

The Economic Consequences of the Brexit vote

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ABSTRACT

On June 2016, the British people voted to leave the European Union. This unexpected result provides us with the opportunity to study the impact of the vote on the economy. We replicate the work done by Born et al. (2017) by applying the synthetic control methods to capture the effect of the vote on different economic variables: firstly on the GDP, later on its components, following the National Accounts. We find proof of an output loss of around 3%, which comes mainly from households consuming less, firms investing less and the British Government spending less. Regarding the balance of trade, we do not find significant changes neither on imports nor on exports.

Keywords: Brexit vote, European Union, synthetic control methods, counterfactual, National Accounts

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1. Introduction

The Brexit vote is an exceptional opportunity for the field of economics to better understand the effects of unexpected macroeconomic shocks: a clear natural experiment. The referendum can be addressed as a comparative case study due to some particular features: first, the result of the vote broke every prediction, and thus, it was totally unexpected; second, it affected one country in particular, allowing us to compare it to neighbouring economies; third, it may help in the comprehension of the mechanisms that underlie the economics of disintegration.^{1 2}

To better understand the roots of the Brexit vote, we must go back some decades. After the Second World War, the necessity to build up a new future for Europe over the ruins of conflict brought along with it the proposal of the European Communities. For many decades, that political, economic and social project went from paper into reality by integrating the duty of most of the European countries in a common purpose. What was initially conceived as a global arena for debate and understanding soon evolved into the greatest and most advanced democratic integration experiment in history: the European Union.

In the eve of the 2008 Great Recession, new countries becoming members of the European club gave the impression that the further integration into the European Union was almost inevitable. However, that belief was about to be dramatically shattered.

The morning of the 24th of June 2016, Europeans woke up and observed that, for the first time ever, the integration in the European Union (EU)³ was about to take the opposite direction that it used to: the British people had voted in a referendum to leave the EU 52 to 48%. That result shook the foundations of a project which was deemed beneficial for all back then.

The United Kingdom's membership to the EU had begun in 1973. Since then, the economic relationships of that country with its continental counterparts had exponentially risen. Although the UK chose not to join neither the Euro Monetary Area

¹ Sampson, T. (2017). Brexit: the Economics of International Disintegration. *Journal of Economic Perspectives*, 31(4), pp. 163-184.

²

³ From this point on, we will refer to the European Union by its acronym in English: EU

to maintain its currency sovereignty, nor the Schengen Area⁴ to keep their border's control, it did accept the European Single Market.⁵ Additionally, the country signed the Treaty of the EU in 1993, which gave rise to the political union.

That process of integration with the neighbouring countries radically changed the economic framework of the United Kingdom. In the decades prior to the joining, the GDP per capita for that country in relative terms to the rest of Western European States had steadily declined from being around a 45% higher in 1950 to a 0% gap at the beginning of the 70s. The membership seemed a wise decision to take to reverse the economic decline. From that point on, the United Kingdom was able to catch up again with the biggest European economies.⁶

There is not much study around the source of the benefits of joining the EU. Campos et al. (2019) estimated the net benefits for the UK to be 8.6% of GDP. This economic impulse might have come from some main channels, according to this very same article. On the one hand, the instant access –with almost no barriers– to millions of European consumers might point out to the benefits of a form of trade liberalization. On the other hand, the urgency to compete with other European companies might have led to an important increase in the productivity of British firms and workers. Other sources add to this list the financial integration, which allowed the mainly London-based industry to become a worldwide reference in its field.

In any case, data from the economic relationship of the United Kingdom with its continental partners suggests a rapid and close integration from the 1970s on. By 2016, 47,71% of the British exports were to EU States, while 54,91% of their imports came from the other side of the Channel. The balance of trade with EU countries yields a negative figure, which means that British companies and individuals import more products and services than they export. When it comes to the labour force, an estimated 1,3 million UK nationals live in EU countries, while the UK hosts around 3,6 million Europeans. In terms of direct economic benefits of the membership, it must be noted that the United Kingdom received up to €7,1 billions in 2017 from EU institutions. This funds came primarily from the European Structural and Investment (ESI) funds and the

⁴ An area of 26 European countries in which passport and border controls are abolished

⁵ A single market that guarantees the free movement of goods, services, capital and labour among the 28 EU member states, created through the Maastricht Treaty in 1993.

⁶ (Campos, Coricelli, & Moretti, Economic Growth and Political Integration: Estimating the Benefits from Membership in the European Union Using the Synthetic Counterfactuals Method, 2014)

European Agricultural Guarantee Fund (EAGF). Moreover, the membership grants access to the European Investment Bank,⁷ which mobilised up to €5,4 billions per year in the period 2011-2017 to support UK-based projects and companies.

It was in this context that the British people voted to leave the EU on 23rd June 2016, hence beginning the process formally known as ‘Brexit’. The UK government under the newly designated Prime Minister Theresa May started the negotiations to determine the conditions under which the United Kingdom was about to leave the economic block. The result of the referendum was clear: leave as a loud wake-up call. However, the terms of the withdrawal from the EU had not been addressed by the voters. These would completely depend on the negotiations to be carried out.

Right away, uncertainty about the near future of the country became an issue to be taken into account. The general opinion agreed that there was going to be an economic impact of the Brexit vote. The ‘Remain’ campaign had made the economy the central issue of their bet to win the referendum.⁸ Nevertheless, the softness of the goodness of fit would entirely depend on the negotiation path that the British government would take.

Now, more than three years after, many of the predictions have not been fulfilled, while other unpredicted economic effects have arisen. This paper will firstly address the existence of any measurable economic impact of the Brexit vote in the United Kingdom by replicating the seminal paper by Benjamin Born, Gernot J. Müller, Moritz Schularick and Petr Sedláček: *The Economic Consequences of the Brexit Vote* (2017). The method to be followed will be that employed in that paper. The analysis will entirely rely on a data-driven approach by using the synthetic control method, an empirical macroeconomic technique initially proposed by Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015).

This procedure will allow us to capture the estimated output gap derived from the Brexit vote. Up-front, we find that the British output has fallen by more than a 3% by 2018Q4 with respect to the expected output under no vote. This loss would represent around 62 billion pounds. The robustness of the results will be tested via placebo effects. We will

⁷ The European non-profit financial lending institution, which does not get financing from the EU Budget, but directly from financial markets. Its main purpose is to support EU based projects or companies which go along the main lines drafted by the EU (Integration and Social Cohesion) by giving favorable-terms loans

⁸ See the webpage of the *Stronger In Campaign*:
https://www.strongerin.co.uk/get_the_facts#oAui0RVdXTuSc8Kg.97

check whether there is any output loss for the countries that we compare the UK to, or if there is any loss for every other period from 2015 to 2017 that is not related to the vote itself.

Once the output effect is addressed, the next step will be to dig deeper into the possible causes of the output loss. The fact that the Brexit has not yet been delivered makes this economic slowdown even more interesting for the macroeconomic field. According to Born et al. (2017), two main reasons may lie behind the slowdown: the uncertainty about the final result of the Brexit negotiations and the anticipation of the forward-looking economic agents. In turn, we pose the hypothesis that those two drivers might already be affecting consumption and investment in the United Kingdom.

The impact of the Brexit vote in the components of the GDP is approached in the extension in section 4. We apply the same synthetic control methods to the National Accounts' components of the output: consumption, investment, public expenditure, exports and imports. We try to decompose the GDP so as to understand the variables that are pulling the output down at most. Through this technique, we obtain mixed results. While the approximations for consumption and public expenditure allow us to conclude that the Brexit vote is already negatively affecting those variables, goodness of fit is not good at all for the investment, exports or imports. However, we find some particular features of those series that are certainly interesting for the analysis to tackle. This will be explained in detail in section 4.

We conclude the article with some final remarks in section 5.

2. The effect of the Brexit vote on the output

2.1. Construction of the synthetic control

As explained in the previous section, the Brexit vote poses a great opportunity to study the aggregate consequences of a sudden change in the macroeconomic prospects of the United Kingdom. To address the causal impact of the vote on the British output, however, we would need another economy to make the comparison with. The optimal case would be to compare the actual output in the UK with the hypothetical one, had the Brexit vote not happened. Unfortunately, only one of those time series is observed.

The synthetic control method as proposed in Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015) jumps over that data problem by constructing a synthetic economy that resembles the evolution of the British output prior to the Brexit vote and is not affected by it: a counterfactual. For the analysis to be rigorous enough, the synthetic has to approximate the actual output as much as possible before the Brexit, so that the post-Brexit evolution of the synthetic can be trusted as a good approximation. The hypothesis behind this procedure is that the output of the United Kingdom would have behaved as the synthetic in the event of the Brexit vote not occurring. Hence, the difference between the two time-series –the actual output and the counterfactual– would yield the estimated impact of the Brexit vote on the economy, the deviation from the *should be* scenario attributable to the referendum. The counterfactual is built over data from other countries that are mostly similar to the United Kingdom and are not affected by the Brexit vote. We call those ‘donor pool countries’, or ‘donor countries’.

To construct the synthetic control unit, we gather quarterly Real GDP data from 29 donor countries and the UK, from 1995Q1 to 2018Q4, a total of 96 quarters.^{9 10 11} The source of our data is the OECD Database. Then, we set the output for every country in 1995Q1 as 1 and transform the data in relative terms to that initial value. We proceed this way because the output in relative terms has less variability than the absolute one, in such a way that the synthetic counterfactual will more precisely capture the evolution of the GDP for the UK. As the Brexit vote (our treatment) happened in the third quarter

⁹ Measured in 2010 Dollars to be able to compare between countries.

¹⁰ The countries from the donor pool are enlisted in Table 1.

¹¹ In our analysis, we omit Slovenia from the donor pool because its information from 1995 is missing.

of 2016, the synthetic will be formed from data spanning from 1995Q1 to 2016Q2, for a total of 86 quarters.¹² We call this period the ‘pre-treatment’. We will define the synthetic control unit as a weighted average of the output of the countries in the donor pool for the pre-treatment period. The weights of that unit will be obtained by minimising the distance between the output of the United Kingdom and that of the synthetic economy as it is displayed below:

$$(\mathbf{X}_1 - \mathbf{X}_0\mathbf{W}^*)'\mathbf{V}(\mathbf{X}_1 - \mathbf{X}_0\mathbf{W}^*) \quad \text{Equation 1}$$

Where \mathbf{X}_1 is a 86 x 1 matrix comprising the output data for the UK, \mathbf{X}_0 is a 86 x 29 matrix for the output data of the donor pool countries, \mathbf{W} is the 29 x 1 matrix of weights for every donor country that we try to minimise and \mathbf{V} is a 86 x 86 nonnegative diagonal matrix.¹³ It must be noted that the weights are subject to the following restriction:

$$\sum_{i=1}^{29} w_i = 1$$

$$w_1, w_2, \dots, w_i, \dots, w_{28}, w_{29} \geq 0$$

The country weights are obtained from an algorithm that calculates the optimal convex combination of the donor pool outputs that most closely approaches the output for the UK at each quarter of the sample. The results are displayed in the table below:

Table 1: country weights for the synthetic counterfactual

| | | | | | |
|----------------|-------|------------|-------|-----------------|-------|
| Australia | <0.01 | Greece | <0.01 | Netherlands | <0.01 |
| Austria | <0.01 | Hungary | 0.18 | New Zealand | <0.01 |
| Belgium | <0.01 | Iceland | <0.01 | Norway | 0.14 |
| Canada | 0.28 | Ireland | 0.03 | Portugal | 0.09 |
| Chile | <0.01 | Israel | <0.01 | Slovak Republic | <0.01 |
| Czech Republic | <0.01 | Italy | <0.01 | Spain | <0.01 |
| Estonia | 0.02 | Japan | 0.20 | Sweden | <0.01 |
| Finland | <0.01 | Korea | <0.01 | Switzerland | <0.01 |
| France | <0.01 | Luxembourg | <0.01 | United States | <0.01 |
| Germany | <0.01 | Mexico | 0.02 | | |

¹² Actually, the Brexit vote happened on June, 23rd, at the end of the second quarter of 2016. However, for data purposes we set the vote to be carried out at the beginning of the third quarter of 2016.

¹³ By following Abadie and Gardeazabal (2003), we will assign higher weights to those variables that have a higher predictive power on the UK output for the pre-treatment period. This V matrix will be obtained from a cross-validation routine, as in Abadie et al. (2015)

As it is observed, many of the countries have weights that are close to zero, while others, like Canada, Hungary, Japan or Norway more clearly resemble the UK economy. This could be an indicator that the weights are closely capturing the British output, given that the countries with the higher weights are very similar to the UK: they are industrialized Western economies which support free-trade but do not belong to the Euro-Monetary Area.¹⁴ Other minor contributions come from Estonia, Ireland, Mexico or Portugal.

