

# Replication package for ‘The Brexit Vote, Productivity Growth and Macroeconomic Adjustments in the United Kingdom’

This README file explains the replication package for the paper “The Brexit Vote, Productivity Growth and Macroeconomic Adjustments in the United Kingdom” by Ben Broadbent, Federico Di Pace, Thomas Drechsel, Richard Harrison and Silvana Tenreyro, published in The Review of Economic Studies.

## 1 Overview

The folder where the README file is located contains the following subfolders:

- **Section2**
- **Section4**
- **Section5**

These folders contain data and code to replicate all results in the paper and corresponding appendices. This README file first provides details about data sources and access descriptions for all data used across the paper (see Section 2 of this README). It then contains detailed instructions to replicate the results (see Section 3 of this README). Following the folder structure, these instructions are organized in three sections (corresponding to the three sections where results are reported in the paper), as the different sections use distinct methods and data.

## 2 Data Availability and Provenance Statements

The following data used in the paper are publicly available

- Eurostat National Accounts data [1], used in Section 2.2 and Appendix A. These data can be freely downloaded. At the time of creating our data set, they were directly accessible online at <https://ec.europa.eu/eurostat/web/national-accounts/database>. Accessing the data currently requires setting up a free “EU Login” account.
  - The file **Section2/Replication\_Section2\_2/Data Eurostat/readme\_Eurostat.txt** contains more details about the specific variables we retrieved.
  - The Stata do files clearly state how the data was transformed to run our regressions.
- OECD National Accounts data [2] (<https://stats.oecd.org/>), used in Section 2.2 and Appendix A. These data can be freely downloaded.
  - The file **Section2/Replication\_Section2\_2/Data OECD/readme\_OECD.txt** contains more details about the specific variables we retrieved.
  - The Stata do files state how the data was transformed for the regression analysis.
- Exchange rate data - used in Section 2.2 and Appendix A

- Euro-Dollar exchange rate: retrieved from FRED [3] (<https://fred.stlouisfed.org/>)
  - GDP deflators for US, Canada, Australia: retrieved from FRED [3] (<https://fred.stlouisfed.org/>)
  - OECD bilateral exchange rates: retrieved from the OECD [2] (<https://stats.oecd.org/index.aspx?queryid=169>)
  - The file **Section2/Replication\_Section2.2/Data Exchange rates/readme\_xrates.txt** contains more details on which specific variables we retrieved.
  - The Stata do files contain all data transformations required to run our regressions.
- ONS National Accounts and Labor Market Statistics [4], used in Sections 2.1, 4 and 5.3 of the paper and Appendix D. These data can be freely downloaded from the ONS website <https://www.ons.gov.uk/>
    - Additional information about the data and data transformations can be found in **Section4/Data/Transformations/README\_transformations.txt**.
  - US CPI annual inflation and US 3-month Treasury Bill: retrieved from FRED [3] (<https://fred.stlouisfed.org/>), used in Section 4 of the paper. Data can be freely downloaded from the FRED website.
    - Additional information about the data and data transformations can be found in **Section4/Data/Transformations/ README\_transformations.txt**.
  - US CPI inflation expectations - retrieved from SPF [5], used in Section 4 of the paper. Data can be freely downloaded from the Federal Reserve of Bank Philadelphia (<https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/median-forecasts>).
    - Additional information about the data and data transformations can be found in **Section4/Data/Transformations/README\_transformations.txt**.

## Data source references

1. **Eurostat**. 1997:Q1-2016:Q2. “Basic breakdowns of main GDP aggregates and employment (by industry and asset)”. <https://ec.europa.eu/eurostat/web/national-accounts/data/database> (accessed 18 July 2021). The list of countries and sectors can be found in Tables A.1 and A.2 of Appendix A.
2. **OECD**.
  - 1997:Q1-2016:Q2. “Currency exchange rates, monthly average (aggregated to quarterly)”, <https://stats.oecd.org/index.aspx?queryid=169> (accessed 28 July 2021). The list of countries can be found in Tables A.1 and A.2 of Appendix A.

- 1997:Q1-2016:Q2. “GVA (output approach) and employment”. <https://stats.oecd.org/Index.aspx?DataSetCode=QNA> (accessed 17 July 2021). The list of countries and sectors can be found in Tables A.1 and A.2 of Appendix A.

