investment in the following year of -0.077 when controlling for GDP growth rates (Panel B). That is equivalent to a decline of 23% in the average firm investment rate for the whole sample ($I/K = 0.34$, see Table 3). As mentioned, GDP growth rates and *IndyRef* uncertainty are positively correlated in the run-up to the referendum. Hence, when we exclude GDP growth rates (Panel A) we estimate the coefficient of the *IndyRef* index to be -0.028, equivalent to a drop of 8% in the average firm investment rate for the whole sample. This change in magnitude when excluding GDP growth rates really affects only the coefficient of the *IndyRef* index whereas other estimated coefficients remain largely unchanged following the exclusion of GDP growth. Nevertheless, this suggests that multicollinearity is an issue between those two variables.[17]

are. This is done in order not to lose a year of observations. That said, results remain unchanged when these two variables are lagged and we confirmed that the uncertainty measures at $t-1$ have no predictive power for cash-flows nor sales growth at t.

[17]The *Variance Inflation Factor* (a tests to study multicollinearity), reveals values much greater than 10 for *IndyRef* when GDP growth rates are included in the regression equation.

Column (2) reports the results with only Brexit uncertainty included. Here we see that the coefficient of Brexit uncertainty remains pretty much unchanged when excluding/including GDP growth rates: -0.045 and -0.046 (Panel A and B respectively). These magnitudes are equivalent to a drop in the average investment rate of 13.2% and 13.5% respectively. Besides, when Scottish policy uncertainty is included alone (column (3)), it reports a coefficient equivalent to a fall of 9% in the average investment rate when excluding the business cycles control (Panel A) and 10% when including it (Panel B).

Next, we challenge the explanatory power of each referendum uncertainty index by simultaneously controlling for Scottish policy uncertainty (columns (4) and (5)).[18] It turns out that both coefficients on the referenda uncertainty indices drop in value. That is especially so for *IndyRef* when excluding GDP growth rates, which is no longer significant. This indicates a strong link between *IndyRef* and Scottish policy uncertainty: the explanatory power observed when *IndyRef* was set alone is absorbed completely by Scottish policy uncertainty. As we will see in the robustness tests below, *IndyRef* displays a negative and significant coefficient once we replace Scottish policy uncertainty with the UK policy uncertainty. This is not the case for Brexit uncertainty, which remains statistically significant after controlling for Scottish policy uncertainty (column (5)). Nonetheless, the coefficient on Brexit uncertainty drops from 13% to 8% but remains highly significant. This indicates also a relationship between the uncertainty caused by Brexit and Scottish policy uncertainty (being the coefficient of this latter uncertainty no longer significant).

Overall these results expose the gravitational effect that Brexit uncertainty had on the other two indices. This comes as no surprise since Brexit, on the one hand, has induced policy changes at the Scottish level while, on the other hand, has fuelled the debate for a second Scottish referendum for independence. Indeed, shortly after the Brexit referendum results, the SNP advocated for another Scottish independence vote on the justification that Scotland voted in favour of the UK staying in the EU by 62% to 38%. In March 2017, the

[18]Note that due to multicollinearity problems that arise when placing the two uncertainty indices together, we exclude the implied volatility index (VFTSE). Using the Variance Inflation Factors we detected values much higher than 10 for the VFTSE when all controls were placed, something which indicates pronounced multicollinearity.

Scottish parliament voted (69 to 59 votes) to demand a second independence referendum.[19] Nonetheless, following the decline in SNP votes during the UK general election (June 2017), Nicola Sturgeon announced that the Scottish government would postpone legislation concerning a second referendum for independence.[20]

The overarching significance of Brexit uncertainty is apparent when the three uncertainty indices enter jointly (column (6)). In this setting, only Brexit uncertainty remains negative and significant.[21] In this formulation, a one standard deviation increase in Brexit uncertainty foreshadows a drop in the average investment rate of 12% in the following year. That is barely unchanged in the case when Brexit uncertainty was postulated as the sole source of uncertainty. To further study how political uncertainty has evolved during and after the referenda took place, in what follows we incorporate a set of dummy variables aiming to isolate the two referenda events and to check also whether or not simple dummy variables have more explanatory power than our uncertainty indices.

We firstly undertake this latter exercise by incorporating simple year-dummy variables describing when the referenda took place. We label these year-dummy variables as $SCOT_{referendum}$ and $BREXIT_{referendum}$ (1 in the year the referendum took place and 0 otherwise). To be consistent with our measurements of uncertainty, all dummy variables are lagged by one year. First, these dummy variables are considered on their own (columns (1) and (4) of Table 6). We observe that although both are negative (except for *IndyRef* when GDP growth rates are excluded, column (1) in Panel A), only the coefficient associated with the Brexit referendum is statistically significant. This seems to confirm the insight from Table 5 on the relevance of Brexit.[22]

More importantly, however, once we add our referenda uncertainty measures *IndyRef* and *Brexit* (columns (2) and (5) respectively), they prevail over the dummy variables; in

[19]See https://www.ft.com/content/195d9986-13d1-11e7-80f4-13e067d5072c.

[20]See https://www.bbc.co.uk/news/uk-scotland-40415457.

[21]Once again, we had to drop the implied volatility index and GDP growth rates from the regression equation due to strong multicollinearity indicated by the Variance Inflation Factors test. For this reason, the results in both panels are the same.

[22]Note that even though these dummies are included individually, the results are unaltered even when the two dummy variables are included.

all cases only the uncertainty indices are statistically significant. This holds independently of whether or not we include/exclude GDP growth rates (Panels A and B). Therefore, we conclude that our uncertainty measures have important explanatory power over and above simple referendum-year dummies. These results also hold when incorporating a dummy variable for the period when the Scottish referendum was being legislated: 2012-2014.

Next, we investigate whether or not *IndyRef* displays any effect on investment once the uncertainty after the Scottish referendum is removed. In other words, we sought to isolate the uncertainty that may have been present in the run-up to the Scottish referendum from any post-referendum uncertainty. When *IndyRef* uncertainty is included on its own (column (1) of Table 5) the size of its estimated coefficient was substantially larger than when put together with Brexit uncertainty. The implication, therefore, may be that *IndyRef* was picking up some of the effects of Brexit uncertainty. For this reason, we now interact *IndyRef* with a dummy variable that removes any post-Scottish referendum uncertainty ($SCOT_{2014} = 1$ from the beginning of the sample period up until the year of the referendum and 0 afterwards). To be consistent with our lagged uncertainty measure, this time dummy variable is also lagged by one year. Column (3) displays the results also controlling for Brexit uncertainty with the dummy variable $BREXIT_{referendum}$. The interaction term *IndyRef**$SCOT_{2014}$ turns out to be negative although not significant. In this scenario, a one standard deviation increase in *IndyRef*, once removing the uncertainty post-referendum, suggests a drop in investment of 4% in the following year.

All in all, the results presented in these two tables allow us to be confident of a strong relationship between Brexit uncertainty and firm investment. The most conservative results -including Scottish EPU and excluding GDP growth rates- foreshadows a drop in average investment rate in the following year by 8% (column (5) Panel A Table 5) while when Brexit uncertainty enters alone, this magnitude represents a drop of 14% of the average investment rate (column (2) Panel A Table 5). Taking into account that Brexit uncertainty rose by 2.65 standard deviations, the lower-bound Brexit uncertainty effect on investment adds to 21.5%.

Regarding the link between *IndyRef* and investment, results seem to indicate a weak and non statistically significant relationship between investment and uncertainty related exclusively with the Scottish referendum for independence. Results when excluding the uncertainty period after the Scottish referendum for independence and business cycles indicate that only the uncertainty regarding the Scottish referendum for independence foreshadows a drop in average investment rate in the following year by 4% (although not statistically significant).

It is worth to mention, however, that the results displayed in this section should be taken with certain cautiousness. Firstly, we have a relatively low amount of years in our sample period. As a result of this, we could only place a limited number of aggregate variables aiming at capturing time-dependent factors that could confound the effect of political uncertainty. Secondly, the time frequency comes at a yearly average which, as we have noted with our uncertainty measures, tend to move at a higher frequency. Nonetheless, we have seen that our measures of uncertainty prevail over a simple time-dummy approach (they remain statistically significant once we incorporate a time dummy variable for when the referenda took place). To somewhat dissipate these concerns, in the following section we will be able to incorporate time-fixed effects in our regression by interacting our uncertainty measures with firm characteristics known to be more sensitive to uncertainty. This should reassure us that any negative effect observed in investment comes indeed from political uncertainty.

5 Heterogeneous effect of uncertainty

So far, we have assumed that the relationship between uncertainty and investment is equal across the different types of companies. However, there are reasons to believe that this may not be the case. For example, there might be cross-sectional heterogeneity among sectors, corporate structure, or balance sheets. In addition, investment decision is not equally costly for all firms in the economy since there might be variations in the degree of investment irreversibility or financial constraints.

To study the plausible cross-sectional heterogeneity link between uncertainty and investment, we include an interactive term for the uncertainty measure and a dummy variable describing different heterogeneous firm characteristics. Note that here we are no longer interested in estimating the average effect of political uncertainty on investment. This allows us to replace the uncertainty indices, macro and time dummy controls in equation (2) with a time fixed effect. This has the added benefit of controlling for any macroeconomic, cross-sectionally invariant forces which may confound the effect of political uncertainty:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \gamma_t + \beta_1 PU_{t-1}{\cdot}H_i + \beta_2 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_3 SG_{i,t} + \epsilon_{i,t} \tag{3}$$

where H_i stands for *heterogeneity* characteristics that are time invariant. In the case of having cross-section and time-variant heterogeneity $H_{i,t}$ the econometric equation will look like the following:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \gamma_t + \beta_1 PU_{t-1}{\cdot}H_i + \beta_2 H_{i,t} + \beta_3 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_4 SG_{i,t} + \epsilon_{i,t} \tag{4}$$

In both of the above equations, the interactive coefficient β_1 is the coefficient of interest. It allows us to evaluate whether or not the effect of uncertainty on investment is likely to have been equal across firms with specific characteristics and their counterparts.