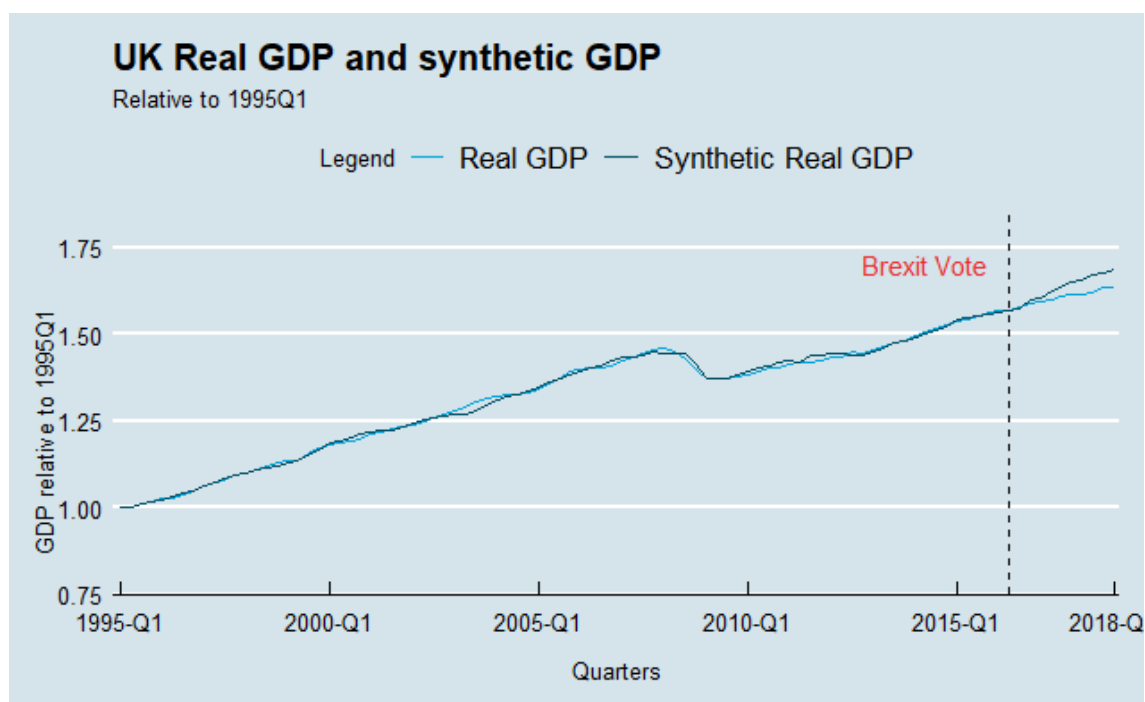
It must be noted that the synthetic has been constructed in two different ways. Firstly, we assume the entire period from 1995Q1 to 2016Q2 to be the pre-treatment and compute the optimal weights for the whole term. In this case, we do not include a validation period. In a second attempt, we divide the pre-treatment period in two sub-periods: the ‘training’, lasting from 1995Q1 to 2005Q2, and the ‘validation’, from 2005Q3 to the Brexit vote. Through this method, we compute the optimal weights in two steps. In the first place, the differences in outputs for the UK and the donor countries are minimized in the training period. As the name suggests, the algorithm is training itself to get the better possible goodness of fit. From this initial optimization problem, the optimal W^* is obtained matching the pre-treatment values of the GDP for the United Kingdom with those of the donor pool countries over the training period and the optimal V^* is obtained minimizing the mean square prediction error over the validation period. Second, we run a second optimization process to find the optimal W for the validation period, taking the optimal V^* matrix computed in the previous step. This way, we get the best possible goodness of fit (or the minimum difference between outputs of treated- and untreated-countries) for the best possible weights. Nevertheless, this two steps method is not suitable when the volatility of the data is not regular along the series, because the second optimization would yield a poor goodness of fit for the non-appropriate previously optimized weights.¹⁵ Accordingly, for simplicity purposes, we will not include a validation period in subsequent calculus, as the differences in methods are not remarkable enough to balance out the problems with certain data series.

Finally, we can now build our synthetic counterfactual by adding the GDP of all donor pool countries properly weighted using the estimated value of W .

¹⁴ Our results are similar to those in Born et al. (2017), pp.7, although with some differences probably due to the time range of the databases used.

¹⁵ As we will face later on for the investment or the exports.

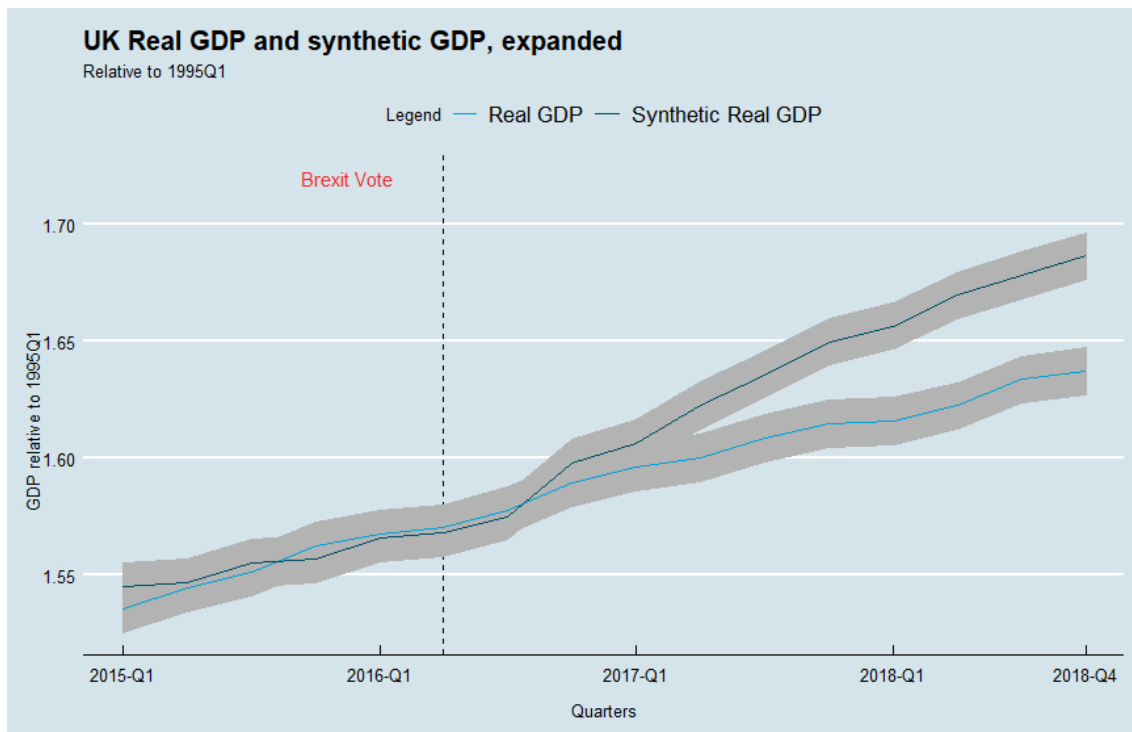
2.2. Estimation results



Graph 1: UK actual GDP and synthetic counterfactual relative to 1995Q1

The main results are displayed in graphs 1 and 2. In the first plot, both time series for the whole sample are represented. The goodness of fit of the counterfactual is very good for all the sample, with small differences in very few quarters. Nevertheless, after the Brexit vote, both series start clearly diverging, the observed output being consistently below the synthetic one. This would point out to the fact that, after the vote, the British economy has lagged behind its expected output levels, had the economy been unaltered by such a vote. This gap could be interpreted as the causal effect of the Brexit vote on the output of the UK, as there is no such a previous deviation.

In the second graph, we focus on the 2015–2018 period to better appreciate the gap in outputs. The causal impact of the Brexit vote can be observed from the third and fourth quarters of 2016 on, some months after the referendum. The gap widens as time goes by, presumably until a Brexit agreement is reached and the uncertainty about the future situation of the British economy vanishes. It must be noticed that the output loss could be permanent. Arguably, when the uncertainty is resolved (both via an agreement or with a no-deal solution), the United Kingdom could return to the pre-Brexit vote growth path, what implies that the UK's GDP would be permanently below the counterfactual. This could mean that even in the case of the UK finally not leaving the

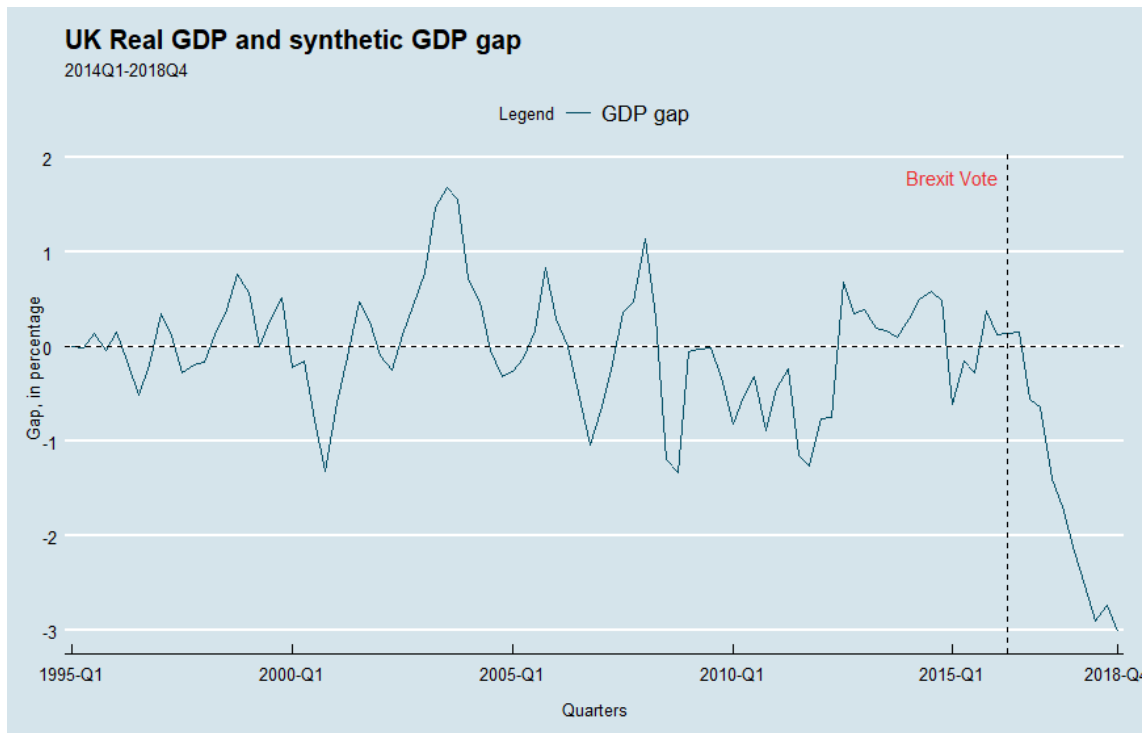


Graph 2: UK actual GDP and synthetic counterfactual relative to 1995Q1 for the 2015-2018 period

European Union, the output gap would not close in years to come. Although the statistical significance analysis is difficult in causal inference, we include in the chart one standard deviation from each time series, represented by the shadowed grey area. We might conclude that the gap between the two outputs is significant provided that their shadowed areas do not overlap from 2017Q1 on.

The estimated gaps are better understood if we have a glance at graph 3. In this third chart, we compute the gap between the observed and the synthetic outputs in percentage points. For the pre-treatment period, the gap oscillated between $\pm 1.5\%$, never exceeding those upper and lower bounds. Indeed, the mean value of the gap for that period was 0.00081%, nearly zero, while the standard deviation was 0.5998.

After the Brexit vote, it is clearly observable a downward trend of the gap. From values close to zero in 2015, the mean gap multiplied by more than 2000, after the gap expanded up to a 3% in the last quarter of 2018, 2 times the maximum gap observed for 1995–2016. The evolution of the gap in percentage points and in accumulated gross quantities is displayed in Table 2.



