Citadel Data Open

The Impact of Major Brexit Related Events on Britain's Job Market

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1 Executive Summary

1.1 Background

The United Kingdom's referendum to leave the EU took the world by storm. As one of the major economic powerhouses in the EU and globally, UK has had a significant impact on the EU throughout history. At the same time, UK "always viewed itself as a semi-detached member of the E.U" [3]. The announcement of Brexit and several major events since the referendum has consequently left significant ramifications in the UK, economically and socially.

1.2 Topic Motivation

Many studies have examined the overall impact of UK leaving the EU and the implications on trade, jobs, and public markets [4], [1]. In particular, there has been large uncertainty on the impact that Brexit will have on different parameters of the job market, with both bullish and bearish views from an economic standpoint. Motivated by these discussions, we investigate how legitimate there concerns were about low job availability post-Brexit referendum. We select UK job availability, i.e., job listings, as one of the key indicators of the economic stability of the country given it is a standard lagging economic metric and a reliable one as job listings are less prone to fluctuations from other external events.

1.3 Topic Question

We officially formulate our topic question as follows:

How have major Brexit related events affected economic outcomes of the UK, using job availability as an indicator?

Specifically, we conduct intervention analysis to see how has job availability been positively or negatively impacted by two events of interest, which are

- Brexit referendum, June 2016, and
- EU Withdrawal Act, June 2018.

The referendum was the first official announcement of the UK's departure from the European Union. The EU Withdrawal Act, which enabled "cutting off the source of EU law in the UK... and removed the competence of EU institutions to legislate for the UK" was regarded as the "most significant constitutional legislation" that has been introduced since the European Communities Act itself in 1972 [6].

1.4 Key Takeaways

1. While overall job availability has increased in absolute terms since the Brexit referedum, our data shows that as events, the referendum and Withdrawal Act have negatively impacted job availability because job availability would have been higher if such events had not transpired.

2. There are greater prospects for UK citizens seeking US-based jobs than UK-based jobs, given the greater number job listings for companies based in the US post-referendum.

3. As an event, the Withdrawal Act had greater negative impact on UK job availability than the initial referendum announcement. This suggests that job availability is more reactive to events that have long-term, tangible outcomes than unexpected social changes.

Our analysis below will support our aforementioned takeaways.

2 Technical Exposition

2.1 Methodology Overview

Our key approach was to measure the specific impact of two key events of interest by predicting the trend of job availability in the UK as if the event had *not* occurred and comparing the predicted results with the actual job availability data post-referendum.

1. Using the dataset containing SOC code legends, we associated unit group with major group. We then grouped by major groups and observed the trends over time in the jobs posted since 2014.

2. The next step in our data exploration was to consider the trends in job listings broken down by the stock exchange countries and observed visual trends. We selected the top 4 countries with the most count of job listing, which are United States (US), Greater Britain (GB), Australia (AU), and France (FR).

3. Using the job listings data in each country prior to the referendum, we predicted the job availability trend post-referendum as if the event had not occurred. Finally, using ARIMA time series model and dynamic time warping, which measures the distance between two time series, we evaluate the similarity between predicted and actual job listings data post Brexit referendum to determine the impact the event had on the job availability in a particular country.

2.2 Model Descriptions

2.2.1 Model Design

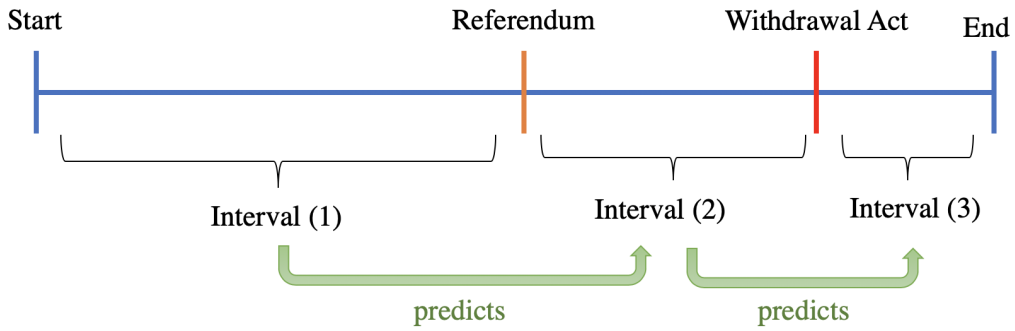

Figure 1: Illustration of country-specific time series segmentation.