5.1 Manufacturing and listed companies

Recent surveys indicate stronger adverse effects of the uncertainty derived from Brexit for the manufacturing sectors than the rest of industries. For example, the *Decision Maker Panel* survey reported that firms in the manufacturing sector are more likely to move part of their operations outside the UK on account of uncertainty due to Brexit (Bloom, Bunn, et al. (2017)). Conversely, as results presented in Panel A from Table 7 show, investment from the 800 Scottish manufacturing companies display a lower sensitivity with political uncertainty than their counterparts. While all the interacted coefficients are positive, only those from *IndyRef* and Scottish policy uncertainty are statistically significant. This could be explained by the fact that manufacturing-business' confidence increased rapidly after an initial drop following the Brexit referendum (see Born et al. (2019)).

Another classification of firms that might be expected to be more sensitive to Brexit uncertainty is those that are listed (those whose stocks are publicly traded). Therefore we could expect them to be more negatively affected by referendum uncertainty. That might be because they are larger and more involved in international trade. On the other hand, they are also less likely to suffer from financial constraints compared to their unlisted counterparts since they may have fewer problems derived from asymmetric information (Carpenter and B. C. Petersen (2002)). Panel B of Table 7 shows that although all dummy-listed-variables interacted with each uncertainty index are negative, they are not significantly different from zero.

5.2 Financing constraints

To further investigate to what extent the *financing constraints* channel is responsible for any heterogeneous outcome of uncertainty on investment, we construct several proxy variables to account for financing constraints. Recall that the *financing constraints channel* states that an increase in uncertainty exacerbates any underlying asymmetric information problem. This, in turn, reduces credit access as it becomes more difficult for lenders to assess the probability of repayment (Gilchrist, Sim, and Zakrajsek (2013); Arellano, Bai, and Kehoe (2010); and Byrne, Spaliara, and Tsoukas (2016)). One would, therefore, expect that companies facing greater difficulties in accessing credit might cut investment more sharply as uncertainty rises, compared to those with easier access to credit. As Doshi, Kumar, and Yerramilli (2017) suggest, the adverse effect of uncertainty on investment will be more powerful for financially constrained firms as they reduce capacity in a bid to minimize possible *ex-post* costs of financial distress.

Following the recent literature, we distinguish between *internal* and *external* financial constraints. On the one hand, *internal financial constraints* operate through restrictions to internal funds generated by the firm that could otherwise, in principle, be targeted towards investment. Thus, firms with lower levels of available internally generated funds (e.g., funds directed to debt service) will be more constrained. On the other hand, *external financial constraints* operate through various forms of information asymmetries.

Following the approach of Guariglia (2008), we define an *external financing constraints* dummy variable based on size and age. The intuition is that younger and smaller firms are more likely to face problems of asymmetric information given their short track records and lower collateral levels (Schiantarelli (1995)).[23] To this end, we first define company i as $Young_{i,t} = 1$, if its age falls within the lowest quartile of the distribution of the ages of all firms operating in her sector and zero otherwise. Similarly, we define company i as $Small_{i,t} = 1$, if its total assets fall within the lowest quartile of the distribution of total assets of all firms operating in her sector and zero otherwise. The *external financing constraints* dummy variable is then represented by those young and small companies $YS_{i,t}$.[24]

We define an *internal financial constraints* dummy variable based on the level of cash-flows and the coverage ratio. This latter variable is the ratio between firm's total profits before tax and before interest and their total interest payments. It is a measure of the number of times a company could make its interest payments relying on her earnings before interest payments and taxes (Guariglia (2008)). Cash-flows, on the other hand, is the total amount of money being transferred into and out of a business, primarily affecting short-term liquidity. The intuition for using cash-flows to capture internal financing constraints hinges on empirical evidence. Provided that cash-flows are the main source of variation in internal funds, firms with low cash-flows levels likely have low levels of internal funds (Cleary, Povel, and Raith (2007)). Therefore, those firms with low levels of cash-flows will find it harder to raise internal funds to finance investment. Nonetheless, a company might have high levels of cash-flows by selling-off its long-term assets or assuming high debt levels (bringing interest payments up). Thus, we define an *internally financially constrained* firm as one with low levels of cash-flows and a low coverage ratio: $lowCF\&CR_{i,t}$. Just as before, we create a dummy variable for companies with low levels of cash-flows and coverage ratio.[25]

Results regarding internal financing constraints (Table 8) show that only *Brexit* uncertainty foreshadows a higher negative drop in investment among those companies with higher levels of financing constraints. The link is particularly strong for Young and Small

[23] A recent empirical study by Hadlock and Pierce (2010) finds that size and age are the best predictors of financing constraints.

[24] The reason we combine these two variables is that size and age may cancel each other. For example, large but young companies might not face financing constraints due to a larger pool of assets available as collateral while small but old companies may have a long track record of activity to inform credit institutions.

[25] Company i is $lowCF_{i,t} = 1$, if its cash-flows level falls within the lowest quartile of the distribution operating in their sector, while company i is $lowCR_{i,t} = 1$, if its coverage ratio falls within the lowest quartile of the distribution of the coverage ratio of all firms operating in her sector.

firms (external financially constrained) exposed to Brexit uncertainty (Panel A).

5.3 Irreversibility of investment

The real-option theory predicts that a rise in uncertainty will have a stronger negative impact on investment for those firms facing a higher degree of irreversibility of investment (Bernanke (1983); McDonald and Siegel (1986), A. Dixit (1989); and Bloom (2000)). When investment is irreversible (capital can only be resold at a lower price than its original purchase price), firms will only invest when demand for their products rise above some upper threshold level. Under uncertainty, this threshold level rises, causing a delay in investment. To proxy irreversibility of investment, we follow Chirinko and Schaller (2009) and use the depreciation to capital ratio. The use of this ratio to proxy irreversibility of investment is motivated by the fact that, in addition to selling capital, firms can reduce their capital stock through depreciation. As noted by Chirinko and Schaller (2009), in companies with low depreciation rates, this recourse is sharply limited.

To be consistent with the approach used to characterise financing constraints, we define now an irreversibility dummy variable $IRR_{i,t} = 1$ for every company whose depreciation to capital ratio falls within the lowest quartile of the distribution of all firms operating in her sector. As predicted by the theory, those firms with a higher degree of investment irreversibility experience higher investment drops when facing political uncertainty compared to those firms with lower degrees of investment irreversibility (Panel A of Table 9). The interactive term between the dummy variable for investment irreversibility and political uncertainty is particularly high for Brexit uncertainty compared to *IndyRef* (-0.042 and 0-0.028 respectively), being both of them statistically significant.

5.4 Isolating the Scottish Referendum for Independence effect

In this section, we study the possible outcome that the Scottish referendum for independence (Sept. 2014) might have had on investment by eliminating the last two years in our sample. In other words, we want to isolate the period of the running up to the Scottish referendum of independence until its instance. It should be recalled that Brexit, on the one hand, has induced policy changes at the Scottish level while, on the other hand, has fuelled the debate for a second Scottish referendum for independence. Just as in the previous subsections, we interact several heterogeneous variables with the *IndyRef* index.

In addition to the heterogeneous variables displayed above, we consider whether or not those Scottish companies operating on the border counties with England are affected differently by this particular referendum uncertainty compared to those established in the rest of Scotland. We believe that those Scottish companies nearer to the border with England have closer relationships with the English economy compared with those further away, and hence may be especially exposed to the political uncertainty derived from the Scottish Referendum for independence. To this end, we classify company i as being on the border if it is registered or its primary trading address falls in either of the three bordering counties with England: *Berwickshire*, *Roxburgh*, or *Dumfries and Galloway*. As expected results show a much stronger and significant negative coefficient across companies operating on the border than for the rest (columns (4) and (7) of Table 10).

Next, we consider whether or not listed companies have reacted more adversely to the Scottish referendum for independence alone. Recall that in subsection 5.1 we found weak evidence (statistically non-significant) of higher negative links between political/policy uncertainty and investment in the case of listed companies. Nonetheless, previous studies have already documented a significant impact of the Scottish independence referendum on Scottish listed companies. This is the case of Darby and Roy (2019), which observed increases in the relative volatility of Scottish companies' stock returns compared to the rest of the UK when polls suggested the referendum result was too close to call. As can be seen in the second and fifth columns of Table 10 (excluding/including time-fixed effects respectively), once we consider the uncertainty of the Scottish referendum of independence alone we find significant evidence that listed companies have cut to a greater extent on fixed tangible investment as a result of *IndyRef* than their counterparts.[26]

[26]Given that these specifications contain firm and time fixed effects, little can be said regarding the average effect of uncertainty on investment. Nonetheless, once both are removed, we observe that the investment rate of listed companies is not significantly different from that of the rest of companies. Taking into account that the average investment rate of listed companies during 2009-15 was 0.34, we could approximate the average effect to be around 29%.

Besides, and in line with previous results, we find that investment from manufacturing companies relate less negative adversely to *IndyRef* than their counterparts once the after Scottish referendum uncertainty is not taken into account (columns (3) and (6) of Table 10). Also in line with the findings of the previous section, our results display a more detrimental link between the Scottish referendum of independence and investment in the case of companies with higher levels of financing constraints (internal and external) and irrereversibility of investment than their counterparts (although only this latter is statistically significant, see Panel B of Table 10).

6 Robustness

6.1 Uncertainty Indices

We consider the implications, if any, of solving the Latent Dirichlet Allocation algorithm (LDA) with a different number of topics. Recall that the log-likelihood approach suggested 20 as the optimal number of topics. However, this measure might lead to over-fitting since we are computing the within sample likelihood. In addition, empirical findings suggest that in some cases, models which perform better on likelihood may infer less semantically meaningful topics (Chang et al. (2009)). Therefore, we want to examine whether it is possible to identify the two referenda topics plus the policy uncertainty in Scotland when using alternative number of topics closer to 20: i.e. $K = 15$, 25, and 30.