Graph 3: UK actual GDP and synthetic GDP gap

Table 2: output gaps in percentage points and gross quantities

| <i>Quarter</i> | <i>%</i> | <i>Period gap</i> | <i>Quarter</i> | <i>%</i> | <i>Period gap</i> |
|----------------|----------|-------------------|----------------|----------|-------------------|
| 2016-Q3 | 0.16 | 3995.375 | 2017-Q4 | -2.16 | -56540.159 |
| 2016-Q4 | -0.55 | -14146.917 | 2018-Q1 | -2.52 | -65969.670 |
| 2017-Q1 | -0.64 | -16579.189 | 2018-Q2 | -2.91 | -76306.070 |
| 2017-Q2 | -1.39 | -36255.634 | 2018-Q3 | -2.73 | -72169.065 |
| 2017-Q3 | -1.69 | -44155.149 | 2018-Q4 | -3.01 | -79654.514 |

In 2016, the referendum shock had hardly had any appreciable effect on the output. However, by the third quarter of 2017, approximately a year after the referendum, the output gap in the UK had already exceeded any previous gap since 1995, with a 44 billion dollars loss,¹⁶ around 34.66 billion pounds, or 1.69 % of the British GDP. The economic downturn exacerbated in the following quarters: by the beginning of 2018 it

¹⁶ American billions equal to European milliards, or thousands of millions. The quantities noted here will be expressed in American billions. Also notice that, although measured at quarterly frequency, output loss is annualised.

had gone well over the 2.5% mark, and at the end of that very same year it reached a loss of 3%. For the last data available, the output gap is estimated to be over 79 billion dollars, slightly over the 62 billion pounds. This would amount to as much as 477 million pounds per week.¹⁷ The 62 billion pounds loss corresponds to a £932 loss for each British national¹⁸ or £3263 for every family or household.¹⁹ It must be noted that this quantity significantly exceeds the famous misleading Vote Leave campaign promise of reallocating 350 million pounds from the EU weekly funding to the National Health Service.²⁰ The accumulated loss by 2018Q4 would correspond to a 63% of the total budget allocated to the National Health Service for the 2018–2019 period,²¹ to approximately an 80% of all the budget dedicated to education, a 1.5 times the investment in defense or a 9.6% of the Total Managed Expenditure of the UK Budget for the 2019–2020 budget year.²²

The results obtained from this analysis are much more pessimistic than those set forth in Born et al. (2017). While they predicted a loss of 2% of the output by the end of 2018, our analysis raises that prediction to a 3%. The difference could come from the fact that when the authors of that paper estimated the effect of the Brexit vote there was still no data available for most of 2017 and 2018, and hence, their analysis could have undervalued the effect of the vote.

2.3. Placebo testing

Although there seems to be a breaking point after the Brexit vote, more tests must be carried out to check for statistical significance of the estimated loss. As a matter of fact, there are many variables that could have affected the final result of our estimation, other

¹⁷ Those values were computed by dividing the accumulated estimated output loss in 2018-Q4 by the 130 weeks that go from 2016-Q3 to 2018-Q4.

¹⁸ Computed via the last available data on Total Population for 2018. See the World Bank Database.

¹⁹ 18,997 million families in 2017 according to the Office for National Statistics. See in: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholds/familiesandhouseholds>

²⁰ See the Vote Leave campaign ad in: <https://digital.library.lse.ac.uk/objects/lse:pen598xoz>

²¹ See the budget prospects for the NHS by period in: <https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/nhs-budget>

²² HM Treasury Budget 2018, pp.4. Available online in: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752202/Budget_2018_red_web.pdf

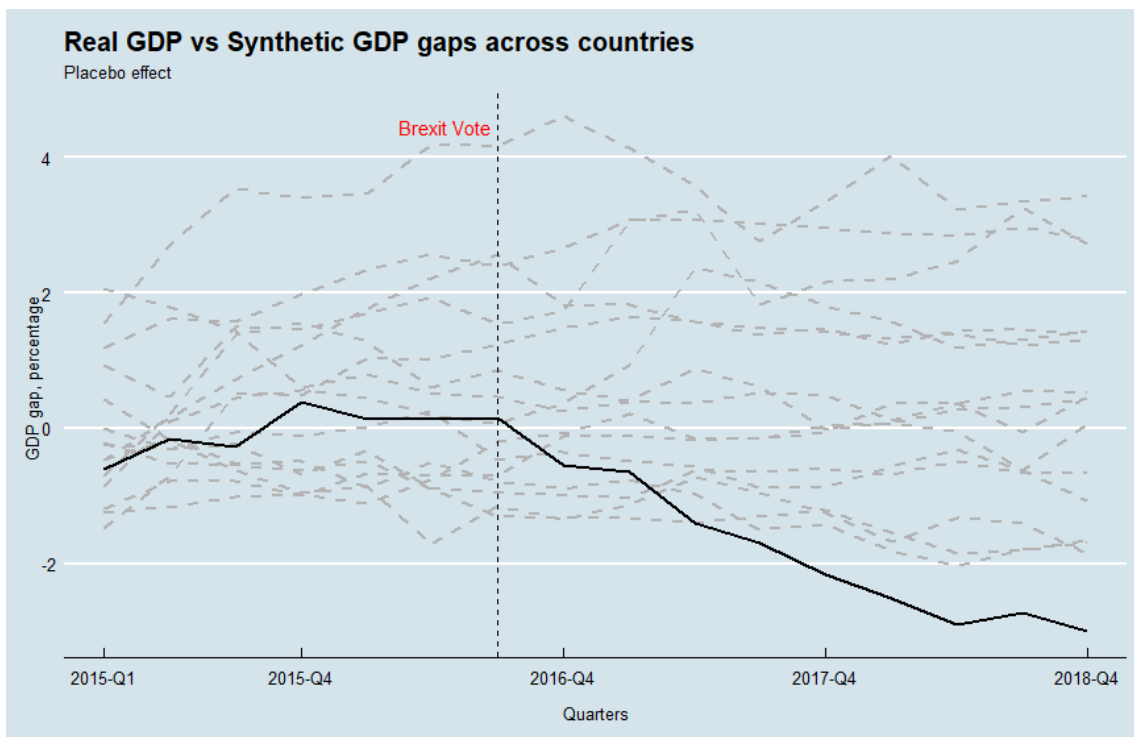
than the referendum itself. Following Abadie et al. (2010) (2015) and Born et al. (2017), some placebo tests will be conducted on the data used.

Through these placebo experiments, we test the two main hypotheses that underlie the causal inference technique employed in the previous sections: that the Brexit vote does not affect other countries and that the change in the output trend happened in 2016Q3, indeed. In short, we try to confirm that the output specifically responded to the Brexit vote by checking that there was no effect on the output when no vote was held: across countries and across quarters. If this were the case, we could consistently assure that there was a causal effect of the referendum.

In the first place, we would like to address the hypothesis of the Brexit vote not affecting the rest of donor pool countries. The synthetic control method rests over the assumption that the treatment does only affect the treated country, the United Kingdom. In this way, we suppose that the rest of countries are not affected by it. However, if this were not the case, the synthetic counterfactual could be biased.

To apply the placebo test to our sample, we set each of the countries in the donor pool as the treated unit and run the algorithm that builds a synthetic counterfactual. The question that we are trying to answer is: did the output of the respective country change the trend in the third quarter of 2016? Once we obtain the 30 synthetic counterfactuals for the UK and the 29 control countries, we compute the gaps between the observed and the constructed outputs. The results are displayed in Graph 4 below, together with the previously obtained gap for the United Kingdom.

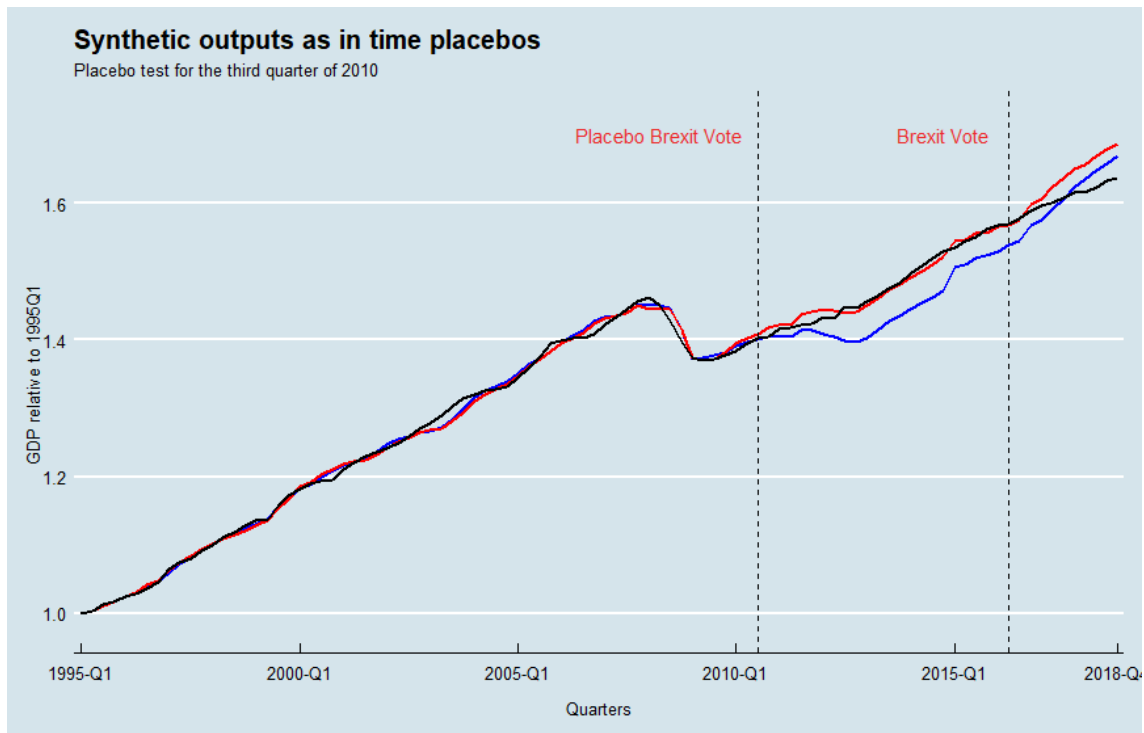
For a better representation, only those countries whose mean square error prior to the vote is less than three times the error from the UK are included in the chart: 15 donor countries and the United Kingdom. The trends differ from country to country, but there is clear widening of the gap for the British output. While in the first half of 2016 the gap was around zero, and in the middle of the countries' distribution, by the last quarter of 2018 the gap for the United Kingdom was the most considerable. This downward trend of the output gap is not observed for the rest of the countries in the donor pool. Consequently, we could conclude that the countries we chose for the comparison are not affected by the Brexit vote, and comprise a good sample. There is no appreciable placebo effect for the countries.



Graph 4: Real GDP vs Synthetic GDP gaps across countries: Placebo effect analysis

Secondly, we would like to test whether the observed causal impact is attributable to the Brexit vote itself. For that purpose, some quarter–placebos will be fulfilled. The synthetic control method will be applied to the output by changing the treatment date for every third quarter between 2000Q3 and 2010Q3. This way, we will obtain 15 synthetic outputs where we assume that the Brexit vote hypothetically happened in those different quarters. The results for the third quarter of 2010, 5 year before the actual Brexit vote, are represented in the following chart.

In this chart, we can observe that there is indeed a placebo effect for the time related synthetics. The black line represents the observed output for the United Kingdom, the red, the original synthetic control taking the third quarter of 2016 as the treatment period. The blue line depicts the synthetic control that arises from varying the treatment period to 2010Q3. There is a significant gap between the counterfactual and the actual GDP for the 2010–2016 period. This would suggest that the in time placebos do not provide internal validity to the analysis, as we observe an output GDP when a fictional Brexit vote is applied. For the placebos to work, we would expect no gap no appear between 2010 and 2016. One placebo not working invalidates the internal validity test.



Graph 5: Synthetic outputs as placebos for the third quarter of 2010

3. The main drivers behind the economic downturn

3.1. The uncertainty and anticipation effects

Three years after the Brexit vote, no solution has been yet delivered by the British government. However, as shown in the previous section, the vote has already significantly impacted the output. The most likely reason for this would be the impact of uncertainty about the future economic condition of the UK on British households and firms.^{23 24}

Born et al. (2017) estimate the individual contribution of both uncertainty and anticipation effects to the output loss. They observe that uncertainty amounts to 1/3 of the loss, while the anticipation captures the rest of the gap, 2/3. These two effects are somewhat conflicting, but are happening together, though. Uncertainty seems to be affecting both the decisions to consume of households and to invest of firms. As they

²³ (Blanchard, L'Huillier, & Lorenzoni, 2013)

²⁴ (Bloom, 2009)

can't be sure about the final deal under which the UK will leave the European Union, they might be deciding to save a higher proportion of their income or profits. Anticipation is also changing the economic decisions in the United Kingdom. Forward-looking agents might be aware of the pessimistic prospects for the following years, and they may be acting accordingly. On this matter, they might be playing the expenditure restraint card to be able to cope with future economic instability.

Forward-looking economic agents –as they are assumed to be in the traditional academic literature– might be differently affected by the downgraded prospects. Additionally, the terms of the economic impact may also play a role in the output loss. Indeed, it must be differentiated between short- and long-term consequences.

The Brexit vote has had some instant consequences that arose just after the voting recount. Firstly, the British pound sterling (GBP) plummeted in the following days as it is observed in the following exchange rates chart: it lost more than a 10% of its value. International pound holders sold millions of that currency in the markets due to the loss of confidence in the economic path that the country was about to take.



Graph 6: British pound Sterling – US Dollar and British pound Sterling – Euro exchange rates Source: Reuters

This depreciation had some immediate impact in the consumption and investment decision of economic agents: exports cheapened, while imports got more expensive.

This condition will be addressed in section 4.4. However, the decrease in the price of exports would be almost cancelled out by the rise in the price of intermediate inputs. This condition is the most likely culprit behind the investment. Investment will be more closely dealt in section 4.3. In addition, the depreciation provoked a significant rise in the inflation of the United Kingdom, which would in the following quarters considerably affect real wages and thus, consumption. This very last issue will be analysed in section 4.2.