We constructed an intervention-aware time series model that evaluates the scale of deviation of post-event country-specific job availability as an approximation to the socio-economical impact of two Brexit-related events.

We binned the monthly job listing count values by selected countries - US, GB, AU, and FR. For each country, we segment the individual time series data into three intervals as illustrated by Fig 2.

For each event, we use the pre-event interval as the train set and the post-event interval as the test set. We use the ARIMA model (with automatic parameter-tuning) to forecast the trend on the post-event time period. We designed this heuristic to construct a "synthetic control" for the post-event time period as if the event did not occur. We then use *Dynamic Time Warping* (explained in details below) distance to measure the deviation of observed trend from the synthetically-controlled forecasted trend.

2.2.2 Assumptions

We make multiple assumptions in our modeling process.

1. We assume that ARIMA makes reliable prediction given the trend in train set.

2. For each interval_i, we assume that the deviation of observed from controlled is a mere reflection of the impact of event_i, whereas the impact of $\text{event}_{j<i}$ can be picked up by ARIMA when training on interval_i.

3. We are aware that our response variable, job availability, is measured by the count of job listings, and that ARIMA may not be the optimal model for count time series analysis. This is due to the violation of normality assumption of ARIMA on count data, whereas a Poisson model is more ideal [2]. However, due to time constraints, we were unable to contruct a meaningful Possion-based model, which we leave for future work.

2.2.3 Dynamic Time Warping

The algorithm is formulated as follows [5]. Given two time series data, X and Y, with sizes $|X|$ and $|Y|$,

$$X = \{x_1, ..., x_{|X|}\}, Y = \{y_1, ..., y_{|Y|}\}, \tag{1}$$

we can construct a warping path W such that

$$W = \{w_1, ..., w_K\}, max(|X|, |Y|) \leq K \leq |X| + |Y|, w_k = (i, j), \tag{2}$$

where i is an index from time series X, and j is an index from time series Y. Then, the optimal warp path is the warp path is the minimum-distance warp path, where the distance of a warp path W is

$$Dist(W) = \sum_{k=1}^{k=K} Dist(w_{ki}, w_{kj}). \tag{3}$$

Given the formula for calculating the DTW distance, we know that the scale of DTW distance is dependent on sample size. Therefore, we normalize the DTW distance by the number of time points along the interval of interest.

2.3 Exploratory Data Analysis

Exploratory data analysis was used to refine a problem statement and identify the main areas of interest. To examine the job postings data we aggregated by months as more refined aggregation could lead to biased results due timings between scrapings and time required to remove the job once it had been taken.

Upon visual inspection, there was no sign that major Brexit events had impact on one particular industry as defined by SOC groups (Fig.2). It is interesting to note that some major categories (for example sales and customer services industry) had strong seasonal fluctuations.

Grouping by the country of company's registration provided more fruitful results. As can be seen on Figure 3, some tendencies start to appear with respect to the events transpiring. Upon inspection we decided to use event 1: referendum and event 4: EU withdrawal acts as the points of interest.

Figure 4 illustrates the geographic breakdown of job availability in the UK job market with the size of the rectangle indicating the percent of jobs available relative to the other countries present. The majority of applications throughout the years can be attributed to GB and US, followed closely by FR. These are among the countries of interest in this work.

To make sure that job postings data is in agreement with occupational statistics, we additionally plot the occupational data over time with grouping by SOC major category (Fig.5). This data is annual, and thus has a lower resolution than job postings. All major groups have an overall positive trend over time, in agreement with Figure 2.