Figure 5 shows the word-clouds of political related topics for different values of K. Their sizes represent the probability of the word occurring in the topic, that is, the larger a word is, the most representative it is for a given topic. The first thing we notice when moving further away from the optimal number of topics indicated by the log-likelihood approach ($K = 15$ and $K = 30$) is that there is no longer a separation between Brexit-related uncertainty and that related to the Scottish referendum for independence. For example, when $K = 15$ we find a single topic containing words such as *independend*, *scotland*, *referendum*, *eu*, and *brexit*.[27] Similarly, when $K = 30$ there is no detachment between the two referendum top-

[27] Even though this topic could be labelled as overall referendum uncertainty, it would be detrimental for our purpose since we want to isolate the uncertainty produced by each referendum.

ics: words such as *referendum*, *scotland*, *independence*, *eu*, *brexit* or *membership* assemble a unique topic. For this reason, selecting $K = 15$ or $K = 30$ renders no validity in our analysis.

However, when we set $K = 25$ the two referendum-related uncertainty topics emerge again as two separate topics: one topic clearly characterizes Brexit uncertainty: *brexit*, *european*, *uk*, *negotiation*, *membership*, *leav* and *vote* while a different topic characterizes the *IndyRef* uncertainty: *scotland*, *independ*, *referendum*, *snp*. Worth is noting that when we compare the three uncertainty indices (*IndyRef*, *Brexit* and *Scottish policy uncertainty*) produced when $K = 20$ and $K = 25$, we observe a degree of high correlation among them: 0.97 between the two *IndyRef* indices; 0.95 between the two *Brexit* indices; and 0.69 between the two *Scot.EPU* indices (see Figure 6). For this reason we believe that even though having 25 topics is also reasonable, results connecting uncertainty and investment will remain almost unaltered.

6.2 Econometric Framework

In addition, we test the robustness of the baseline results to several alternative methodological specifications and additional control variables. First, we incorporate additional controls at the firm and macro level to further address concerns of endogeneity. Second, we apply different econometric models to ensure that results are not driven by the particular modelling choices.

The robustness tests are introduced solely to the results that appear in Table 5 because they are likely the most vulnerable ones to endogeneity issues given that we do not include time fixed effects. Recall that including time fixed effects has the added benefit of controlling for any macroeconomic, cross-sectionally invariant forces which may confound the effect of political uncertainty not previously accounted for.

Concerning additional variables, we first consider the incorporation of Economic Policy Uncertainty for the whole UK. After all, any policy implications that shape the Scottish landscape carry consequences to the whole UK. We borrow from Baker, Bloom, and Davis

(2016) their economic policy uncertainty index[28] and include it into the baseline regression (equation (2)). Results in Panel A of Table 11 show that our three uncertainty indices remain negative and significant. Moreover, when the UK's EPU is considered alone (column (6)), its coefficient indicates that a one standard deviation rise in UK's EPU foreshadows a drop in average investment by 6 to 7 per cent in the following year (including or excluding GDP growth rates respectively).

Next, we consider controlling for firm's size trough the number of employees. Duchin, Ozbas, and Sensoy (2010) have stressed the importance of firm's size for accessing external finance during recession times. Also, we have presented evidence of financing constraints affecting investment in the previous section. Therefore, we wish to test whether or not the average effect of political uncertainty presented in Section 4 substantially changes once we control for the firm's size. To this end, we add the natural logarithm of the total number of employees. Results in Panel B of Table 11 show that the uncertainty coefficients are barely unchanged and remain statistically significant. When the coefficients enter alone (columns (1) to (3) in Table 11) a one standard deviation increase in *IndyRef* and Brexit uncertainty foreshadow a drop in average investment of 6% and 11% respectively whereas the baseline findings displayed an 8% and 13.5% reduction in investment respectively.[29]

Regarding the econometric model, we first consider removing firm fixed effects from the baseline regression (equation (2)). The within-group transformation (fixed effects transformation) could induce correlation between the lagged political uncertainty variables and the current error term, something that would render strict exogeneity invalid (i.e., $E(PU_{t-1} \cdot \epsilon_{i,t}) \neq 0$, see Gulen and Ion (2015)). Therefore, estimating our baseline specification without the within-group transformation would not suffer from this problem and would, therefore, yield a consistent estimate for our political/policy uncertainty variables. We do this in Panel A of Table 12 and we find that the estimate for our political uncertainty indices remains almost unchanged. Therefore, we can conclude that controlling for firm fixed effects

[28] http://www.policyuncertainty.com/.

[29] In addition, we have also tried controlling for government expenditure (Scottish government expenditure per capita) and firm-specific uncertainty (the cross-industry standard deviation of the growth rate in profits). Because results remain unchanged when we incorporate these two additional controls and for clarity purposes, the results are not presented. Nonetheless, results are available upon request.

does not significantly alter the coefficient estimate of our political uncertainty indices and that a possible violation of strict exogeneity will have a negligible impact on our main results.

We then consider the model in first differences rather than using firm fixed effects to remove any firm time-invariant omitted variable bias. This approach addresses the concerns that results may be driven by a spurious correlation due to a common trend in the uncertainty and investment variables. The first differences approach deals with these two concerns by taking the first differences of every variable (including the error term):

$$\Delta\frac{I_{i,t}}{K_{i,t-1}} = \beta_1 \Delta PU_t + \beta_2 \Delta\frac{CF_{i,t}}{K_{i,t-1}} + \Delta\beta_4 M_i, t + \Delta\epsilon_{i,t} \tag{5}$$

Nonetheless, one of the downsides of the first differences approach is that it removes a whole year of observations in the sample and two observations per firm when there is a gap in the series of observations. Be it as it may, once again our main result remains virtually unchanged (Table 12, Panel B).

Next, we examine the investment regression in a dynamic panel format by incorporating the lag dependent variable as a control (see for example Bloom, Bond, and Van Reenen (2007)):

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \rho\frac{I_{i,t-1}}{K_{i,t-2}} + \beta_1 logPU_t + \beta_2\frac{CF_{i,t}}{K_{i,t-1}} + \beta_3 SG_{i,t} + \beta_4 M_t + \epsilon_{i,t} \tag{6}$$

Because the within-group and first-difference transformation needed to eliminate the firm fixed effects mechanically correlates the lagged investment variable with the error term, we estimate this specification using the system GMM methodology (Blundell and Bond (1998)). Following the approach of Gulen and Ion (2015), we use $\frac{I_{i,t-2}}{K_{i,t-3}}$ and $\frac{I_{i,t-3}}{K_{i,t-4}}$ as instruments for $\Delta\frac{I_{i,t-1}}{K_{i,t-2}}$ in the difference equation, and $\Delta\frac{I_{i,t-2}}{K_{i,t-3}}$ as an instrument for $\frac{I_{i,t-1}}{K_{i,t-2}}$ in the level equation. This set up rejects AR(1) errors while not AR(2) errors. As can be seen, the coefficients for the uncertainty indices remain negative but only Brexit uncertainty retains statistical significance (Table 12, Panel C). Nonetheless, the inclusion of these instruments reduces the sample data considerably by removing four years of observations, and this could induce sample bias. This fact, together with the impossibility to cluster standard errors by firms or year makes the static specification our preferred approach.

7 Conclusion

In this study, we analyse the effect of three distinctive uncertainty narratives embedded in the Scottish press, namely *IndyRef*, *Brexit uncertainty*, and *Scottish policy uncertainty* on private investment of Scottish firms. To frame these distinctive sources of uncertainty, we use an unsupervised machine learning algorithm able to classify news articles with a range of themes without prior knowledge regarding their content. On analysing these narratives trough time, we observe that they co-move strongly with the Google search queries "Scottish Independence" and "Brexit". For example, *IndyRef* and the Google query "Scottish Independence" display prominent spikes when the chancellor of the Exchequer George Osborne argued that a 'Yes' vote meant Scotland giving up the pound (Feb 2014) and during the Scottish referendum for independence (September 2014). Besides, the Google query "Brexit" and *Brexit uncertainty* both ramp-up during the month of the Brexit referendum and maintain high levels in the aftermath.

We then examine the relationship between the indices just described and firm investment by applying a standard investment regression to a longitudinal panel dataset formed of 3,589 Scottish firms. Our baseline results suggest that a one standard-deviation increase in Brexit uncertainty foreshadows a reduction in investment by 8% on average in the following year. Besides we find that the uncertainty associated with the Scottish referendum for independence while negligible for the overall firm network, had a negative and significant outcome on the investment of listed and border companies (those operating on the border with England). These results are robust to controlling for alternative measures of investment opportunities and macroeconomic uncertainty as well as to several identifying econometric frameworks.

Nonetheless, given the relative low amount of years in our sample, a certain caution is warranted regarding these results. Given the relatively low number of years in our sample, we could only place a limited amount of aggregate variables aiming to capture time-dependent factors that could confound the effect of political uncertainty. To somewhat reduce these concerns, in further analysis we incorporate time-fixed effects in our regression by having our uncertainty measures interact with firm characteristics known to be more sensitive to uncertainty. This should reassure us that any negative effect observed in investment indeed comes from political uncertainty.

To this end, we examine the hypothesis of whether manufacturing, unlisted, more financially constrained and those with higher irreversible investment rates companies cut down on investment more severely than the rest of companies as a result of an increase in uncertainty. In line with the literature, we find evidence that those firms that are more likely to be financially constrained display higher drops in investment in the presence of uncertainty. This holds principally for firms with either internal or external financing constraints and Brexit uncertainty. Also consistent with priors, we find a stronger negative relationship between firms whose investment is more likely irreversible and political uncertainty.