The long-term consequences of the Brexit vote are more difficult to estimate. Some research has been made about the future implications on trade and However, this particular issue is hard to present, given that no leave-deal has been yet negotiated.

In the following sections, we apply the synthetic control method as previously has been employed for the GDP. We decompose the output in its main components following the National Accounts' criteria: consumption, investment, public expenditure and balance of trade (exports and imports will be separately addressed). Through this approach, we try to estimate the individual contribution of each component to the output loss. Moreover, we look for the reasons behind it by revising some literature.

3.2. Consumption

Consumption has traditionally captured most of the national income of the United Kingdom. British families' consumption was 63.28% of the GDP in 2018Q1. Were households more prone to be affected by the economic uncertainty caused by the Brexit vote, then their consumption would have faced a significant slowdown for the quarters following the referendum. The instability of consumption under uncertainty shocks has for long been studied in the Economics field. Households usually react fastly about future pessimistic prospects by reducing their consumption and increasing the savings.

The impact of the Brexit vote in the consumption will be estimated by replicating the synthetic control approach in section 3 of this article. For that purpose, we collect gross consumption data from 1995Q1 to 2018Q4 and for the same countries that we previously had. We set the value of consumption in 1995Q1 as 1 and transform the rest of the data in relative terms to that initial value. Again, this will allow us to obtain a

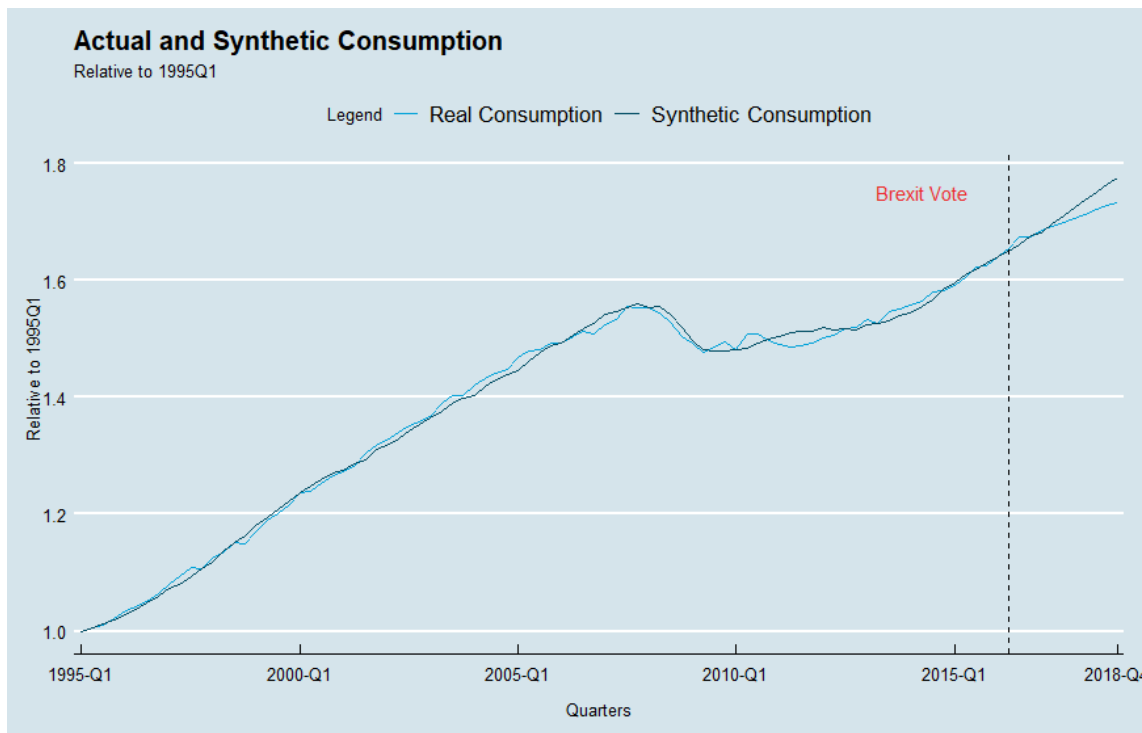
closer synthetic, as gross consumption is subject to more volatility. We will construct a synthetic British consumption series by minimizing the distance between the consumption for the UK and the donor pool countries for the 1995Q1—2016Q2 period. The process strictly follows the one more deeply explained for the output estimation.

Table 3: country weights for the synthetic consumption

| | | | | | |
|----------------|-------|------------|-------|-----------------|-------|
| Australia | <0.01 | Greece | <0.01 | Netherlands | 0.275 |
| Austria | <0.01 | Hungary | 0.172 | New Zealand | <0.01 |
| Belgium | <0.01 | Iceland | <0.01 | Norway | <0.01 |
| Canada | <0.01 | Ireland | <0.01 | Portugal | <0.01 |
| Chile | <0.01 | Israel | <0.01 | Slovak Republic | <0.01 |
| Czech Republic | 0.03 | Italy | <0.01 | Spain | <0.01 |
| Estonia | 0.06 | Japan | 0.03 | Sweden | <0.01 |
| Finland | <0.01 | Korea | <0.01 | Switzerland | <0.01 |
| France | <0.01 | Luxembourg | <0.01 | United States | 0.375 |
| Germany | <0.01 | Mexico | 0.05 | | |

Table 3 summarises the weights obtained from running the algorithm that selects the best composition of donor countries so as to minimize the differences in consumption for our sample. The results are again suitable for the United Kingdom: the countries with the highest weights are the United States, Netherlands and Hungary, all Western economies with similar patterns of consumption. There are also small contributions from the Czech Republic, Estonia, Japan or Mexico. We can observe that most of the economies replicate the United Kingdom in having their own currency and hence, independent monetary policy.

As noted in section 3, the synthetic counterfactual for the consumption will be carried out in a single spell, treating the period that goes from 1995Q1 to 2016Q2 as a unique pre-treatment. We can build up the synthetic consumption by adding the weight for each country multiplied by its consumption data.

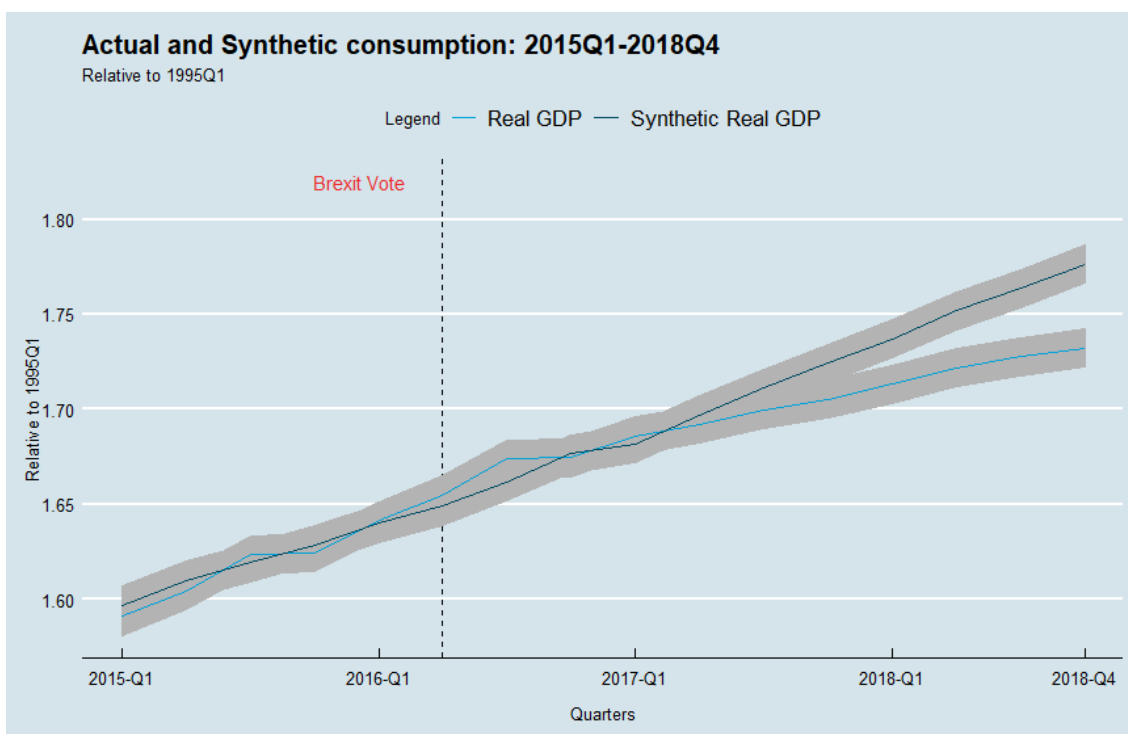


Graph 7: Actual and synthetic consumption series for 1995Q1 – 2018Q4, relative to 1995Q1

Both time series are plotted in chart 7 above. Although the goodness of fit between them is not as precise as it was for the output, the square error of the difference is still small enough to validate the estimation. The most problematic part is around 2010, where the synthetic doesn't capture well the peaks in consumption. This problem could be due to both the economic crisis that struck Europe at that time and the monetary and fiscal policies that the British government took to mitigate its effects. However, an important divergence between the two series can be observable after the Brexit vote, in the right-hand side of the graph. This change in the trend can be better noticed if we restrict the series to the 2015Q1–2018Q4 period as in graph 8 below.

There are two evident different periods in the chart. Between 2015 and 2016, the gap tends to zero. This means that the synthetic was good in capturing the movement in the actual consumption. We might say that the co-movement between the two series was high. The widening of the gap between the actual consumption and the one that would have arose had the Brexit vote not been held is clear from 2017 on. The gap seems to be growing over time, presumably until a Brexit agreement is signed and uncertainty vanishes. As the statistical significance is difficult to test in causal inference, a one

standard deviation band is included around the series. This can help us understand that the gap is significant when both bands do not overlap anymore. This happens approximately around the last quarter of 2017, a year after the vote.



Graph 8: Actual and synthetic consumption series for 2015Q1 – 2018Q4, relative to 1995Q1

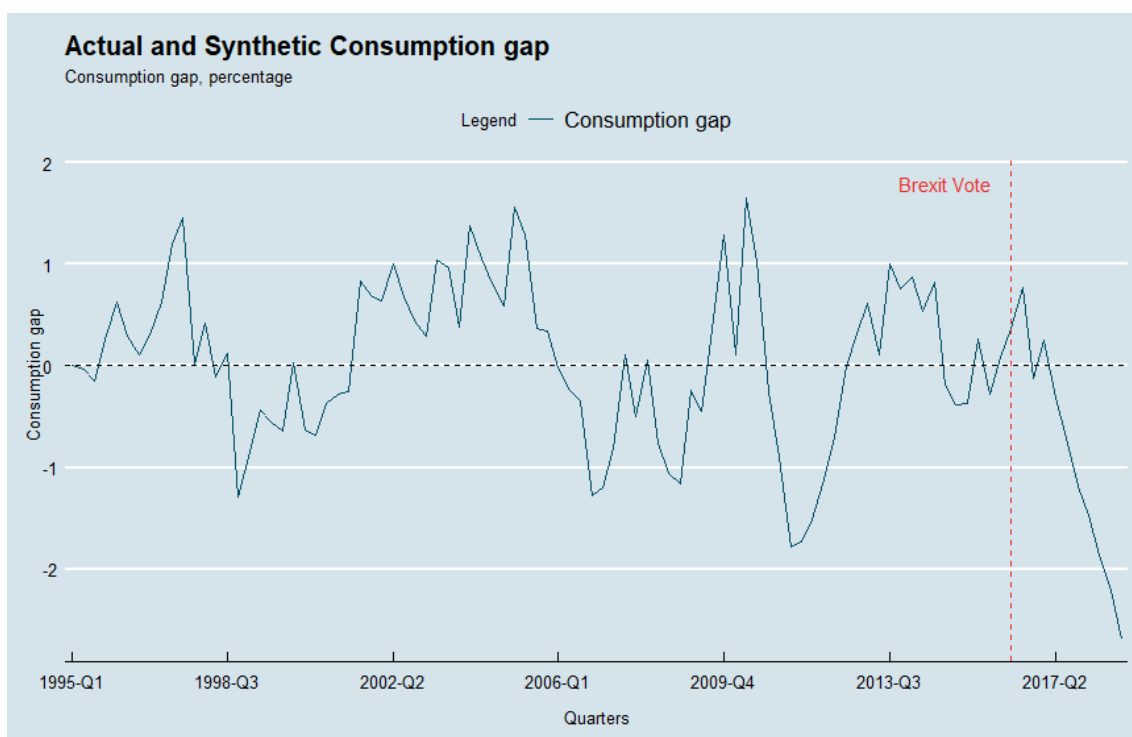
The magnitude of the gap with respect to the *should be* scenario is displayed in numbers in Table 4 and graphically in the following chart 9.