We also visually inspected the trend of the number of immigration citizenship application, breaking down into EU and non-EU categories. We observe that after 2016 when the UK enter the era of turbulence caused by Brexit, there is an upward trend for the number of applicants from EU countries, but downward trend for

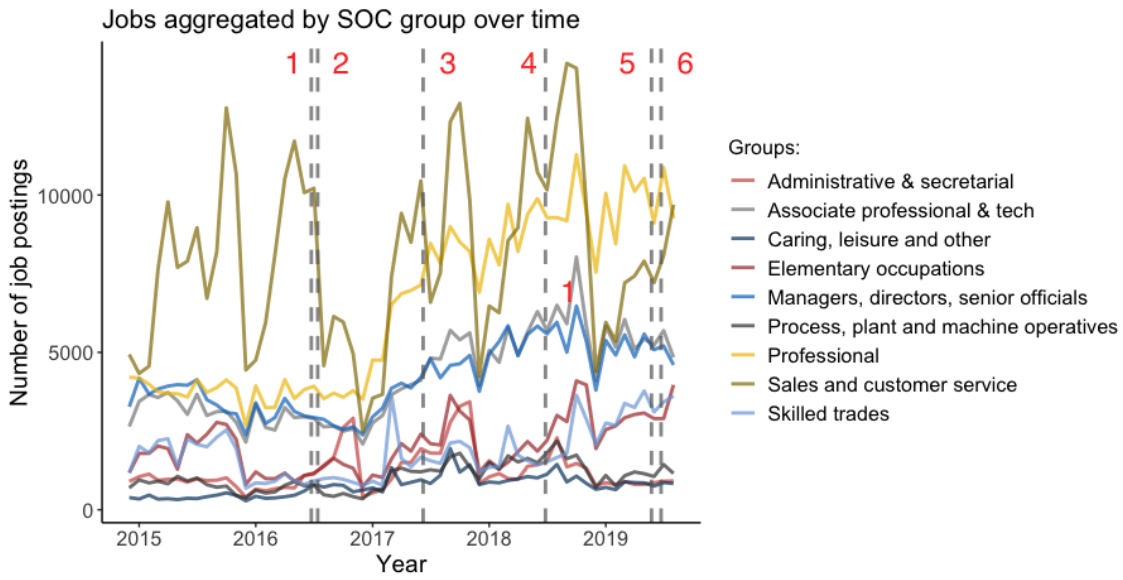

Figure 2: Job postings aggregated by SOC group. *Event 1*: UK EU Referendum; *event 2*: Theresa May is elected; *event 3*: General election; *event 4*: EU Withdrawal Act; *event 5*: Theresa May announces resignation; *event 6*: Boris Johnson is elected

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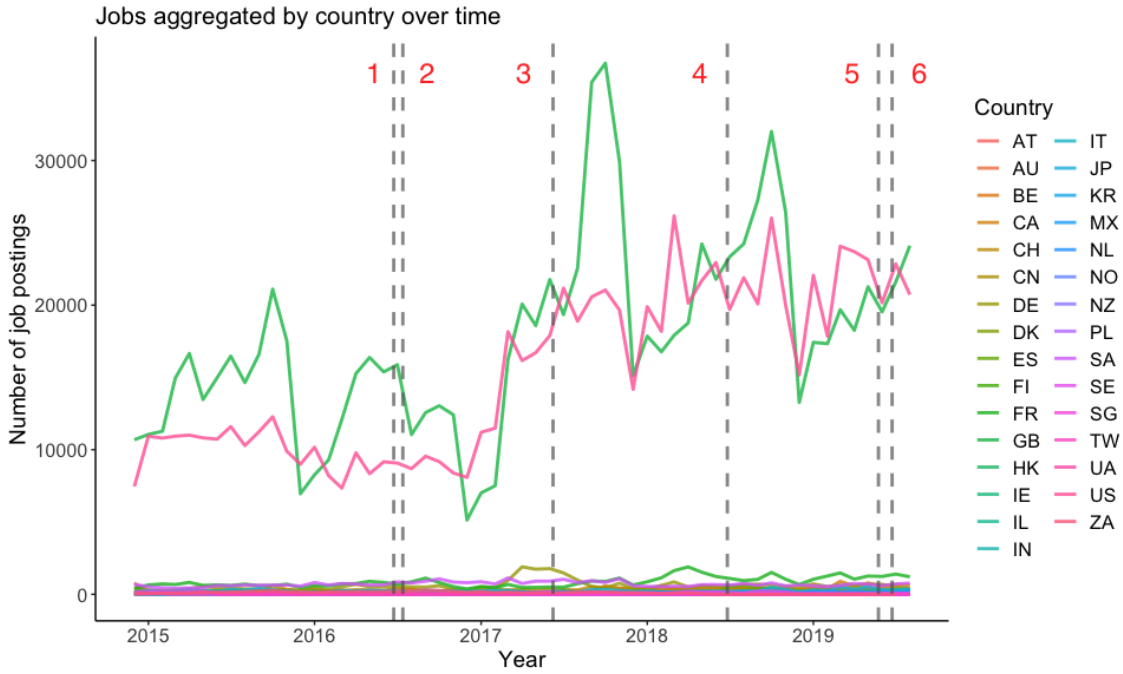