In addition, we distinguish between non-manufacturing and manufacturing firms. The *Decision Maker Panel* survey reported that firms in the manufacturing sector are the most likely to move part of their operations outside the UK due to the uncertainty produced by Brexit (Bloom, Bunn, et al. (2017)). Nonetheless, more recent evidence suggests that business confidence from the manufacturing sector has actually increased after Brexit (see Born et al. (2019)). We find evidence supporting this latter behaviour: investment from Scottish manufacturing companies appear less sensitive to political uncertainty.

The resulting policy implications may be important, in particular to the current economic climate. Referenda are becoming a popular tool for politicians, yet their consequences as a source of uncertainty often escape the political debate. In this paper, we show not only that referenda are a significant source of political and policy uncertainty but also that they affect private investment in a negative way independently of their outcome.

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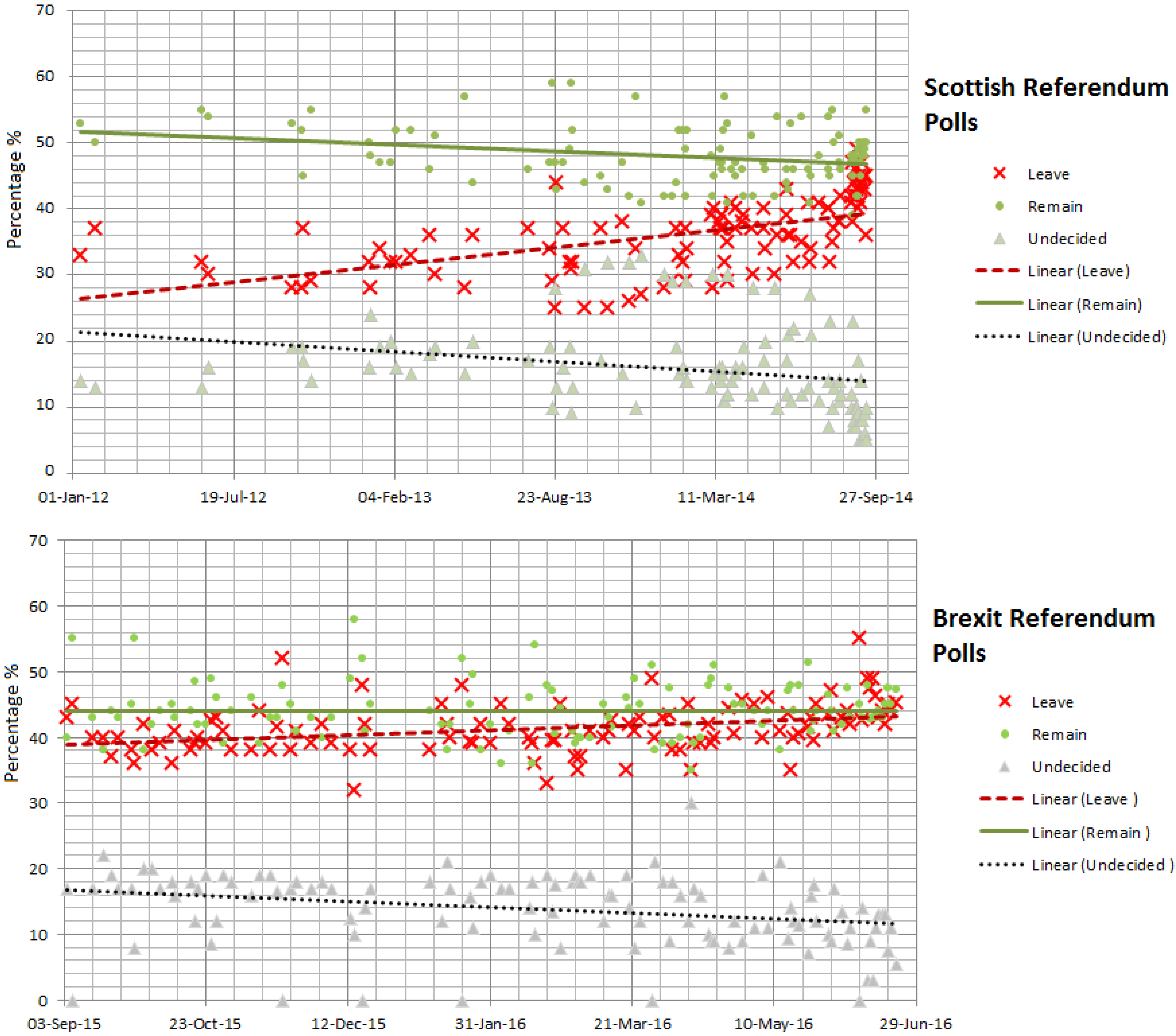
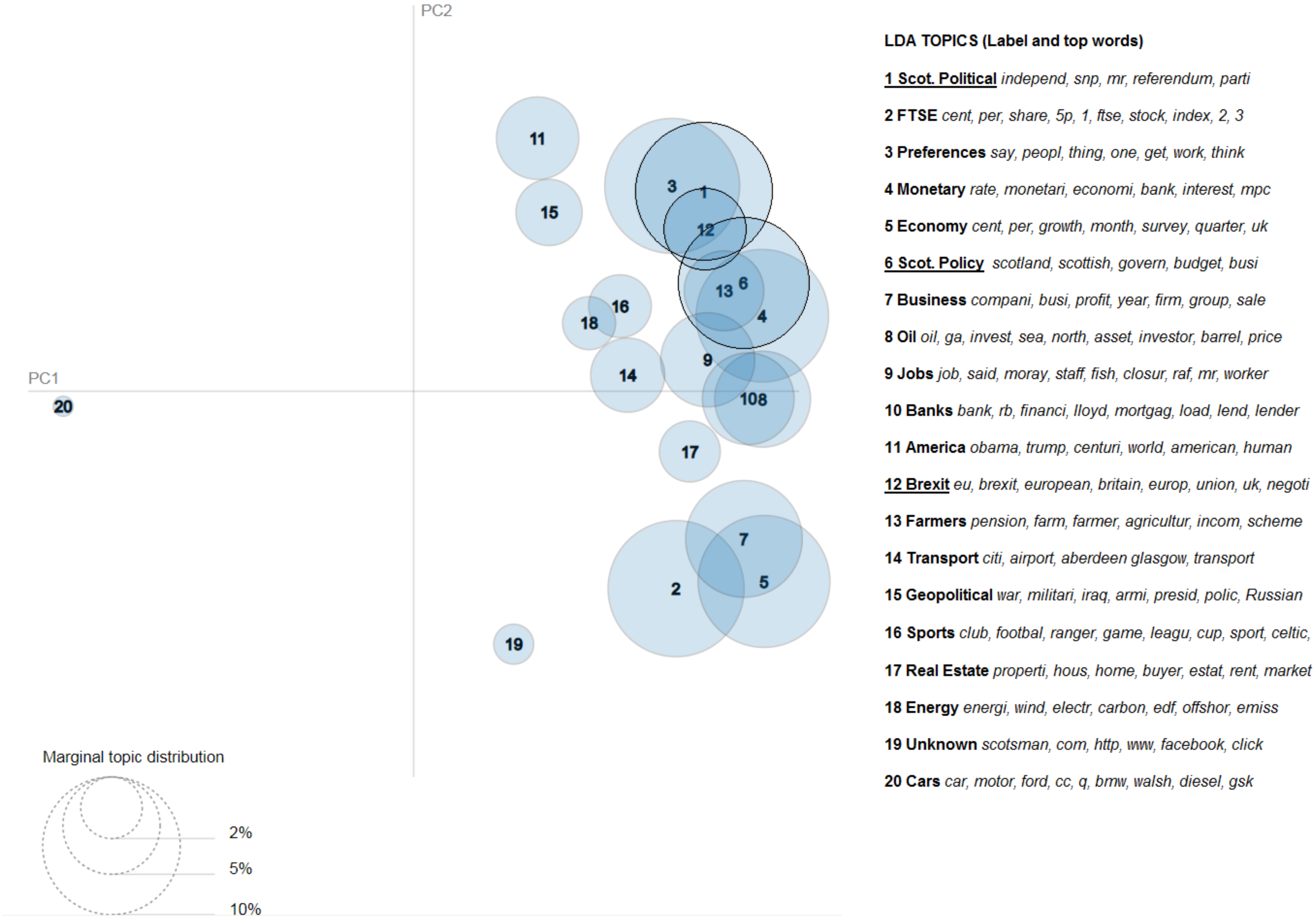
Figure 1: Scottish and Brexit Referenda Polls