Table 4: consumption gaps in percentage points and gross quantities

| <i>Quarter</i> | <i>%</i> | <i>Period gap</i> | <i>Quarter</i> | <i>%</i> | <i>Period gap</i> |
|----------------|----------|-------------------|----------------|----------|-------------------|
| 2016-Q3 | 0.73 | 1194440 | 2017-Q4 | -1.12 | -18794.85 |
| 2016-Q4 | -0.12 | -1979.63 | 2018-Q1 | -1.38 | -23361.78 |
| 2017-Q1 | 0.23 | 3888.15 | 2018-Q2 | -1.74 | -29578.43 |
| 2017-Q2 | -0.31 | -5079.65 | 2018-Q3 | -2.09 | -35596.85 |
| 2017-Q3 | -0.67 | -11251.99 | 2018-Q4 | -2.53 | -43191.35 |

As mentioned above, goodness of fit for the consumption is not as good as for the output. Consumption is much more volatile than output, although less than other

variables as investment or exports. This leads to more regular gaps, and of bigger magnitude. The large goodness of fit gap in 2010 can be observed in the second half of the graph. However, if we choose to omit that event, the widening of the gap as a consequence of the Brexit vote is clear. Except for the aforementioned 2010 difference, the consumption gap in our estimation does not exceed the $\pm 1.5\%$ barrier. The mean gap for the 1995Q1–2016Q2 period is $+0.07\%$, while the standard deviation is 0.7338. After the Brexit vote, one year is enough for the gap to exceed the -1.5% bound. It does even go further, as it is displayed in Table 4. For the post-treatment period, the mean gap escalates to a value of -0.9% , 12 times the pre-treatment mean. The standard deviation for that very same period is 1.0568, signaling that the volatility of the consumption has grown after the referendum. As the two periods compared are not



equal in size, we must wait some more quarters to check whether consumption has indeed suffered a severe slowdown or if the widening of the gap is a temporary situation due to the uncertainty.

Graph 9: Actual vs synthetic consumption gap in percentage, whole series

Table 4 gathers the consumption gap evolution in numbers. Actual and synthetic consumption start departing one from another at some point in 2017. By the end of that year, the gap breaks the 1% mark, with an accumulated loss of consumption of 18.79

billion dollars, or almost 15000 million pounds. The difference accelerated in 2018, to exceed the 2% bound halfway through that year. The last data available generates a consumption gap of 2.53%, which in monetary terms would mean a loss of 43.191 billion dollars, or more than 34000 million pounds. This quantity would amount to a 42.68% of the whole loss for the output in the United Kingdom estimated in section 3, or a 1.3% loss of the output. It is equivalent to a £261 million weekly loss in consumption with respect to the no Brexit vote hypothetical situation. In other words, each British citizen would have already lost £511.38 in consumption as an effect of Brexit, or £1.789,75 for every household. These figures can be easily compared to the situation prior to the Brexit vote. As estimated by the StrongerIn referendum campaign, every household used to contribute with £340 annually, compared to the estimated £3000 that they received in exchange.²⁵

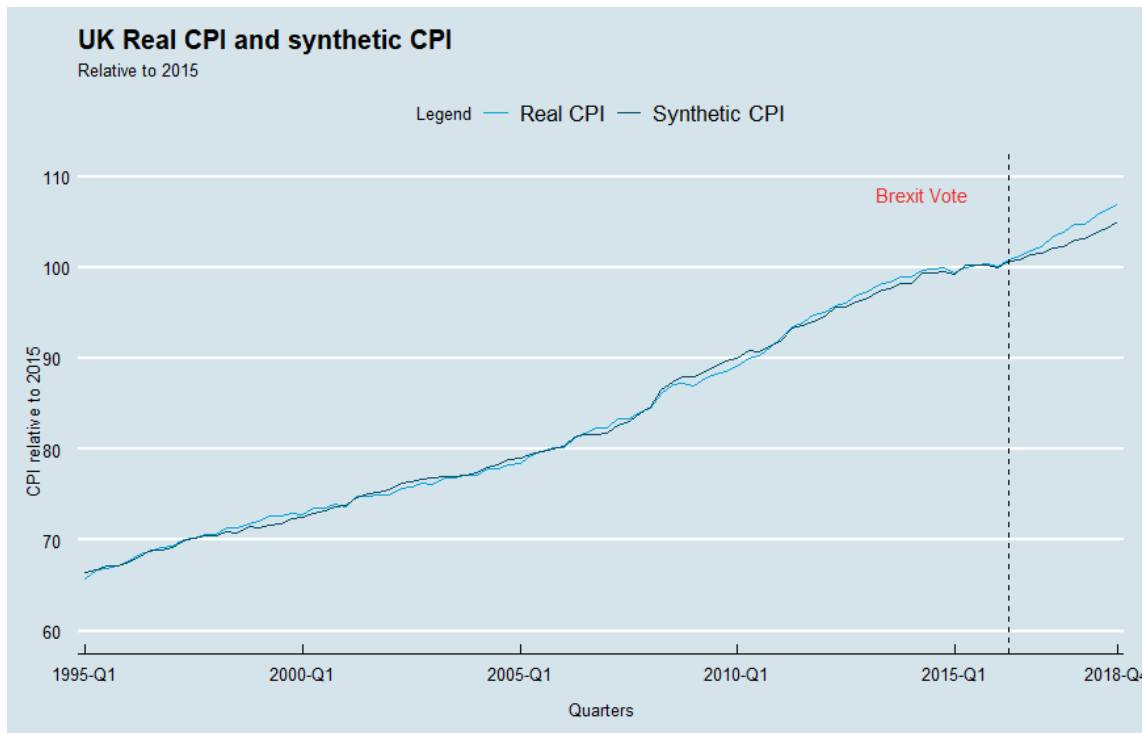
Even though the existence of an impact on consumption has already been analysed, the conveyor belt through which the Brexit vote is affecting families' decisions is still to be untangled. Breinlich et al. (2017) firstly addressed the impact of the vote on the British households' living standards mainly via the CPI inflation²⁶ and the depreciation of the pound.

For that purpose, they compare in the first place the actual CPI inflation in the United Kingdom with that from other European countries for the 2015–2017 period. They conclude that the CPI from the UK has consistently departed from the CPI for the rest of the countries since the Brexit vote.

With more data available, the conclusions from that paper will be checked for the whole 1995–2018 period via the synthetic control method. If inflation has indeed been affected by the Brexit vote, then the loss of consumption previously found could be due to this erosion of British families' purchasing power. Consumption might be at a standstill because real wages are falling as a consequence of growing unexpected inflation and stagnant nominal wages. Following the previously explained estimation technique, we construct a synthetic series for the CPI inflation of the United Kingdom. The two series are displayed in the following graphs:

²⁵ See in: <https://www.strongerin.co.uk/economy#CSbmZrfbvdYglzH2.97>

²⁶ Consumer Price Index inflation.



Graph 10: UK real CPI inflation and synthetic CPI, 2015 = 100

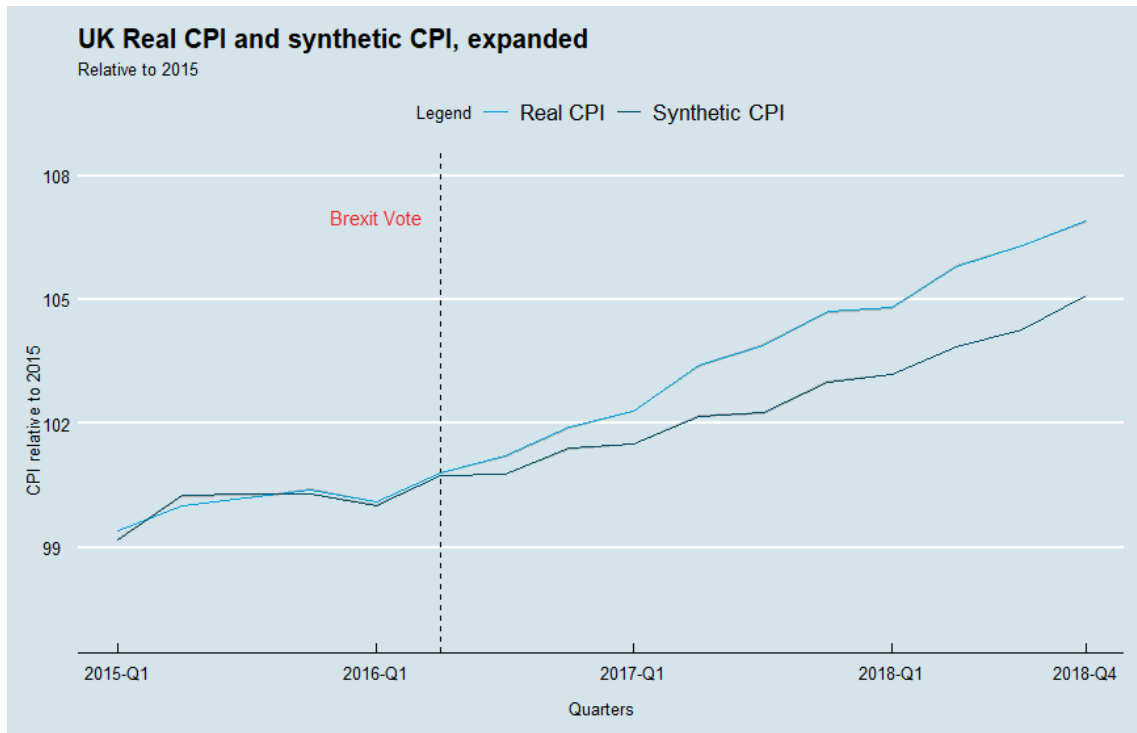
The goodness of fit from 1995 to 2016 is good enough to trust the causal effects of the Brexit vote in the inflation, measured by the Consumer Price Index. From 2016Q3 on, we observe a widening gap between the observed inflation and the hypothetical one, had the Brexit vote not happened. The size of the gap is better understood if we restrict the chart to the 2015–2018 period, as in graph 11.

Until the Brexit vote, the gap between the actual CPI inflation for the United Kingdom and the synthetic CPI regularly oscillated between $\pm 1\%$. In 2016Q3, the trend is broken, and inflation escalates up to a 2%. As for the inflation rate of the United Kingdom,²⁷ it got from 0.5% in June 2016 up to 3% by the end of 2017. Since then, it dropped to the 2% mark, where it has remained until now.²⁸ This inflation raise is estimated in Breinlich et al. (2017) to have costed around £408 per year to British households, the equivalent of 56% of the total consumption loss of £1.789,75 that was estimated above.²⁹ They do also refer to the fact that the inflation raise, together with the nominal wages being constant, has led to British workers losing as much as a week's pay because of the fall in real wages.

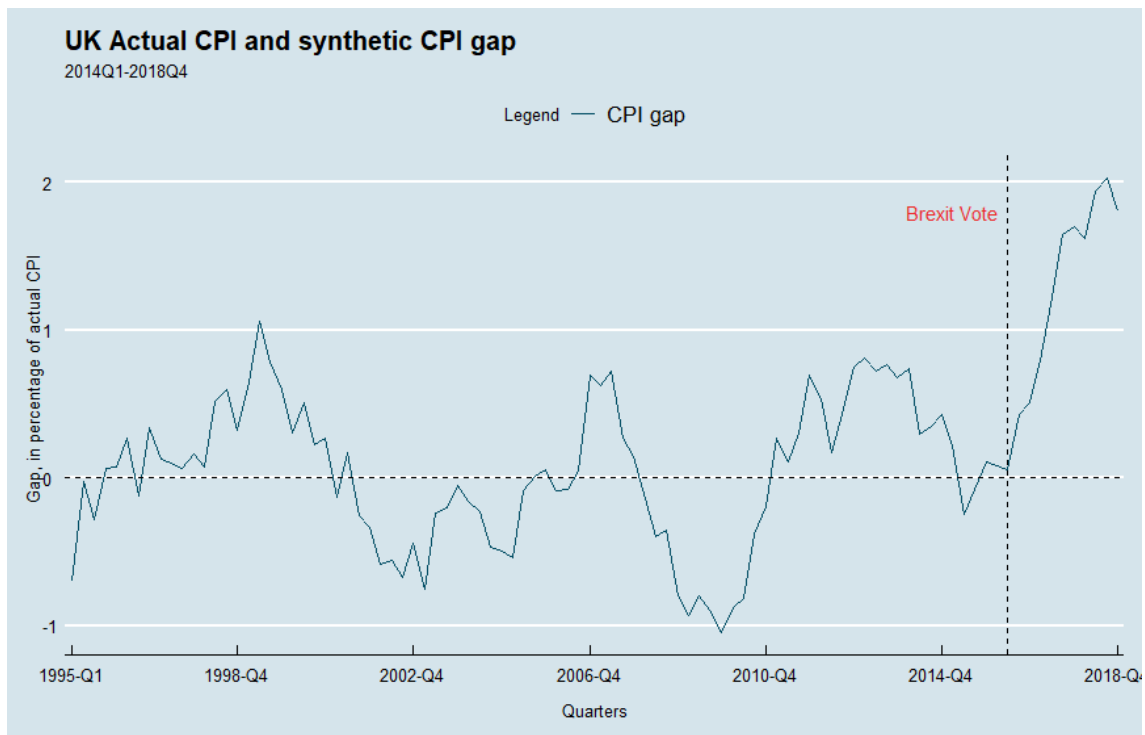
²⁷ Calculated as the variation in the CPIs between periods.