Figure 3: Job postings aggregated by country codes. *Event 1*: UK EU Referendum; *event 2*: Theresa May is elected; *event 3*: General election; *event 4*: EU Withdrawal Act; *event 5*: Theresa May announces resignation; *event 6*: Boris Johnson is elected

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people from non-EU countries (Fig. 9). We speculate that the upward trend is due to the EU citizens who were residing in UK, and who, in light of the Brexit, decided to get citizenship to stay in the country in the future.

To conclude, exploratory data analysis has shown that grouping by the country

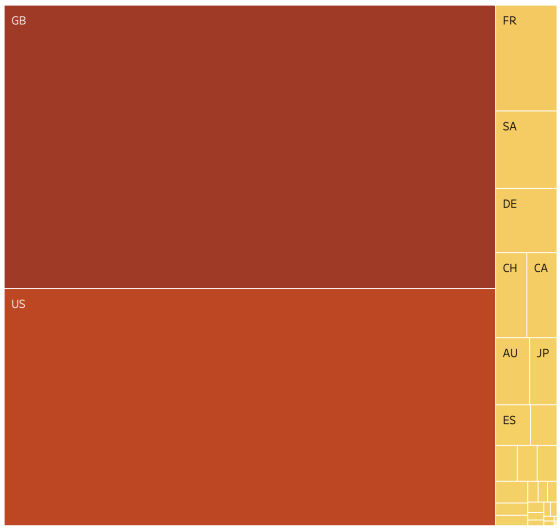

Figure 4: Area graph for number of applications per country.