### 3. FRED.

- 1997:Q1-2016:Q2. “Currency Conversions: US\$ Exchange Rate: Average of Daily Rates: National Currency:USD for the Euro Area (19 Countries) (aggregated to quarterly)”. Series code: CCUSMA02EZM618N. <https://fred.stlouisfed.org/> (accessed 3 August 2021).
- 1997:Q1-2016:Q2. “GDP implicit price deflators (USA, Canada, Australia)”. Series codes: USAGDPDEFQISMEI, CANGDPDEFQISMEI, AUSGDPDEFQISMEI. <https://fred.stlouisfed.org/> (accessed 28 July 2021).
- 1987Q1-2016Q2. “TB3MS - 3 Month Treasury Bill: Secondary Market, Percent, Quarterly, NSA”. <https://fred.stlouisfed.org/series/TB3MS> (accessed 31 September 2021).
- 1987Q1-2016Q2. “CPIAUCSL\_PC1 - Consumer Price Index for all urban consumers: All Items in U.S. City Average, Percentage Change from Year Ago, Quarterly, SA”. <https://fred.stlouisfed.org/series/CPIAUCSL> (accessed 31 September 2021).

### 4. ONS.

- 1997-2018. “Supply and Use Tables, Annual”. <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables/current> (accessed 17 October 2017 and 30 October 2020).
- 1990-2019. “GDP output approach – low-level aggregates, Quarterly and Annual, SA”. <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates/current> (accessed 31 March 2021).
- 1994Q1-2019Q4. “Labour productivity by industry division, Average Total Hours, by Industry, Quarterly, SA”. <https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/labourproductivitybyindustrydivision> (accessed 18 January 2021).
- 1987Q1-2019Q4. “UK Economic Accounts time series, CP and CVM, £m, Annual and Quarterly, SA.” <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/unitedkingdomeconomicaccounts/current> (accessed 30 June 2021 and 30 September 2021).
- 1987Q1-2019Q4. “Consumer trends, CVM, £m, Annual and Quarterly, SA.” <https://www.ons.gov.uk/economy/nationalaccounts/satelliteaccounts/datasets/consumertrendschainedvolumemeasureseasonallyadjusted/current> (accessed 30 June 2021).
- 1987Q1-2019Q4. “Consumer trends, CP, £m, Annual and Quarterly, SA.” <https://www.ons.gov.uk/economy/nationalaccounts/satelliteaccounts/datasets>

- [/consumertrendscurrentpricesseasonallyadjusted/current](#) (accessed 30 June 2021).
- 1997Q1-2019Q4. “Business investment by industry and asset: CP, £m, Quarterly, SA.” <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/businessinvestmentbyindustryandasset/current> (accessed 26 April 2021).
  - 1997-2014. “Breakdown of gross operating surplus/mixed income of the UK by industry section”. <https://www.ons.gov.uk/economy/grossdomesticproductgdp/adhocs/007583breakdownofgrossoperatingsurplusmixedincomeoftheukbyindustrysection2007to2014> (accessed 10 October 2017).
  - 1987Q3-2019Q4. “LFS: Population Aged 16+: UK: All: 000s, Quarterly”. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/mgsl/lms/previous> (accessed 23 March 2021).
  - 1987Q3-2019Q4. “LFS: Total actual weekly hours worked (millions), UK, All, Quarterly, SA”. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/ybus/lms/previous> (accessed 18 May 2021).
  - 1987Q3-2019Q4. “Number of People in Employment (aged 16 and over), 000s, Quarterly, SA”. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/mgrz/lms/previous> (accessed 19 May 2021).
  - 2000M1-2019M12. “AWE: Whole Economy Level: Seasonally Adjusted Total Pay Excluding Arrears, (£), Monthly”. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/timeseries/kab9/emp/previous> (accessed 18 May 2021).
  - 1987M7-2000M9. “AWE Historical: Whole Economy Level: Seasonally Adjusted Total Pay Excluding Arrears, (£), Monthly”. Bank of England (accessed 18 May 2021).
5. **Survey of Professional Forecasters.** “CPI6 - Consumer Price Index (CPI), Median Level Forecast Data for Levels”. <https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/median-forecasts> (accessed 31 September 2021).