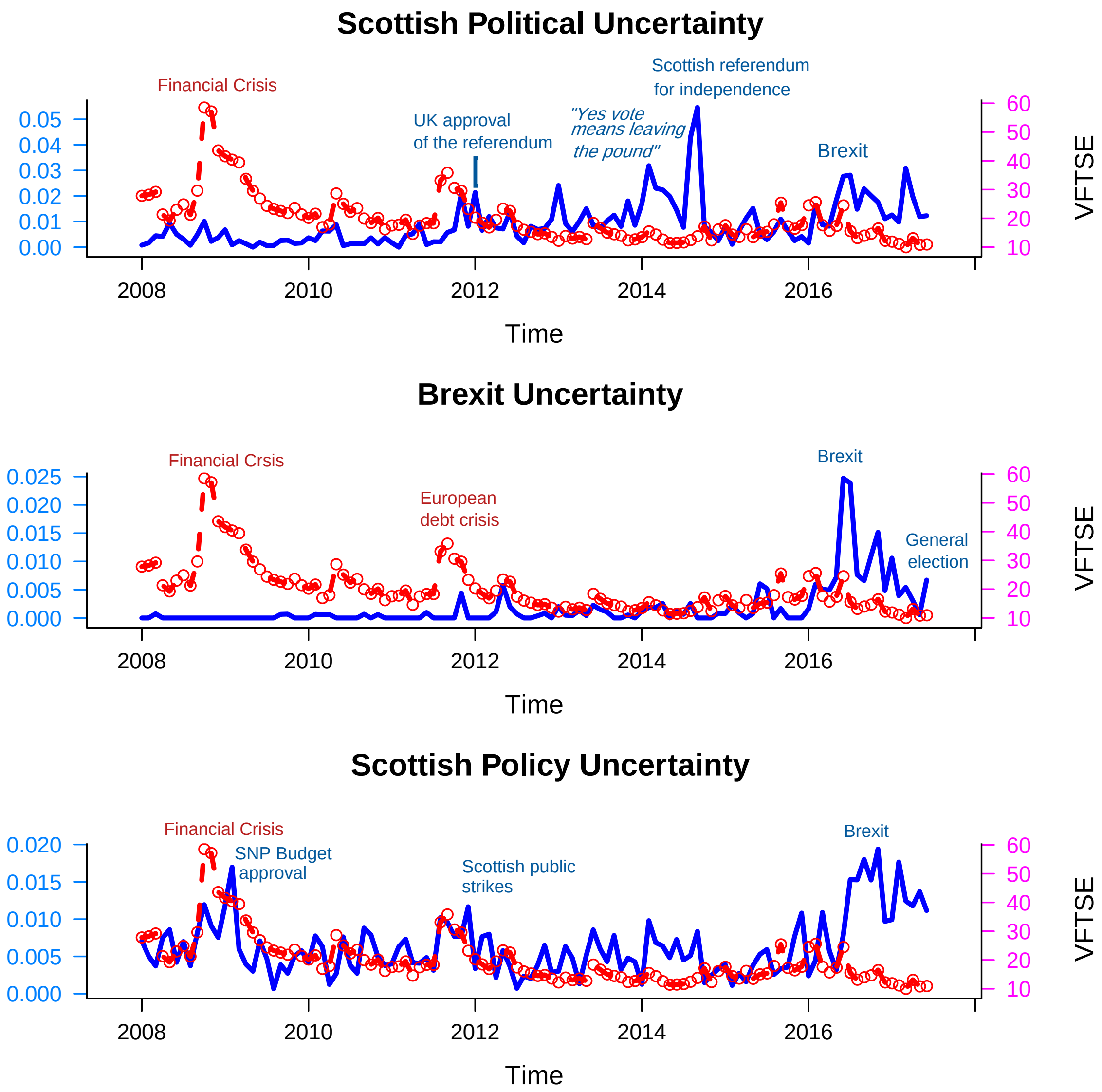
Notes: Scottish Referendum polls information is obtained from *YouGov*, *Survation*, *Panelbase*, *Ipsos*, *BMG* and *TNS*. Brexit Referendum polls information is obtained from the Financial Times (see https://ig.ft.com/sites/brexit-polling/)

Figure 2: Global view of the LDA topics



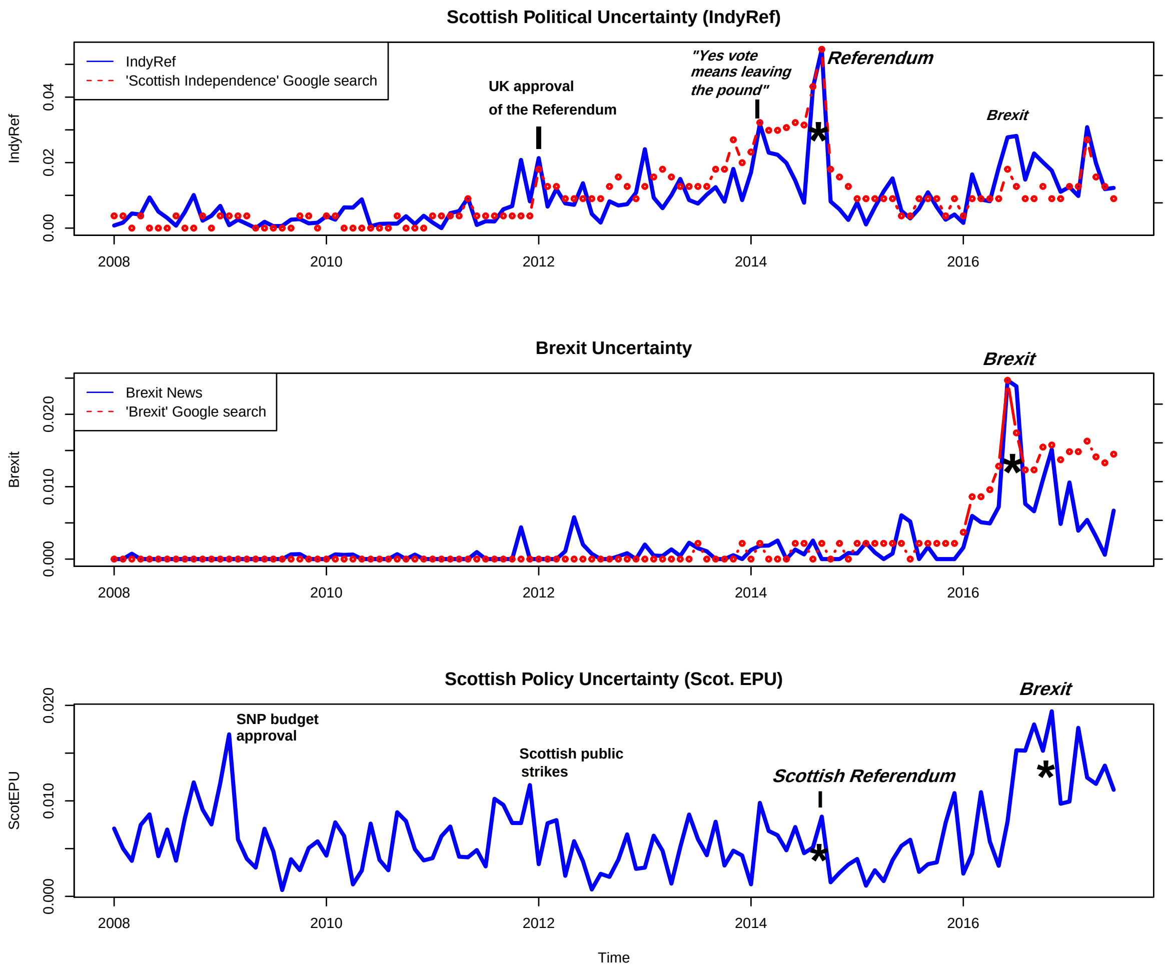
Notes: This Figure shows how large and semantically close/different economic uncertainty topics produced by the LDA are. The figure was produced using the library LDAvis developed by Sievert and Shirley (2014). The three topics of interest are in bold (*IndyRef*, Brexit uncertainty and Scottish policy uncertainty). To see the 30 main words of each topic please see Table 2.

Figure 3: Evolution of Uncertainty indices in Scotland (continuous line, left legend) and the implied volatility index, VFTSE (dotted line, right legend)



Notes: *IndyRef*, Brexit Uncertainty and Scottish Policy Uncertainty indices are built by computing the monthly ratio between news articles describing these uncertainty topics and the total number of news articles. The newspapers used are *The Aberdeen Press & Journal*, *The Glasgow Herald* and *The Scotsman*. Time period from Jan 2008 to June 2017. The implied volatility index, VFTSE, in levels is extracted from *Bloomberg*.

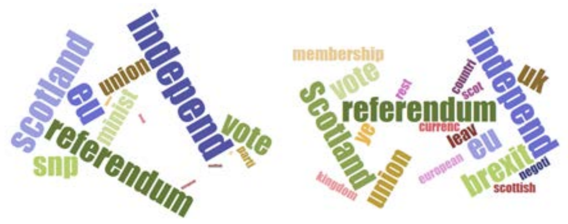
Figure 4: Evolution of Uncertainty indices in Scotland (continuous line, left legend) and the Google searches of *Scottish Independence* and *Brexit* (right legend)



Notes: *IndyRef*, Brexit Uncertainty and Scottish Policy Uncertainty indices are built by computing the monthly ratio between news articles describing these topics and the total number of news articles. The newspapers used are *The Aberdeen Press & Journal*, *The Glasgow Herald* and *The Scotsman*. Google searches of the terms *"Scottish Independence"* and *"Brexit"* only looked in the region of Scotland and their series are presented in natural logs. * indicates when the referendums took place.

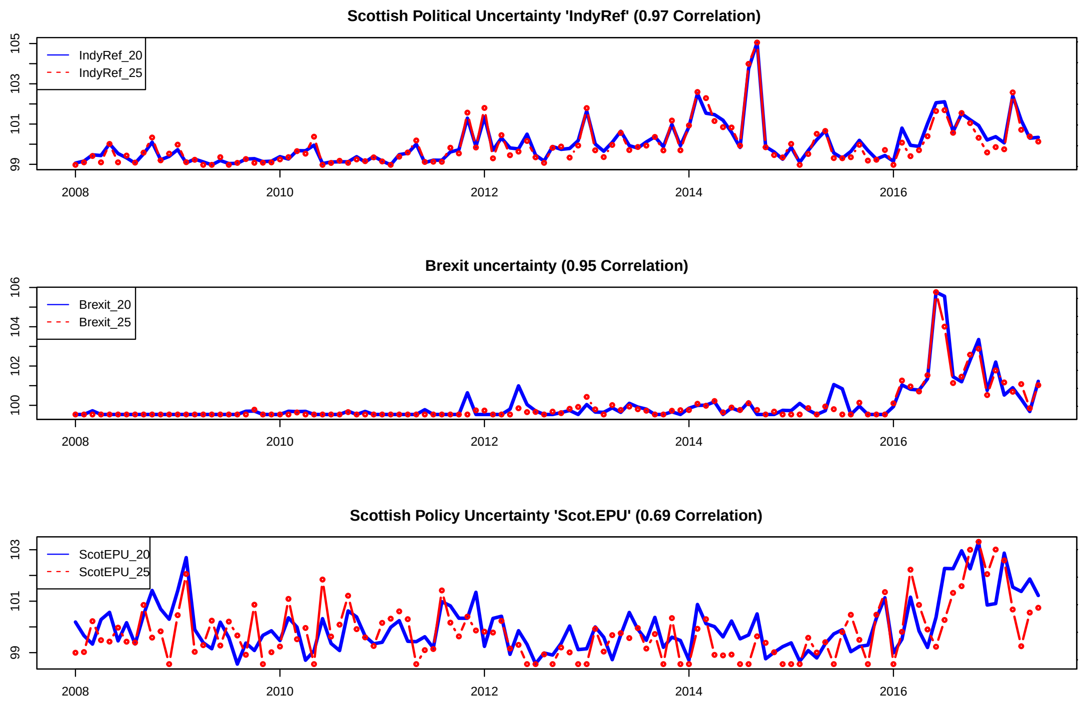
Figure 5: Word clouds of political topics for different values of K. For each word cloud the size of a word reflects the probability of this word occurring in the topic

(a) *IndyRef* $K = 20$ (b) *IndyRef* $K = 25$ (c) *Brexit* $K = 20$ (d) *Brexit* $K = 25$



(e) *Political* $K = 15$ (f) *Political* $K = 30$

Figure 6: Evolution of the uncertainty measures computed using 20 and 25 topics



Notes: All series are standardize to mean 100 and 1 standard deviation.