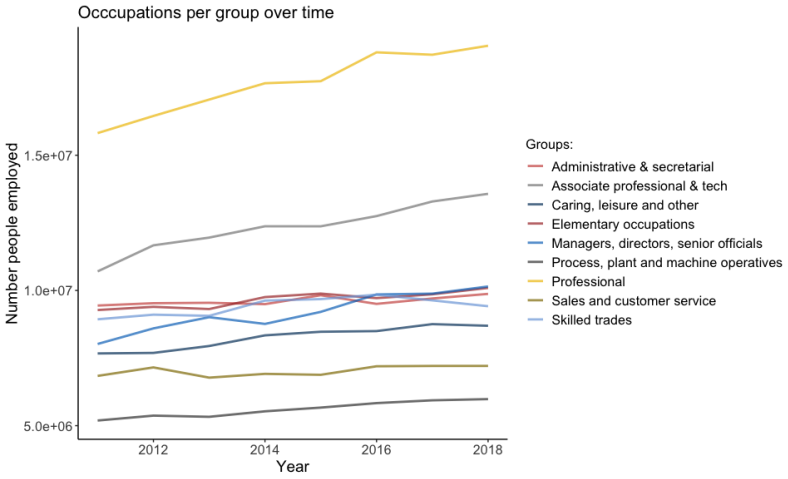

Figure 5: Number of people employed in group

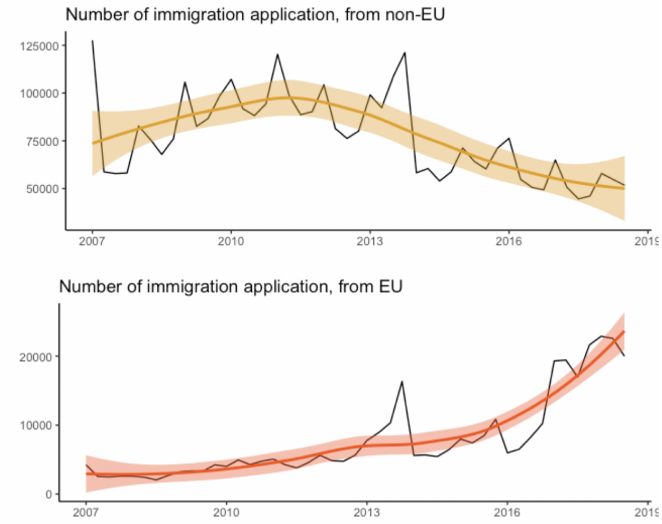

Figure 6: Number of applications for UK citizenship, EU v.s. non-EU

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for job postings is most promising, and will be a focus of the further study in this work. It also helped us to define which countries and major events would be of the most interest in the analysis, and to check the validity of our assumption that job postings reflect the population occupation data. Finally, showed us an interesting social effect of increased number of applications from EU citizens.

2.4 Time Series Analysis

Our intervention-aware time series model indicated the greatest discrepancy between actual and predicted job availability in US-based companies after the Brexit referendum, with a normalized log distance of 9.85, showing that predicted job availability was significantly lower than the actual job availability (Fig. 7).

Assuming our ARIMA model accurately predicts the potential time series trend

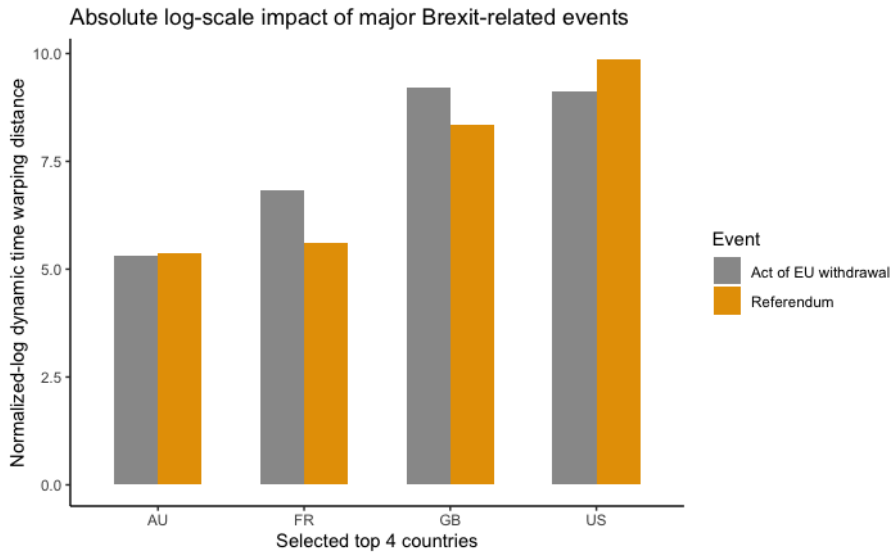

Figure 7: Compare impact of two Brexit events on selected stock exchange countries.

without the intervention of the Brexit referendum, we can conclude that because of the intervention, there is a positive impact on the availability of US-based jobs for UK citizens. Similarly, our model shows that because of the Brexit referendum, there was a slight negative impact on the availability of UK-based jobs.

The 2018 Withdrawal Act as an event had a greater negative impact on the UK job availability for EU-based companies than the initial Brexit referendum as an event. This is indicated by a greater negative discrepancy between actual and predicted job availability post-Withdrawal Act versus the discrepancies post-referendum.

3 Conclusion: Findings and Significance

We now tie together our analysis with the key findings we introduced at the beginning of the paper.