²⁸ See the inflation evolution in: <https://tradingeconomics.com/united-kingdom/inflation-cpi>

²⁹ Breinlich et al. (2017), pp. 2



Graph 12: UK real CPI inflation and synthetic CPI, 2015-2018 period, 2015 = 100



Graph 11: UK actual CPI and synthetic CPI gap, in percentage of the actual CPI inflation

Secondly, Breinlich et al. (2017) turn their attention to the depreciation of the pound in order to explain the raise in inflation, and hence, the gap in consumption. They isolate the different products in a usual consumption basket (through which the CPI is calculated) by their import shares. If inflation was indeed a consequence of the depreciation of the pound, two differentiated effects should be observable in the consumption basket. Those goods and services with higher external exposure should suffer higher inflation, because the fact of imports becoming more expensive makes those products more expensive too. On the contrary, those goods mainly produced in the United Kingdom should have faced lower inflation rates. Dividing all the goods and services into high exposure and low exposure categories, they find a clear break in the tendency around the Brexit vote.³⁰ Until 2016Q3, both series had oscillated around zero, as it was a period of low inflation. However, high import exposure products' prices started rising after the vote, reaching a maximum of an almost 6% inflation in the midst of 2017. Low import exposure products, meanwhile, had an inflation of around 0–2% for the same period. This study provides robust proof that the consumption loss of the British households is derived from the immediate depreciation of currency that succeeded the vote: those goods and services that have faced the higher inflation peaks (those with higher import exposure) are the most usual ones in the common British consumption basket.³¹

3.3. Investment

Investment has historically had a significant weight on the national income of the United Kingdom. Investment in the British economy was 17.22% of the GDP in 2018Q1,³² down from the maximum levels observed some decades ago. The tertiarisation of the British economy, particularly since the boom of financial and other services in the 80s, has pushed investment down. However, some manufacturing sectors

³⁰ Breinlich et al. (2017), pp. 7

³¹ Such as Bread and cereals, Milk, cheese and eggs, Coffee, tea and cocoa, Beer, Wine, Furniture and furnishings. See the entire list in: Breinlich et al. (2017), pp. 8

³² See the evolution of investment in: IMF Cross Country Macroeconomic Statistics, UK, National Accounts

are still very intensive in capital investment. Additionally, foreign direct investment³³ is a crucial part of British investment. For the last data available, in 2017 inward FDI reached up to £1336.5 billion, a 4.6% of the UK GDP,³⁴ while outward FDI was £1,313.3 billion, leaving a slightly negative net FDI investment position.³⁵ The impact of Brexit on domestic investment will be analysed in the first place, with the foreign direct investment coming next.

Since investment requires medium– and long–term decisions, uncertainty about the future condition of the economy tends to increase volatility. This particular feature of investment will complicate the analysis of the impact of the Brexit vote in it, as it quickly reacts to uncertainty, announced interest rate changes and future economic prospects. Additionally, we should take into account that foreign direct investment is even more volatile as the national one. All these will lead to a non–smooth evolution of investment that will certainly hurt the accuracy of the synthetic control.

The impact of the Brexit vote in the investment will be addressed by applying the synthetic control method set forth in section 3 of this article. We will use the gross fixed capital formation³⁶ data for the 1995Q1–2018Q4 period as a proxy for investment. The same 30 countries are chosen for the analysis. As in the previous cases, we set the value of 1995Q1 to 1 and normalise the rest of values with respect to that one. This particular measurement of the investment will yield a better goodness of fit than the gross quantities or the proportion of investment of the GDP. We construct a synthetic investment by minimizing the distance between the British and the donor pool countries' GFCF for the pre–treatment period. The countries with largest contributions to the prediction of investment in the United Kingdom are assigned bigger weights.

Those weights obtained from the algorithm that gives the optimal solution are displayed in Table 5 below. As expected, countries with similar economic frameworks better help increase the goodness of fit for the United Kingdom, such as Germany, Japan, New

³³ Usually shortened as FDI

³⁴ World Bank Databank, World Development Indicators, Foreign Direct Inflows, % of GDP

³⁵ Detailed data on UK foreign investment can be found in:

<https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/foreigndirectinvestmentinvolvingukcompanies/2017>

³⁶ Official definition by the NBER: *The Gross Fixed Capital Formation, or GFCF, is a measure of investment included in the expenditure measurement of GDP. It is calculated by subtracting the disposals to the acquisitions of fixed assets by firms, the government or households. In this sense, it is a good approximation of the investment in the national firms.*

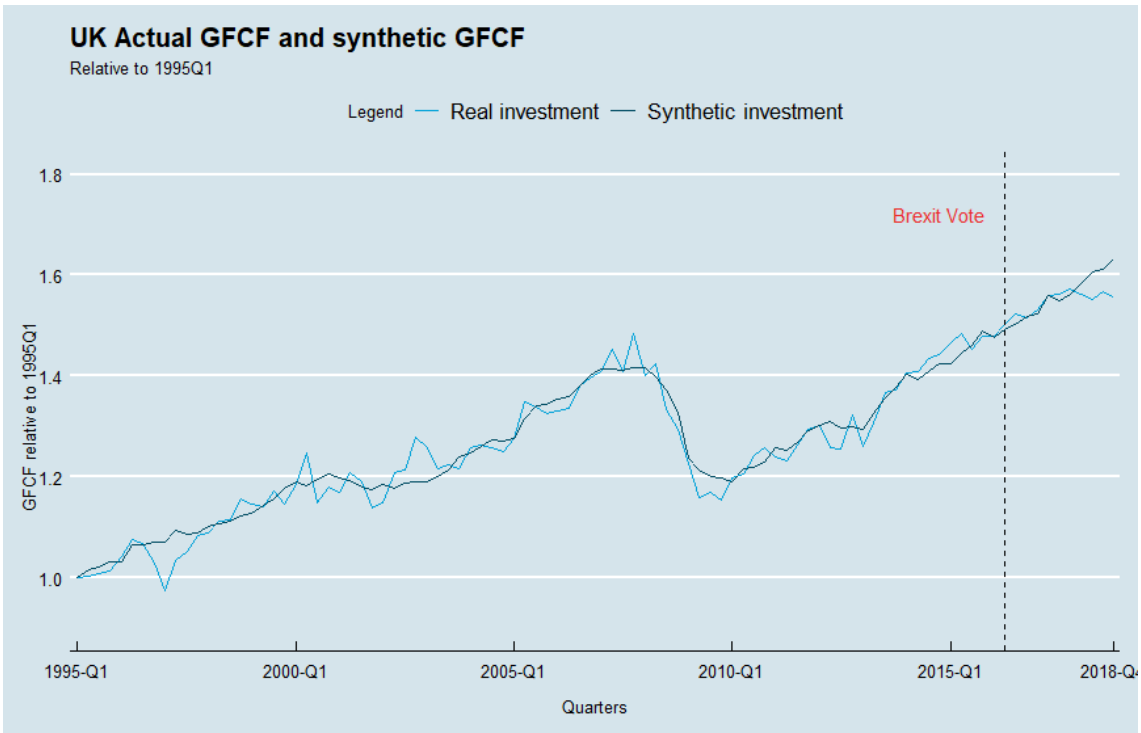
Zealand or Switzerland. There are also minor contributions from Estonia, Hungary, Spain and the United States.

Table 5: country weights for the synthetic investment

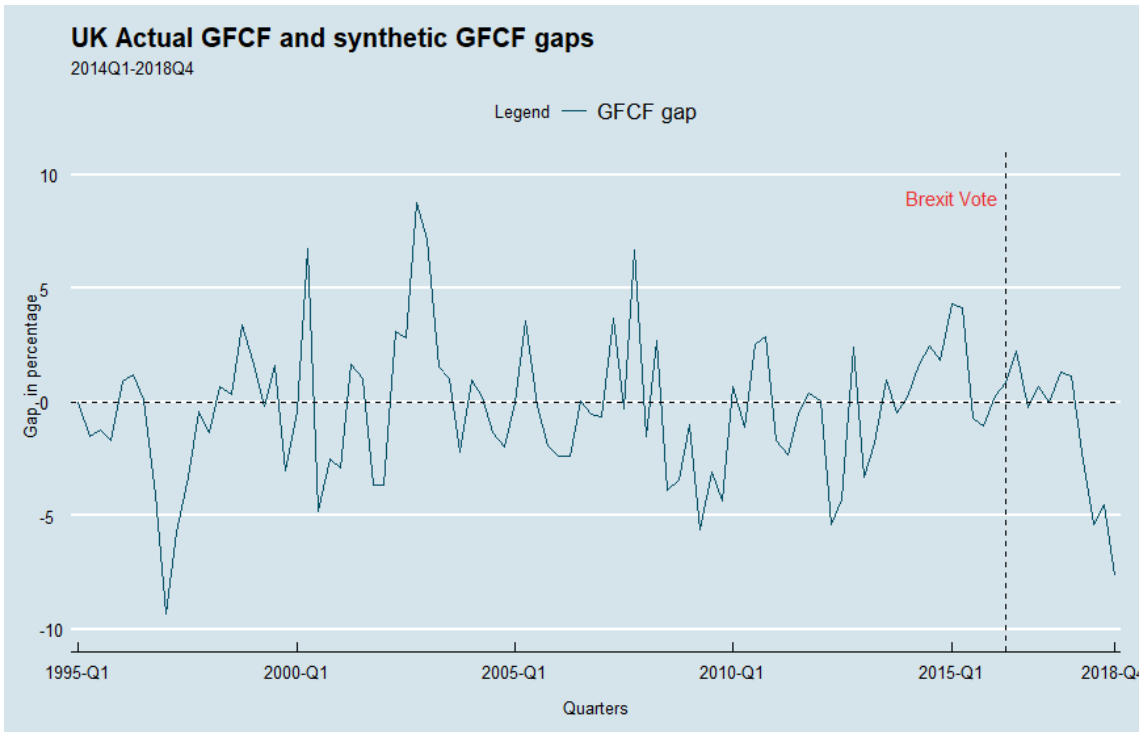
| | | | | | |
|----------------|-------|------------|-------|-----------------|-------|
| Australia | <0.01 | Greece | <0.01 | Netherlands | <0.01 |
| Austria | <0.01 | Hungary | 0.06 | New Zealand | 0.10 |
| Belgium | <0.01 | Iceland | <0.01 | Norway | <0.01 |
| Canada | <0.01 | Ireland | <0.01 | Portugal | <0.01 |
| Chile | <0.01 | Israel | <0.01 | Slovak Republic | <0.01 |
| Czech Republic | <0.01 | Italy | <0.01 | Spain | 0.05 |
| Estonia | 0.02 | Japan | 0.31 | Sweden | <0.01 |
| Finland | <0.01 | Korea | <0.01 | Switzerland | 0.16 |
| France | <0.01 | Luxembourg | <0.01 | United States | 0.06 |
| Germany | 0.23 | Mexico | <0.01 | | |

Once we have the optimal weights, we can construct the synthetic as explained before: for each period, we multiply the weights by the investment data for each country. We then display both the actual investment series for the United Kingdom and the counterfactual in the following graph 13.

Unsurprisingly, the synthetic counterfactual fails to fit the investment at many periods, due to the great volatility of it. However, this find doesn't completely discard the possibility of reaching some interesting conclusions. Big gaps against the actual investment suggest negative shocks, while big gaps in favour mean positive ones. Taking this into account, a significant gap can be observed some quarters after the Brexit vote. This difference between the series is better understood if include the time evolution of the gaps.



Graph 14: UK actual investment and synthetic counterfactual measured by the GFCF, relative to 1995Q1



Graph 13: UK actual investment and synthetic counterfactual gaps, in percentage points

Gaps tend to be large across the time series. There are some peaks that almost reach the 10% difference, although the gap is usually between $\pm 5\%$. After the Brexit vote, the

investment gap is clearly widening, well over the -7% lower-bound. That downturn would mean an estimate of \$21,85 billions, or 17,43 billion pounds. Nevertheless, we couldn't conclude whether this investment loss with respect to the hypothetical no vote scenario is attributable to the vote itself or other underlying reasons. This comes from the poor goodness of fit that we observe.

We then revise some related literature so as to determine whether after the Brexit vote there's been a negative impact on investment or not. There is not much work done on British domestic investment, due to the complexity of isolating the Brexit vote effect from other effects. Notwithstanding that, many papers have focused in the impact on outward and inward investment flows, much more affected by uncertainty and anticipation effects. We divide the analysis into two parts: firstly, the investment of British firms abroad; then, the foreign direct investment in British soil.