### 3 Replication Instructions

As noted above, separate replication instructions are provided for Sections 2, 4 and 5 of the paper as well as the corresponding tables and figures in the Appendix.

## 3.1 Replication of results for Section 2

### 3.1.1 Computational Requirements

The hardware, OS and software used are listed below. With this configuration, any codes for Section 2 run in less than one minute.

- CPU: 12th Gen Intel Core i5-12500, 3 GHz
- RAM: 16GB
- OS: Windows 10 Enterprise
- Software: Stata version 16. Extra Stata packages required: winsor, sum2docx, reghdfe, outreg2 (use “ssc install” command to install these).

In all Stata do files, the current directory at the top needs to be adjusted. The code has not been tested on other hardware, operating systems or software versions.

### 3.1.2 Replication of results in Section 2 (and related appendices)

Note that the instructions here are for the results in Section 2.2. The code to produce Figure 1 in Section 2.1 is contained in the **Section5** folder: see the instructions 3.3.3 of this document below.

The folder **Section2/Figures\_Tables\_Section2** contains the data underlying

- Table 1, Figure 2
- Appendix Tables A1, A2, A3, A4

It also contains a MATLAB function to create Figure 2 from its underlying data.

The subfolder **Section2/Replication\_Section2\_2** contains the raw data and Stata do files for Section 2.2 and Appendix A. The subfolders beginning with **Data** contain the underlying raw data, with further explanations. The subfolder “Do files” contains the Stata do files.

- 05\_regressions.do runs the regressions, i.e. creates Tables 1, A3, A4.
- 04\_summary\_stats.do creates the data for Figure 2, and Tables A1, A2.
- The do files beginning with 00\_ to 03\_ create the data set for the regressions from scratch.

## 3.2 Replication of results for Section 4

### 3.2.1 Computational Requirements

The hardware, OS and software used is listed below (and the timings detailed in Section 3.2.3 refer to this configuration):

- CPU: Intel Core i5-6300U
- RAM: 16GB
- OS: Windows 10 Enterprise
- Software: MATLAB 2016b (64bit), Dynare version 4.5.7.

The code has not been tested on other hardware, operating systems or software versions.

### 3.2.2 Replication package structure

The folder **Section4** contains the following subfolders:

- **Data** Contains Excel spreadsheets with data (and data transformations) to plot Figure 1, compute Tables 6 and E.1 and plot Figures D.1 to D.4. The folder has two spreadsheets: one with all final data and one with only the transformed data (to estimate the model). The folder contains one subfolder where data and data transformations are stored.
- **Figures** Contains Figures D.1-D.4 of the Appendix (in `.eps` format). The figures are stored after running the Matlab script as explained below.
- **Estimation** Contains dynare code to run the estimation of the model using data from 1987Q3 until 2016Q2.
- **Results** Contains estimation results files generated from estimation (in `.mat` format) and also Tables 2-5 corresponding to Section 4 of the paper (in `.xlsx` format).

### 3.2.3 Replication of results in Section 4 (and related appendices)

#### Data

There are three files and one subfolder in this folder:

1. The spreadsheet `BrexitPaperData.xlsx` contains all the transformed data used in Sections 2.1, 4, 5 and Appendices D and E. The script to plot the Figures in Appendix D reads from this spreadsheet.
2. `Estimation0N.xlsx` spreadsheet contains data to run the estimation of the model. The dynare script (`.mod`) reads data from this file.
3. `data_plots.m` script produces Figures D.1-D.4, reading from `BrexitPaperData.xlsx`, and saves Figures in `.eps` format into the **Figures** folder.

4. The subfolder **Transformations** contains 8 spreadsheets with data and data transformations. Additional information can be found in **RawData/README\_transformations.txt**.