As our exploratory data analysis demonstrates, the overall job listings posted have increased overtime in absolute terms, but our time series analysis demonstrates that the *expected* number of job listings should have been higher had the two Brexit related events not occurred (with the exception of US-based companies post-referendum and pre-Withdrawal Act). Specifically, there could have been greater job availability had the Withdrawal Act not occurred, which had a greater negative impact as an event than the referendum. This finding provides a framework for understanding the kind of impact on job prospects that different types of events can have, namely that job availability is likely to be less sensitive to unexpected social changes than official laws with tangible geopolitical ramifications. This characteristic of job availability as a data metric makes it a less volatile, more reliable economic indicator as well.

Finally, our data indicates a lower number of actual job listings from UK-based companies than expected, but an increase in overall job availability and employment by occupation, indicating that the lower number job listings after the Brexit referendum is less of a measure of job availability/prospects for UK citizens than it

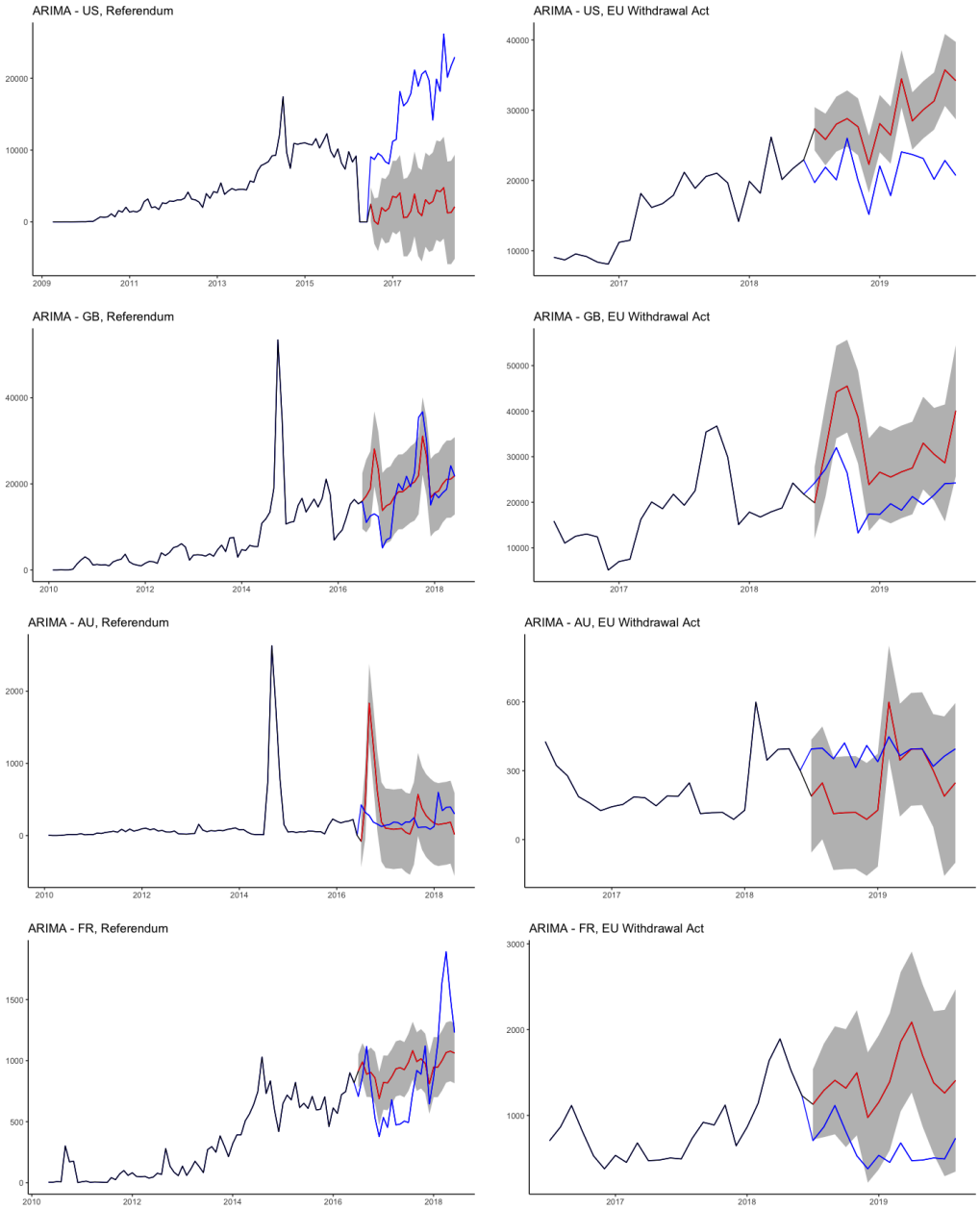