Breinlich et al. (2019)³⁷ apply the synthetic control methods to establish whether there's already been a capital flight in the United Kingdom. Indeed, they find that both British firms and international companies set up in British land have started to move some of their activities to other European or American countries. Hence, they would be anticipating the future barriers to their activity once Brexit is implemented and thus, moving to EU Member States to avoid trade or regulatory frictions. They estimate that the Brexit vote has led to a 12% increase in British firms' investment in EU countries by the beginning of 2019, fundamentally in the service sector.³⁸ In numbers, this increase would amount to £8.3 billion, which would probably have been invested domestically had the Brexit vote not happened. This capital flight could be partly behind the drop in investment that we accounted for in our synthetic trial.

At the same time, Breinlich et al. (2019) do also investigate the EU investments in the United Kingdom. If Brexit would mean the construction of a tall wall between the UK and Europe neighbours, it is to expect that European companies wouldn't want to risk by investing in British soil. Actually, they find a 11% drop in EU investments on the other side of the English Channel, amounting to £3.5 billions. This lessening in investment has probably slowed the jobs creation and general activity in the UK. The

³⁷ Holger Breinlich, Elsa Leromain, Dennis Novy and Thomas Sampson (2019). *Voting with their Money: Brexit and Outward Investment by UK Firms*. CEP Brexit Analysis No. 13. London School of Economics and Political Science.

³⁸ Principally from the financial sector and its complementary services, which will be briefly addressed in section 4.6.

conclusions reached in this paper are consistent with the observed data from the UK Office for National Statistics, which has already noticed an abrupt slowdown in EU investments in the UK, together with some acceleration in the outward investments.³⁹

3.4. Balance of trade

Trade is one of the riskiest and yet most important issues regarding Brexit. Firstly, it is relevant because of its significant contribution to the output of the United Kingdom. That country has always been very closely related to trade, and it still is. In 2016, exports were a 30.53% of the GDP, while imports were at 31.43%.⁴⁰ An estimate of 8% of all British enterprises sold goods and services abroad for the same period, including the big exporting companies that employ tens of thousands of workers.⁴¹ That number would certainly and significantly grow if we accounted for all the companies that import intermediate consumption goods and services.

Second, trade between the United Kingdom and its neighbouring countries rose to a 47% of all exports in 2017, with the remaining 53% being with the rest of the world.⁴² In 2017, the UK exported to the EU £274 billion worth goods and services, while they imported for a value of £341 billion. In consequence, the United Kingdom runs a trade deficit with their continental counterparts, which could clearly be affected after Brexit. More important, according to a report by the Department for Business Innovation & Skills of the British government, of the 8% of Small and Medium Enterprises (SMEs) that export their products or services, 82% of them did so to the European Union.⁴³ If no supplementary agreement were reached after the Brexit and tariffs were imposed on British exports, those SMEs would be the most affected.

³⁹ *Foreign direct investment involving UK companies: 2017*. Office for National Statistics. See the complete document in: <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/foreigndirectinvestmentinvolvingukcompanies/2017>

⁴⁰ ONS Balance of Payments Dataset.

⁴¹ ONS Annual Business Survey (ABS)

⁴² ONS Balance of Payments Dataset: Exports, European Union and Exports: Total Trade in Goods & Services.

⁴³ *BIS estimate of the proportion of UK SMEs in the supply chain of exporters*, May 2016

Thirdly, the estimate for the exports of EU countries in global terms ranges from 8% to 18% of total exports, making the United Kingdom its second trading partner, only behind the United States, and immediately ahead of China.⁴⁴ For some European countries, like Ireland, the United Kingdom is the main trade partner when it comes to imports. For others, like Germany or Spain, the UK represents a major part in the exports. In consequence, any trade shock that affected the British trade sector would certainly hurt the economies of some European countries too.

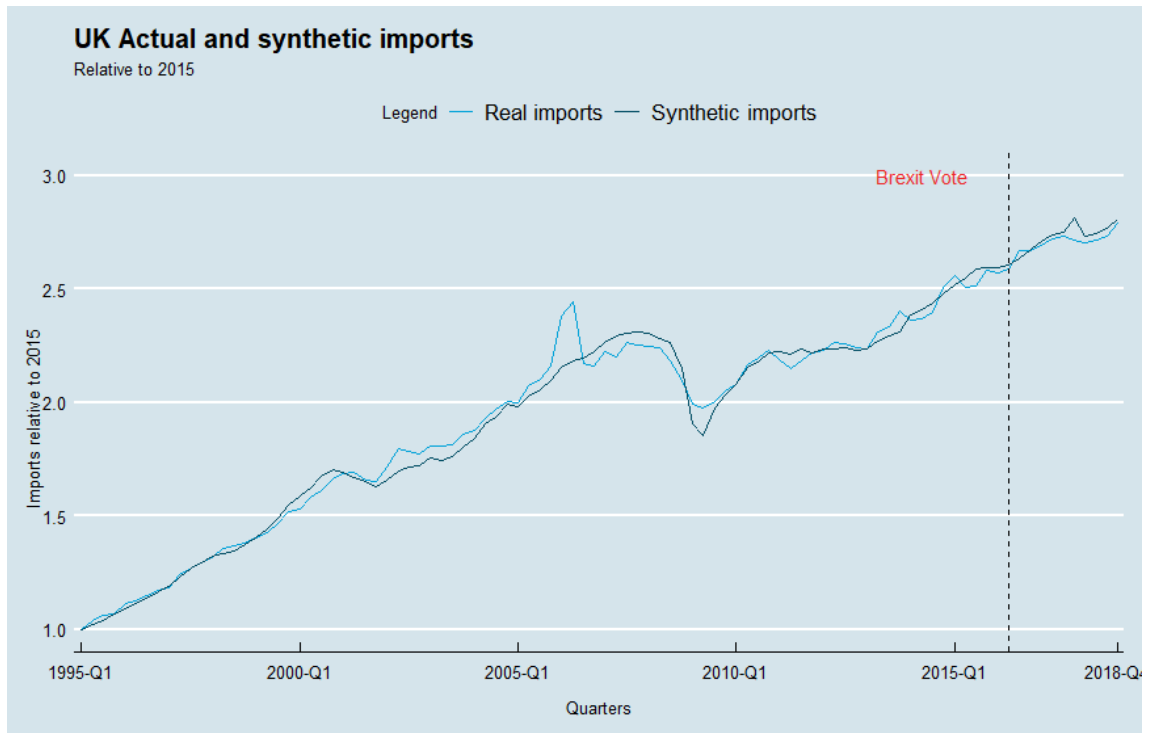
Fourth, and last, the trade shock derived from the rupture of UK–EU relations will completely depend on the deal that is finally signed. On the one hand, should the UK decide to remain being a participant in the EU Single Market by applying to be a member of EFTA,⁴⁵ then trade wouldn't suffer many frictions, at least in the medium– and long–run. On the other hand, if the country negotiated to leave the EU with no deal at all, thus instantly losing access to EU customers, trade would probably suffer a devastating effect. Even with negotiations open with third countries, the effect of trade barriers imposed on many products could be devastating for the service sector and many export–oriented manufacturing companies.

To capture the possible short–run effect of the Brexit vote on the balance of trade, we fulfill two separate analysis' for the UK exports and imports. Due to the depreciation of the British pound, we expect some effect to be observable. The method that we use is the same as previously: the synthetic control. We skip the methodological part and jump directly to the graphical results for simplification purposes.

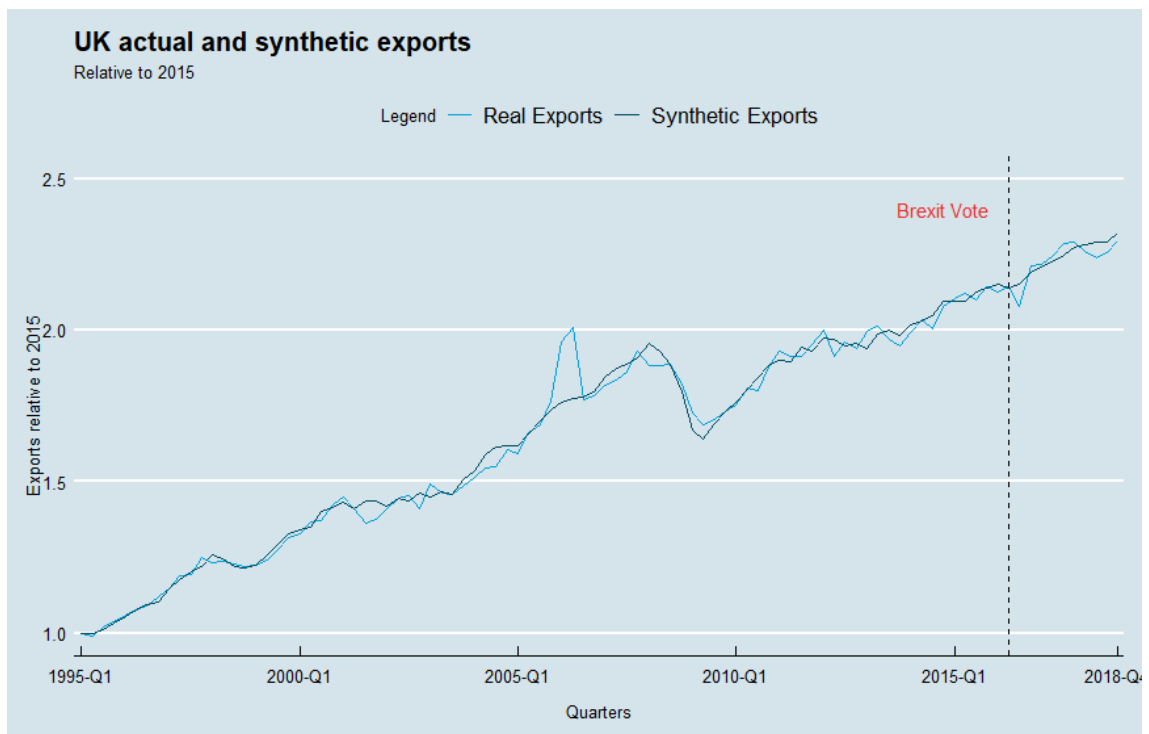
As expected, goodness of fit for both the imports and the exports is not good enough to yield reliable conclusions. However, there are some features of the series than must be noted. The depreciation of the pound that was mentioned above might have changed the trade dynamics for the United Kingdom, although not very significantly. The depreciation must have made exports more competitive, as foreign companies find it now cheaper buying from British firms; imports, in the meantime, have increased their price, because buying from foreign countries is now more expensive.

⁴⁴ European Commission Trade Helpdesk (2018)

⁴⁵ European Free Trade Agreement: regional free trade agreement area consisting of Iceland, Norway, Liechtenstein and Switzerland, which, not being part of the European Union, closely collaborate with it through their external participation in the Single Market or the Schengen Area.



Graph 15: UK actual and synthetic imports, relative to 1995Q1



Graph 16: UK actual and synthetic exports, relative to 1995Q1

If we observe the evolution of exports, there is a small gap around 2017. The gap is negative, which means that the synthetic predicts higher exports than they actually were. Those countries in the donor pool were steady in exports at that time, but those in the United Kingdom suffered a minor decrease. Up to 2018, the gap seems to have closed

again. It must be noted that the poor quality of the goodness of fit might invalidate this result, as similar gaps are observable through the whole series. This could indicate that the gap might come from problems with the fit, and not from the Brexit vote itself.

Imports, however, do not seem to have significantly diverged from the synthetic counterfactual. Although there is a small gap after the vote, both series then come to converge again. As we can't decompose the imports into different categories of products, we can't determine whether imports have been affected by the referendum.

Both exports and imports are certainly going to be affected by the breakup from the EU, but currently, there are no signs of trade frictions due to the uncertainty or anticipation from the vote.⁴⁶

3.5. Public expenditure

In the last five years, the British different governmental authorities' public expenditure has consistently remained around a 38% of the GDP.⁴⁷ Prior to the Brexit vote, the budget deficit in the United Kingdom was closing at a steady path, due to increasing tax revenues.⁴⁸ This allowed the government to allocate more resources to the NHS or local authorities. However, it is likely that consumption and investment gaps shown in previous sections might have already affected the financial stability of the budget.

We analyse the impact of Brexit by following the same procedure as before. We obtain data for public expenditure for the 1995Q1–2018Q4 period for the same 30 donor countries plus the United Kingdom. We then construct our counterfactual public expenditure with the optimal weights that are enlisted below:

⁴⁶ (Dhingra, 2017)

⁴⁷ It accounts for an 18% of the aggregate demand (or GDP via the expenditure approach) for the same period, making it the second component after private consumption. Data from the UK Office for National Statistics. See in: <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/publicsectorfinance/bulletins/publicsectorfinances/december2018#links-to-data-and-related-publications>

⁴⁸ Springford, J. (2019). The cost of Brexit to september 2018. *Centre for European Reform*.