Table 1: Number of topics and log-likelihood scores

	10	20	30	40	50	60
log P(w | K)	-24502056	-24465226	-24477848	-24485771	-24581108	-24609611

Definitions of the variables used:

Investment: It is constructed as the difference between the book value of tangible fixed assets (which include land and building; fixtures and fittings; plant and vehicles; and other fixed assets) of end of year t and end of year t-1 while adding depreciation of year t.

Capital stock: tangible fixed assets.

Cash-flows: It is defined as the sum of after tax profit and depreciation.

Coverage ratio: It is defined as the ratio between the firm's total profits before tax and before interest (also referred as Operating Profit or EBIT) and its total interest payments.

Total assets: It is defined as the sum of fixed assets and current assets.

Table 2: Topics unveiled by the LDA

Label	%	Top words
Scot. Political	9.9	independ, snp, mr, referendum, parti, vote, labour, minist, scotland, elect, campaign, would, sturgeon, tori, ye, salmond, polit, scottish, voter, poll, westminister, govern, conserv, leader, parliament, cameron
FTSE	9.8	cent, per, share, 5p, 1, ftse, stock, index, 2, 3, fell, 4, 2017, 5, 6, rose, close, analyst, 100, 7, 8, gbp, 9, 0 market, gain, group, biggest, trade, us
Preferences	9.6	say, peopl, thing, one, get, work, think, time, go, feel, like, way, know, realli, someth, lot, make, seem, much, look, art, mani, want, want, always, idea, old, good, even, differ, women
Monetary Policy	9.3	rate, monetari, economi, bank, interest, mpc, inflat, market, polici, cut, recess, econom, us, central, governor, euro, commite, risk, global, england, crisi, dollar, recoveri, would, king, fed, low, carney
Economy	9.2	cent, per, growth, month, survey, quarter, uk, rise, figur, year, manufactur, sector, show, 0, increas, retail, consum, 2, forecast, said, economi, 1, output, rate, economist, report, sale, latest, spend, fall
Scottish Policy	9	scotland, scottish, govern, budget, busi, univers, public, educ, need, fund, council, report, tax, local, commun, support, work, enterpris, plan, organis, sevic, challeng, sector, develop, research, student, econom
Business	7.2	compani, busi, profit, year, firm, group, sale, oper, acquisit, 2016, brand, turnov, execut, million, said, market, pre, revenu, whiski, custom, scotch, half, chief, trade, manag, deal, continu, murgitroyd, base
Oil	4.8	oil, ga, invest, sea, north, asset, investor, barrel, price, equiti, fund, trust, bp, field, compani, industri, shell, explor, aberdeen, portfolio, product, bond, manag, yield, drill, opec, crude, wood, return, petroleum
Jobs	4.7	job, said, moray, staff, fish, closur, raf, mr, worker, highland, trourism, employ, redund, plant, visitor, base, workforc, industri, 000, app, announc, futur, visitscotland, paterhead, fisheri, island, defenc, factori, buchan
Banks	4.4	bank, rb, financi, lloyd, mortgag, load, lend, lender, debt, credit, hbo, insur, clydesdal, tsb, custom, hsbc, barclay, taxpay, repay, billion, borrow, sharehold, royal, save, money, fund, gdp, deposit, branch, pay
America	3.6	obama, trump, centuri, world, american, human, bush, church, america, clinton, man, histori, donald, death, burn, republican, presid, barack, sdg, white, father, detent, polit, woman, supper, live, africa, nation, god
Brexit	3.5	eu, brexit, european, britain, europ, union, uk, negoti, leav, countri, membership, singl, trade, brussel, immigr, agreement, vote, greec, member, deal, want, referendum, free, hammond, exit, relationship
Farmers	3.3	pension, farm, farmer, agricultur, incom, scheme, ubi, payment, rural, pay, retir, nfu, crop, annuiti, milk, cap, beef, legisl, employe, dairi, sheep, food, fee, 2019, meat, benefit, tonn, wheat, employ, lamb
Transport	2.9	citi, airport, aberdeen glasgow, transport, passeng, rail, council, airlin, road, project, centr, rout, councillor, traffic, bu, ferri, site, local, inver, plan, skinner, baa, heathrow, develop, travel, edinburgh, east, firstgroup
Geopolitical	2.3	war, militari, iraq, armi, presid, polic, russian, russia, hester, attack, hamon, ministri, un, prision, iran, weapon, islam, afghanistan, troop, protest, marshal, holland, socialist, ukrain, egypt, bomb, sanction, arab

Other Topics		
Sports	2.1	club, footbal, ranger, game, leagu, cup, sport, celtic, player, hotel, season, murray, team, golf, spl, fan
Real Estate	2	properti, hous, home, buyer, estat, rent, market, tenant, offic, housbuilding, land, build, edinburgh
Energy	1.5	energi, wind, electr, carbon, edf, offshor, emiss, nuclear, turbin, coal, power, googl, onshor, rivaz, water
Unknown	0.8	scotsman, com, http, www, facebook, click, scotsmanbusi, read, mail, link, page, parcel, lossiemouth, kinloss
Cars	0.2	car, motor, ford, cc, q, bmw, walsh, diesel, gsk, poundland, glaxo, atlanti, mudoch, handbag, uber, barnard

Notes: This table displays the most representative words per topic unveiled by the *Latent Dirichlet Allocation* algorithm (3rd column), the proportion of the given topic with respect to all topics (2nd column), and the label given to each topic (1st column)

Table 3: Descriptive statistics firm level data

	FAME universe	Sample used	Manufacturing	Listed	YS	lowCF&CR	IRR	Border
$I_{i,t}/K_{i,t-1}$	0.36	0.34	0.27	0.32	0.46	0.25	0.20	0.24
	(0.98)	(0.85)	(0.65)	(0.68)	(1.07)	(0.69)	(0.67)	(0.46)
$CF_{i,t}/K_{i,t-1}$	2.52	2.36	1.17	1.86	3.06	-0.6	0.37	0.87
	(10.41)	(9.26)	(5.39)	(8.93)	(10.98)	(2.36)	(2.17)	(3.23)
$SG_{i,t}$	0.075	0.07	0.069	0.07	0.12	0.012	0.068	0.08
	(0.301)	(0.27)	(0.267)	(0.27)	(0.36)	(0.29)	(0.26)	(0.24)
n	4,238	3,589	800	43				65
N	24,006	22,769	5,480	337	1,652	2,280	5,525	405

Notes: This table reports sample means and standard deviations (in parenthesis) for the variables of interest and different subgroups. The subscript i indexes firm, and the script t represents time, where $t = 2009...2017$. $I_{i,t}/K_{i,t-1}$ represents investment rate, where $I_{i,t}$ is investment in fixed assets and $K_{i,t-1}$ the capital stock at $t-1$; $CF_{i,t}/K_{i,t-1}$ indexes cash-flows over the capital stock and $SG_{i,t}$ represents sales growth. FAME universe include Scottish companies operating in all sectors, whereas Sample used omits the regulated and financial sectors and include only companies with at least three years of observations. Manufacturing and listed companies are those operating in the manufacturing sector and which are traded in a listed stock exchange respectively. YS stands for young and small companies (companies whose age and size falls within the lowest quartile of the distribution of the ages and sizes of all firms operating in their sector). Similarly, lowCF&CR stand for low cash-flows and Coverage ratio (companies whose cash-flows and Coverage Ratio fall within the lowest quartile of the distribution of all firms operating in their sector). IRR stands for high irreversibility of investment while Border stands for those companies operating on the three Scottish counties bordering England.

Table 4: Descriptive statistics uncertainty indices

	IndyRef	Brexit	Scot. EPU	VFTSE	EPU UK	GDP Growth
IndyRef	1					
Brexit	0.43	1				
Scot. EPU	0.27	0.44	1			
VFTSE	-0.34	-0.17	0.11	1		
EPU UK	0.35	0.85	0.49	0.06	1	
GDP Growth	0.21	-0.01	-0.12	-0.43	-012	1

Correlation matrix between the three measures of uncertainty: *IndyRef*, Brexit uncertainty and Scottish policy uncertainty and other macro/uncertainty measures: the implied volatility index (VFTSE), UK's economic policy uncertainty index, Scottish GDP growth rates. All variables are in monthly frequency except GDP growth rates (quarterly frequency) from Jan 2008 until June of 2017. Variables are obtained from Scottish government statistics, Bloomberg, Economic Policy Uncertainty and own calculations.