## Model Estimation

The script `run_estimation.m` in the **Estimation** folder saves the estimation results in worksheet **Table5** of **TablesPaper.xlsx**. The worksheet **Table5** in the spreadsheet has been saved under the same format as it appears in Section 4.3. In order to execute the file, the **Estimation** folder needs to be specified as the current directory in MATLAB. There are two options within the script: `load_results=1` loads only selected stored results from **Results/soetnt\_res.mat** and `load_results=0` runs the full Bayesian estimation of the model. Prior and posterior estimates have also been stored separately in **soetnt\_res.mat**. Whilst the option that reads results takes less than one minute to execute, the estimation of the model takes approximately 6 hours to execute.

Under option `load_results=0`, the script executes the dynare file **soetnt.mod**. To estimate the model, ensure that the dynare path is set. Upon file execution, dynare reads the observables from the **Estimation.xlsx** spreadsheet. After completion, Matlab/Dynare generates a file with results (**soetnt\_results.mat**) in the same folder. The estimation results can be retrieved from the `oo_` structure. Prior distributions have been stored in worksheet **Table5** of the spreadsheet **TablesPaper.xlsx**.

### 3.2.4 Production of Figures D.1-D.4 (Appendix)

The script `plotData.m` in the **Data** folder produces Figures D.1 and D.4 in the Appendix. The script takes less than 1 minute to execute. The script reads from the spreadsheet **BrexitPaperData.xlsx**. The script produced 4 figures that are saved in the **Figures** folder in `.eps` format.

## 3.3 Replication of results for Section 5

### 3.3.1 Computational Requirements

The hardware, OS and software used is listed below (and the timings detailed in Section 3.3.3 refer to this configuration):

- CPU: Intel Core i5-6300U
- RAM: 16GB
- OS: Windows 10 Enterprise
- Software: MATLAB 2020b (64bit), Dynare version 4.5.7.

The code has not been tested on other hardware, operating systems or software versions.

### 3.3.2 Replication package structure

The folder **Section5** contains the following subfolders:

- **Data** Contains Excel spreadsheet with the data used to plot Figure 1 and Tables 6 and E.1. This data is a subset of the dataset used in Section 2. The spreadsheet `selectedDataSeries.xlsx` contains a subset of worksheets in **Section2/Data/Transformations/DataSOETNT\_Dec2020.xlsx**. The spreadsheet contains an additional transformation to work out the model consistent trade balance.
- **Figures** Contains figure outputs (in pdf format) from the plotting codes.
- **Functions** Contains functions used to generate and plot the results.
- **Results** Contains results files (in mat format) generated from the Brexit simulations.

### 3.3.3 Replication of results in Section 5 (and related appendices)

The main scripts call the script `tidyUpAndSetPath.m`, which clears the workspace and adds the relevant paths for the data files, functions, figures and results. These are expressed relative to the working directory containing the scripts. This script also adds the dynare path which can be modified to match the user's configuration.

Some of the scripts described below require pre-computation of results by other scripts. It is therefore recommended that they are executed in the order listed below. Computation times reported are based on the configuration described in Section 3.3.1.

**Brexit simulations** Two scripts produce the relevant results:

1. `runBrexitSimVariants.m` produces the baseline Brexit simulation reported in Section 5 of the paper, together with the variants reported in Appendices E and F. The script takes approximately 3 minutes to execute. Results are saved as `.mat` files in the **Results** folder.
2. `plotBrexitSimFigures` plots Figures 3–4 in the main text and Figures E.1–E.6 and F.1–F.4 in Appendices E and F. The script takes less than 1 minute to execute. Results are saved (in pdf format) in the **Figures** folder. Note that the results files generated by `runBrexitSimVariants.m` must exist before this script is executed.

**Comparison of simulations with data** Two scripts produce the relevant results:

1. `compareSimAndData.m` produces Table 6 in the paper. The script takes less than 1 minute to execute. The result is saved as `simVsDataTable.tex` in the **Figures** folder.
2. `compareSimAndDataRobustness.m` produces Table E.1 in Appendix E. The script takes less than 1 minute to execute. Results are saved as `simVsDataTableRobustness.tex` in the **Figures** folder.

Note that the results files generated by `runBrexitSimVariants.m` must exist before these scripts are executed.



### 3.3.4 Production of **Figure 1**

The script `plotFigure1.m` produces **Figure 1** in the paper. The script takes less than 1 minute to execute. The results is saved as `Figure1.pdf` in the **Figures** folder.