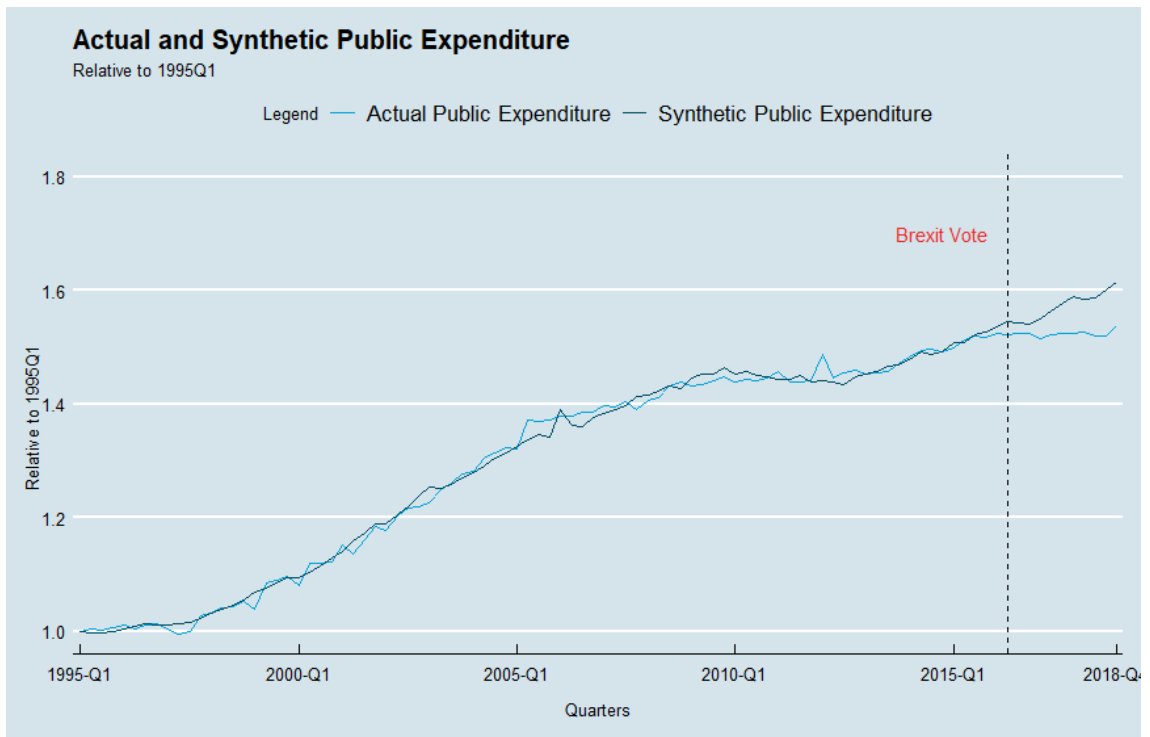
Table 6: country weights for the synthetic public expenditure

| | | | | | |
|----------------|-------|------------|-------|-----------------|-------|
| Australia | <0.01 | Greece | 0.09 | Netherlands | <0.01 |
| Austria | <0.01 | Hungary | 0.24 | New Zealand | <0.01 |
| Belgium | <0.01 | Iceland | <0.01 | Norway | <0.01 |
| Canada | 0.09 | Ireland | 0.02 | Portugal | 0.13 |
| Chile | <0.01 | Israel | <0.01 | Slovak Republic | <0.01 |
| Czech Republic | <0.01 | Italy | <0.01 | Spain | 0.06 |
| Estonia | 0.11 | Japan | <0.01 | Sweden | <0.01 |
| Finland | <0.01 | Korea | <0.01 | Switzerland | <0.01 |
| France | <0.01 | Luxembourg | 0.25 | United States | <0.01 |

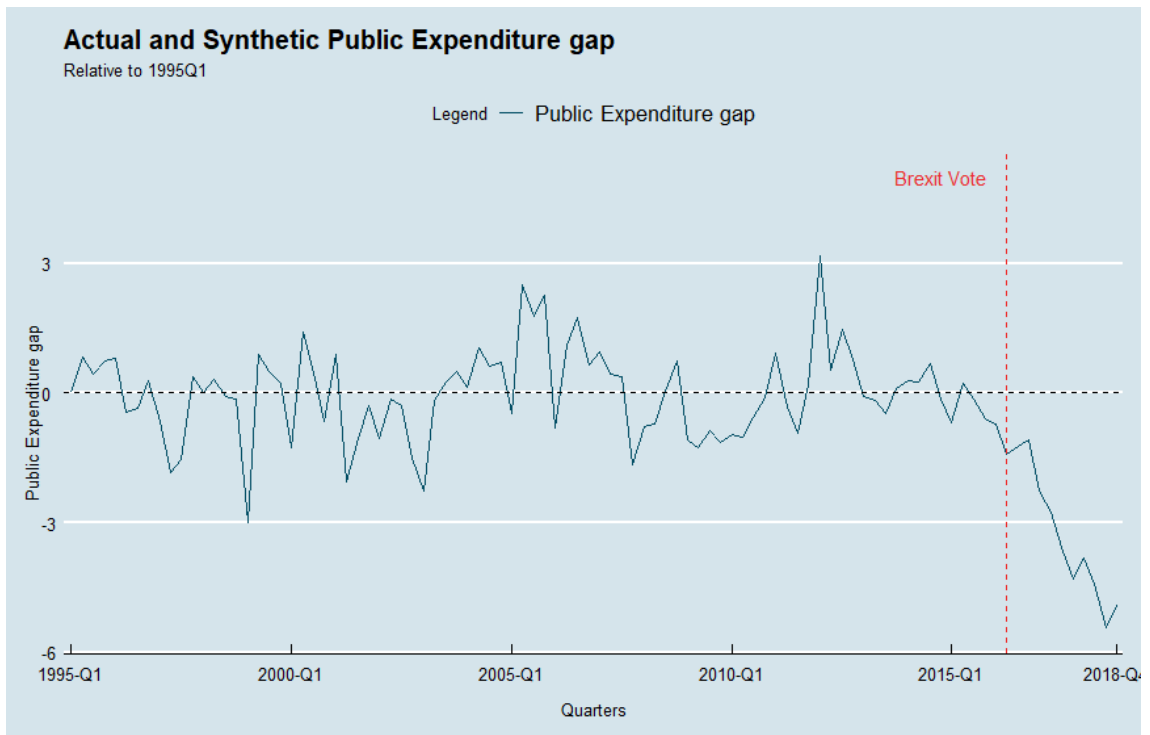
The actual public expenditure and the synthetic counterfactual are compared in graph 15. Goodness of fit is quite good for the pre-treatment period, so the conclusions that we will obtain can be trusted as consistent. Public expenditure doesn't suffer major changes, until the gap clearly widens from 2015 on. The gap starts some quarters before the vote is actually held. That fact could be attributable to the government preparing its finances for a possible Brexit result in the vote that was about to be held the following year.

The widening gap is easily noticeable in graph 16. Up to the Brexit vote, the gap had never been higher than 3% in both directions. After the referendum, though, the real public expenditure for the United Kingdom falls behind the hypothetical counterfactual. The numbers of this gap are computed and enlisted in Table 7.

By the middle of 2017, the gap had already surpassed the 3% bound. One year later, the gap was well over 4%, and increasing. At the end of 2018, for the last available data we have for the analysis, the gap ascended to 4.92%, or 25,21 billion pounds of difference. There has been a notorious slowdown in the public expenditure. However, the source for that downturn is still to be determined. Although the Brexit vote poses a great candidate, there might be other reasons behind it.



Graph 18: UK actual and synthetic public expenditure, relative to 1995Q1



Graph 17: UK actual and synthetic public expenditure gap in percentage points

Table 7: Public expenditure gaps in percentage points and gross quantities

| <i>Quarter</i> | <i>%</i> | <i>Period gap</i> | <i>Quarter</i> | <i>%</i> | <i>Period gap</i> |
|----------------|----------|-------------------|----------------|----------|-------------------|
| 2016–Q3 | -1.22 | -6211.09 | 2017–Q4 | -4.31 | -21858.22 |
| 2016–Q4 | -1.08 | -5463.45 | 2018–Q1 | -3.82 | -19447.78 |
| 2017–Q1 | -2.27 | -11425.47 | 2018–Q2 | -4.43 | -22408.39 |
| 2017–Q2 | -2.76 | -14001.23 | 2018–Q3 | -5.42 | -27406.84 |
| 2017–Q3 | -3.58 | -18182.04 | 2018–Q4 | -4.92 | -25210.58 |

The British government’s 2018 “*EU Exit: Long-term economic analysis*” report gives some clues about the evolution of public expenditure for the following budget periods.⁴⁹ The depreciation of the pound, the inflation spike or the investment relocations are regarded as responsible for some downgrade in the tax revenues prospects for the next years. Calculus from the Treasury and the Exchequer from the UK used to predict a closing of the budget deficit for the 2016–2017 period, coming from the rise in tax collection. However, borrowing has grown again after the vote. The Treasury obtained in its study a relation of £7.6 billion of extra borrowing for every 1% that the output falls. Springford (2019) estimates that the referendum is already costing around 320 million pounds a week to the British Treasury from higher borrowing. According to our estimate for output loss of 3%, the extra borrowing attributable to the Brexit vote would amount to more than £22,8 billion, not far from the £25 billion loss in public expenditure obtained above. The extra borrowing could increase the service of debt budget allocation, even more if the Bank of England increases the interest rate to fight against the rising inflation.

Additionally, preparation for the Brexit deliverance has meant importance changes in the UK Budget, which could hurt the total expenditure⁵⁰. The 2017–2018 Budget

⁴⁹ See in:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760484/28_November_EU_Exit_-_Long-term_economic_analysis__1_.pdf

⁵⁰ *Summary: Costing Brexit (2018)*. Institute for Government. See in: <https://www.instituteforgovernment.org.uk/summary-costing-brexit>

included a £3 billion contingency fund for the following two years. This money was supposed to be employed to counterbalance the short-term effects of Brexit. What's more, two new departments have been created under the framework of the British government to deal with Brexit itself: the Department for Exiting the European Union and the Department for International Trade. Existing departments have reallocated some of their funds for future need, too.

Lastly, the fall in public expenditure could be a conscious decision by the British government to avoid future financial problems. Predictions from the Chancellor of the Exchequer are pessimistic about the future state of the economy.⁵¹ Consumption and investment are expected to decline even faster once the final deal (or no deal) is reached. Trade will certainly depend on the type of deal, but it will surely have some impact on the British industry and services. If these expectations are fulfilled, tax revenues might steeply fall, and public expenditure could increase from unemployment benefits, service of debt or unexpected costs of Brexit. To soften this hypothetical situation, the British government might already be adjusting the Budget in consequence.

Therefore, the obtained gap in public expenditure could come from the fact that the vote has moderately hurt the taxation system, leading to higher borrowing, and hence, to the necessity of budget cuts to maintain the deficit under control. From other perspective, the gap could be due to the goodness of fit needed to counteract future negative effects from Brexit.

⁵¹ Chancellery of the Exchequer (2018). *EU Exit: Long-term economic analysis*.

4. Concluding remarks

When the Brexit vote was implemented, little was known about the possible economic consequences that it could arise, apart from more or less accurate predictions and forecasts. As the Brexit was an event that had never happened before, barely was understood about the aftermath of the process of disintegration.

Today, around three years after the referendum and with some months still to go until the deadline on 31st October 2019, data provides us with some results of interest⁵². Up to the last quarter of 2018, the Gross Domestic Product of the United Kingdom is estimated to have suffered a loss of more than 3% with respect to its *business-as-usual* scenario, had the Brexit vote not been carried out. This expected loss might have come both from the uncertainty about the future relation between the UK and the EU, as well as from the anticipation of rational economic agents, who might already be preparing for the worst possible scenario.

Once the gap of the GDP is computed, we look for the underlying causes behind it. Using the components of the National Accounts, we estimate that consumption amounts to as much as 42% of the GDP loss. Although families or households increasing their savings could be the reason for this slowdown in consumption, we find some consistent proof regarding the effect of the spike in inflation on consumption. The devaluation of the British pound has provoked inflation to rise, which has significantly hurt the purchasing power of households.

Investment is also an important component when it comes to explaining the GDP loss. We find some evidence of British firms investing less, though the results are not as consistent as for consumption. In addition, we gather some academic work about the increase in investment of British firms in the EU soil, while foreign direct investment might have fallen in British land.

Regarding trade, we don't find any effect of the vote neither on exports nor in imports. As negotiations about the future trade relationship of the UK and the EU are still being

⁵² The United Kingdom was initially supposed to be leaving the European Union on March 29th 2019, but the British Government applied for an extension until autumn, as no satisfying deal had been yet reached.

carried out, this result is consistent. We expect the balance of trade to change once the Brexit is fulfilled.

Public expenditure has suffered an important change in its trend after the vote, with a loss of around 5% with respect to the no-Brexit scenario. The fall in tax revenues due to consumption and investment losses might be behind this find. The British Government adjusting its Budget to be able to cope with a recession in a near future or the increase in the debt might also be argued as plausible reasons.

In short, the British economy is already being hurt by the vote that took the country of the European Union, where it had belonged for many decades. Further analysis should be carried out in a near future, once the conditions on the agreement are clear.

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