Table 5: Baseline regression Results

	Panel A						Panel B					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
$IndyRef_{t-1}$	−0.028**			−0.001		0.014	−0.077***			−0.045***		0.014
	(0.011)			(0.007)		(0.009)	(0.013)			(0.014)		(0.009)
Brexit_{t-1}		−0.046***			−0.027***	−0.040***		−0.045***			−0.031***	−0.040***
		(0.007)			(0.010)	(0.013)		(0.008)			(0.010)	(0.013)
Scot. EPU_{t-1}			−0.031***	−0.029***	−0.015	−0.009			−0.034***	−0.015*	−0.011	−0.009
			(0.007)	(0.007)	(0.009)	(0.010)			(0.007)	(0.008)	(0.010)	(0.010)
$CF_{it}/K_{i,t-1}$	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SG_{it}	0.202***	0.205***	0.205***	0.205***	0.204***	0.206***	0.202***	0.205***	0.207***	0.205***	0.206***	0.206***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
$VFTSE_{t-1}$	−0.029***	−0.018***	0.002				−0.024**	−0.017*	0.019**			
	(0.010)	(0.007)	(0.006)				(0.010)	(0.010)	(0.009)			
Local Elections	−0.044***	−0.020	−0.028**	−0.028**	−0.025**	−0.012	−0.104***	−0.021	−0.037***	−0.078***	−0.003**	−0.012
	(0.016)	(0.012)	(0.012)	(0.014)	(0.012)	(0.015)	(0.019)	(0.013)	(0.013)	(0.020)	(0.012)	(0.015)
ΔGDP_{t-1}							3.675***	0.075	1.422**	3.022***	0.770*	
							(0.731)	(0.648)	(0.608)	(0.906)	(0.446)	
R^2	0.045	0.046	0.045	0.045	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
N	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769
Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustered id	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the stock of fixed assets at the beginning of period) on the three types of uncertainty at time $t-1$ (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty). Additional controls are cash-flows scaled by the stock of fixed assets at the beginning of period ($CF_{i,t}/K_{i,t-1}$), sales growth rate ($SG_{i,t}$), the Scottish GDP growth rate (ΔGDP_t), the implied volatility index ($VFTSE$), and local election dummy to control for elections uncertainty. All regressions include firm fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6: Baseline regression Results and referendum dummies

	Panel A					Panel B				
	Scottish Uncertainty			Brexit Uncertainty		Scottish Uncertainty			Brexit Uncertainty	
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
$\text{SCOT}_{referendum}$	0.012	0.027				−0.006	−0.017			
	(0.019)	(0.019)				(0.022)	(0.022)			
$IndyRef_{t-1}$		−0.033***					−0.078***			
		(0.012)					(0.014)			
$IndyRef_{t-1}$*SCOT_{2014}			−0.012					−0.052**		
			(0.012)					(0.022)		
$\text{BREXIT}_{referendum}$			−0.138***	−0.130***	0.114			−0.132***	−0.127***	0.113
			(0.023)	(0.022)	(0.108)			(0.023)	(0.023)	(0.108)
Brexit_{t-1}					−0.081**					−0.081**
					(0.035)					(0.035)
$CF_{it}/K_{i,t-1}$	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SG_{it}	0.207***	0.203***	0.205***	0.207***	0.203***	0.208***	0.202***	0.203***	0.207***	0.203***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
$VFTSE_{t-1}$	−0.005	−0.028***	−0.020*	−0.012*	−0.023***	0.004	−0.024**	−0.020**	−0.009	−0.022**
	(0.007)	(0.010)	(0.011)	(0.006)	(0.008)	(0.009)	(0.010)	(0.011)	(0.009)	(0.011)
Local Elections	−0.019	−0.044***	−0.034**	−0.027**	−0.014	−0.028**	−0.110***	−0.072***	−0.029**	−0.014
	(0.013)	(0.016)	(0.015)	(0.012)	(0.014)	(0.014)	(0.021)	(0.022)	(0.013)	(0.014)
ΔGDP_{t-1}						1.124	4.028***	2.522**	0.248	0.033
						(0.723)	(0.866)	(1.158)	(0.641)	(0.650)
R^2	0.045	0.046	0.046	0.046	0.046	0.045	0.046	0.046	0.046	0.046
N	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769	22,769
Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustered id	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the stock of fixed assets at the beginning of period) on the three types of uncertainty at time $t-1$ (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty); Scottish referendum time dummy at $t-1$, Scottish referendum legislation period at $t-1$ and Brexit dummy at $t-1$. In addition, we include a lagged year-dummy variable for the Scottish and Brexit referendums ($\text{SCOT}_{referendum}$ and $\text{BREXIT}_{referendum}$ respectively), and a time dummy variable removing the post scottish referendum for independence period SCOT_{2014} (see Section 4). For information on additional controls see Table 5. All regressions include firm fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7: The Heterogeneous effect of policy uncertainty on investment

	Dependent variable: Investment rate ($I_{it}/K_{i,t-1}$)		
Panel A: Manufacturing versus non-manufacturing companies			
	IndyRef$_{t-1}$	Brexit$_{t-1}$	Scot. Policy$_{t-1}$
	(1)	(2)	(3)
Uncertainty*Manufacturing	0.028**	0.014	0.026*
	(0.012)	(0.013)	(0.014)
R^2	0.044	0.044	0.044
Panel B: Listed versus non-listed companies			
Uncertainty*Listed	−0.068	−0.004	−0.019
	(0.043)	(0.025)	(0.026)
R^2	0.044	0.044	0.044
N	22,769	22,769	22,769
Firm Fixed Effects	yes	yes	yes
Time Fixed Effects	yes	yes	yes
Clustered id	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the capital stock at the beginning of period) on the three types of uncertainty (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty) interacted with dummy variable for manufacturing and listed firms (panel A and B respectively). Additional controls are cash-flows scaled by the capital stock at the beginning of the period ($CF_{i,t}/K_{i,t-1}$) and sales growth rate ($SG_{i,t}$). All regressions include firm and time fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 8: Financial Constraints

	Dependent variable: Investment rate ($I_{it}/K_{i,t-1}$)		
Panel A: Young and Small firms (externally constrained)			
	IndyRef$_{t-1}$	Brexit$_{t-1}$	Scot. Policy$_{t-1}$
	(1)	(2)	(3)
YS	-0.105^{*}	-0.128^{**}	-0.109^{*}
	(0.062)	(0.061)	(0.063)
Uncertainty*YS	0.004	-0.080^{***}	-0.011
	(0.028)	(0.028)	(0.028)
R^2	0.043	0.043	0.043
N	22,290	22,290	22,290
R^2	0.043	0.043	0.043
Panel B: Low cash-flows and coverage ratio firms (internally constrained)			
lowCF&CR	0.084^{***}	0.077^{***}	0.080^{***}
	(0.022)	(0.021)	(0.021)
Uncertainty*lowCF&CR	-0.0002	-0.032^{*}	-0.021
	(0.018)	(0.019)	(0.018)
R^2	0.046	0.046	0.046
N	14,774	14,774	14,774
Firm Fixed Effects	yes	yes	yes
Time Fixed Effects	yes	yes	yes
Clustered id	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the capital stock at the beginning of period) on the three types of uncertainty (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty) interacted with dummy variables for Young and small firms and those with low levels of cash-flows and coverage ratio (panel A and B respectively). Additional controls are cash-flows scaled by the capital stock at the beginning of the period ($CF_{i,t}/K_{i,t-1}$) and sales growth rate ($SG_{i,t}$). All regressions include firm and time fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 9: Irreversibility of investment

	Dependent variable: Investment rate $(I_{it}/K_{i,t-1})$		
	IndyRef_{t-1}	Brexit_{t-1}	$\text{Scot. Policy}_{t-1}$
	(1)	(2)	(3)
IRR	0.490***	0.484***	0.490***
	(0.048)	(0.047)	(0.048)
Uncertainty*IRR	−0.028**	−0.042***	−0.008
	(0.014)	(0.015)	(0.016)
R^2	0.078	0.078	0.077
N	21,843	21,843	21,843
Firm Fixed Effects	yes	yes	yes
Time Fixed Effects	yes	yes	yes
Clustered id	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the capital stock at the beginning of period) on the three types of uncertainty (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty) interacted with a dummy variable for irreversibility of investment. Additional controls are cash-flows scaled by the capital stock at the beginning of the period ($CF_{i,t}/K_{i,t-1}$) and sales growth rate ($SG_{i,t}$). All regressions include firm and time fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 10: Scottish referendum for independence uncertainty and investment (excluding years 2015-16)

	Dependent variable:						
	Investment Growth rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$IndyRef_{t-1}$	−0.003	−0.002	−0.011	−0.001			
	(0.014)	(0.014)	(0.015)	(0.014)			
$IndyRef_{t-1}$*Listed		−0.097*			−0.098*		
		(0.055)			(0.055)		
$IndyRef_{t-1}$*Manufact.			0.035**			0.035**	
			(0.014)			(0.014)	
$IndyRef_{t-1}$*Border				−0.089*			−0.089*
				(0.051)			(0.051)
$CF_{it}/K_{i,t-1}$	0.025***	0.025***	0.025***	0.025***	0.025***	0.025***	0.025***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SG_{it}	0.201***	0.201***	0.204***	0.201***	0.201***	0.204***	0.201***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
$VFTSE_{t-1}$	−0.012	−0.012	−0.011	−0.012			
	(0.011)	(0.011)	(0.011)	(0.011)			
Local Elections	−0.005	−0.005	−0.005	−0.005			
	(0.022)	(0.022)	(0.022)	(0.022)			
R^2	0.041	0.042	0.042	0.042	0.041	0.041	0.041
N	18,906	18,906	18,906	18,906	18,906	18,906	18,906
Firm Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effects	no	no	no	no	yes	yes	yes
Clustered id	yes	yes	yes	yes	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the capital stock at the beginning of period) on the Scottish referendum uncertainty ($IndyRef_{t-1}$). By considering the period from 2009 until 2015 we isolate the uncertainty developed by the Scottish Referendum for independence alone. In addition, we interact $IndyRef_{t-1}$ with a dummy variable for listed and Manufacturing companies as well as those companies operating on the border with England. For information on additional controls see Table 5. All regressions include firm fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Continuation of Table 10

	Dependent variable:		
	Investment Growth rate		
	(1)	(2)	(3)
Financing Constraints and Investment Irreversibility			
$IndyRef_{t-1}$*YS	−0.013		
	(0.026)		
$IndyRef_{t-1}$*lowCF&CR		−0.0131	
		(0.015)	
$IndyRef_{t-1}$*IRR			-0.021^{*}
			(0.013)
R^2	0.036	0.038	0.057
N	11,911	17,944	17,972
Firm Fixed Effects	yes	yes	yes
Time Fixed Effects	yes	yes	yes
Clustered id	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the capital stock at the beginning of period) on *IndyRef* interacted with dummy variables for *external financial constraints* (Young and small firms, YS); *internal financial constraints* (those with low levels of cash-flows and coverage ratio, lowCF&CR); and high investment irreversibility (IRR). Additional controls are cash-flows scaled by the capital stock at the beginning of the period ($CF_{i,t}/K_{i,t-1}$) and sales growth rate ($SG_{i,t}$). All regressions include firm and time fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. Sample from 2009-2015.