Figure 8: Time series intervention analysis per country.

is an indicator of business health. If allowed more time, we would investigate the correlation between the job listings and the stock performances of the respective companies to test our hypothesis that while company prospects may have been negatively impacted by Brexit events, hence the decrease in recruiting efforts, the job prospects for citizens may not be. Furthermore, the increase in actual US-based job availability after the referendum but before the Withdrawal Act indicate that US companies may have faith in UK citizens seeking out US based jobs, especially as UK-based jobs are lower than expected.

In conclusion, our comparative intervention analysis has allowed us to compare actual UK job availability with expected UK job availability had the Brexit referendum and Withdrawal Act not occurred to understand the specific impact that these events had on job prospects in the UK.

3.1 Shiny APP

We were able to build a Shiny APP that runs locally for intervention time series analysis, unfortunately we were not able to publish on time. Here is a screen shot of the server:

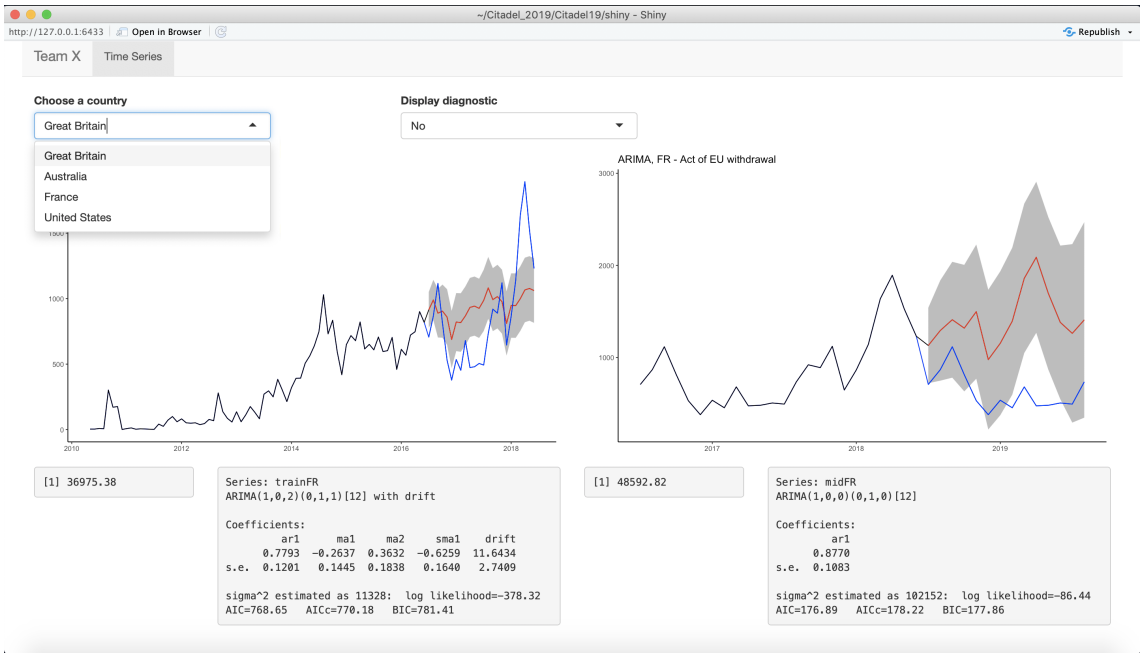

Figure 9: Shiny App screenshot

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