Table 11: Baseline regression robustness: additional control

	Dependent variable: Investment rate ($I_{it}/K_{i,t-1}$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Adding UK's Economic Policy Uncertainty index						
$IndyRef_{t-1}$	-0.067^{***}			-0.055^{***}		
	(0.018)			(0.020)		
$Brexit_{t-1}$		-0.050^{***}			-0.042^{***}	
		(0.012)			(0.016)	
$Scot.EPU_{t-1}$			-0.025^{***}	-0.016^{*}	-0.009	
			(0.007)	(0.008)	(0.010)	
$UK.EPU_{t-1}$	0.007	0.013	-0.008	0.008	0.011	-0.021^{**}
	(0.010)	(0.011)	(0.008)	(0.010)	(0.011)	(0.008)
R^2	0.046	0.046	0.046	0.046	0.046	0.045
N	22,769	22,769	22,769	22,769	22,769	22,769
Panel B: Adding log(No. of employees)						
$IndyRef_{t-1}$	-0.062^{***}			-0.029^{**}		
	(0.012)			(0.012)		
$Brexit_{t-1}$		-0.036^{***}			-0.018^{**}	
		(0.007)			(0.009)	
$Scot.EPU_{t-1}$			-0.027^{***}	-0.017^{**}	-0.014^{*}	
			(0.006)	(0.007)	(0.008)	
$log(\text{No Employees}_{i,t})$	-0.005	-0.007	-0.009	-0.006	-0.007	
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	
R^2	0.040	0.040	0.039	0.039	0.039	
N	19,747	19,747	19,747	19,747	19,747	
Controls	yes	yes	yes	yes	yes	yes
Fixed Effects	yes	yes	yes	yes	yes	yes
Clustered id	yes	yes	yes	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the stock of fixed assets at the beginning of period) on the three types of uncertainty at time $t-1$ (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty). For information on additional controls see Table 5. Panel A introduces Baker, Bloom, and Davis (2016) UK Economic Policy uncertainty index to the baseline regression. Panel B includes firm size in the form of the natural log of the total number of employees. All regressions include firm fixed effects, and standard errors are clustered at the firm level. Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Continuation of Table 11 (without GDP growth rates)

	Dependent variable: Investment rate ($I_{it}/K_{i,t-1}$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Adding UK's Economic Policy Uncertainty index						
$IndyRef_{t-1}$	-0.027^{**}			0.002		
	(0.011)			(0.008)		
$Brexit_{t-1}$		-0.051^{***}			-0.037^{**}	
		(0.012)			(0.015)	
$Scot.EPU_{t-1}$			-0.025^{***}	-0.027^{***}	-0.013	
			(0.009)	(0.007)	(0.010)	
$UK.EPU_{t-1}$	-0.022^{***}	0.007	-0.009	-0.008	0.010	-0.023^{***}
	(0.008)	(0.012)	(0.010)	(0.008)	(0.011)	(0.007)
R^2	0.046	0.046	0.046	0.046	0.046	0.045
N	22,769	22,769	22,769	22,769	22,769	22,769
Panel D: Adding log(No. of employees)						
$IndyRef_{t-1}$	-0.021^{**}			0.008		
	(0.009)			(0.005)		
$Brexit_{t-1}$		-0.038^{***}			-0.014	
		(0.007)			(0.009)	
$Scot.EPU_{t-1}$			-0.025^{***}	-0.028^{***}	-0.020^{***}	
			(0.006)	(0.006)	(0.007)	
$log(\text{No Employees}_{i,t})$	-0.009	-0.007	-0.008	-0.009	-0.001	
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	
R^2	0.038	0.040	0.039	0.039	0.039	
N	19,747	19,747	19,747	19,747	19,747	
Controls	yes	yes	yes	yes	yes	yes
Fixed Effects	yes	yes	yes	yes	yes	yes
Clustered id	yes	yes	yes	yes	yes	yes

Notes: Panels C and D presents the same specification as those in Panel A and B (respectively) but excluding GDP growth rates from the regression controls.

Table 12: Baseline regression econometric model robustness

	Dependent variable: Investment rate $(I_{it}/K_{i,t-1})$				
	(1)	(2)	(3)	(4)	(5)
Panel A: Without Fixed-Effects					
$IndyRef_{t-1}$	-0.083^{***}			-0.035	
	(0.029)			(0.043)	
$Brexit_{t-1}$		-0.035^{**}			-0.011
		(0.014)			(0.024)
$Scot.EPU_{t-1}$			-0.021^{**}	-0.017	-0.019
			(0.010)	(0.012)	(0.013)
R^2	0.054	0.046	0.046	0.046	0.046
N	22,769	22,769	22,769	22,769	22,769
Fixed Effects	No	No	No	No	No
Clustered id	yes	yes	yes	yes	yes
Panel B: First-differences estimation					
$IndyRef_{t-1}$	-0.066^{***}			-0.038	
	(0.020)			(0.024)	
$Brexit_{t-1}$		-0.037^{***}			-0.025
		(0.011)			(0.016)
$Scot.EPU_{t-1}$			-0.024^{***}	-0.012	-0.008
			(0.009)	(0.011)	(0.013)
R^2	0.040	0.040	0.040	0.040	0.040
N	19,180	19,180	19,180	19,180	19,180
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Clustered id	yes	yes	yes	yes	yes
Panel C: GMM estimation					
$IndyRef_{t-1}$	-0.123^{***}			-0.062	
	(.041)			(0.153)	
$Brexit_{t-1}$		-0.064^{***}			-0.029
		(0.021)			(0.142)
$Scot.EPU_{t-1}$			-0.052^{***}	-0.026	-0.028
			(0.018)	(0.066)	(0.118)
N	18,349	18,349	18,349	18,349	18,349
Fixed Effects	yes	yes	yes	yes	yes
Clustered id	No	No	No	No	No
Controls	yes	yes	yes	yes	yes

Notes: In this table, we regress investment rate $I_{it}/K_{i,t-1}$ (Investment in fixed assets scaled by the stock of fixed assets at the beginning of period) on the three types of uncertainty at time $t-1$ (*IndyRef*, Brexit uncertainty or Scottish policy uncertainty). For information on additional controls see Table 5. Panel A shows the baseline results without firm fixed effects while Panel B shows it using first differences fixed-effects. In both specifications, standard errors are clustered at the firm level. Panel C shows a dynamic investment regression model estimated using a system GMM model (see Section 6). Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Continuation of Table 12 (Excluding GDP growth rates)

	Dependent variable: Investment rate $(I_{it}/K_{i,t-1})$				
	(1)	(2)	(3)	(4)	(5)
Panel D: Without Fixed-Effects					
$IndyRef_{t-1}$	-0.020^{*}			0.022	
	(0.012)			(0.018)	
$Brexit_{t-1}$		-0.040^{***}			-0.053^{***}
		(0.009)			(0.018)
$Scot.EPU_{t-1}$			-0.027^{***}	-0.038^{***}	0.013
			(0.008)	(0.012)	(0.016)
R^2	0.054	0.054	0.054	0.054	0.054
N	22,769	22,769	22,769	22,769	22,769
Fixed Effects	No	No	No	No	No
Clustered id	yes	yes	yes	yes	yes
Panel E: First-differences estimation					
$IndyRef_{t-1}$	0.015			0.038^{*}	
	(0.016)			(0.021)	
$Brexit_{t-1}$		-0.029^{**}			-0.052^{***}
		(0.012)			(0.018)
$Scot.EPU_{t-1}$			-0.004	-0.034^{***}	0.012
			(0.011)	(0.013)	(0.015)
R^2	0.040	0.040	0.040	0.040	0.040
N	19,180	19,180	19,180	19,180	19,180
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Clustered id	yes	yes	yes	yes	yes
Panel F: GMM estimation					
$IndyRef_{t-1}$	-0.038			0.133^{**}	
	(0.035)			(0.064)	
$Brexit_{t-1}$		-0.071^{***}			-0.086^{***}
		(0.019)			(0.009)
$Scot.EPU_{t-1}$			-0.048^{***}	-0.105^{***}	0.017
			(0.018)	(0.033)	(0.030)
N	18,349	18,349	18,349	18,349	18,349
Fixed Effects	yes	yes	yes	yes	yes
Clustered id	No	No	No	No	No
Controls	yes	yes	yes	yes	yes

Notes: Panels D, E and F presents the same specification as those in Panel A, B and C (respectively) but excluding GDP growth rates from the regression controls.

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