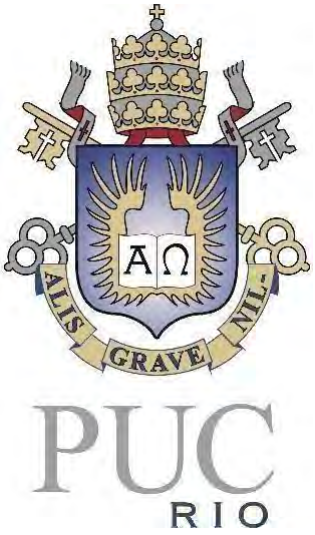
PONTIFÍCIA UNIVERSIDADE CATÓLICA DO RIO DE JANEIRO

DEPARTAMENTO DE ECONOMIA

MONOGRAFIA DE FINAL DE CURSO



"An analysis on Brexit's empirical economic forecasts and what should be expected in the long run"

Edward F. Booth

Matrícula:1712036

Orientador: Yvan Bécard

Rio de Janeiro

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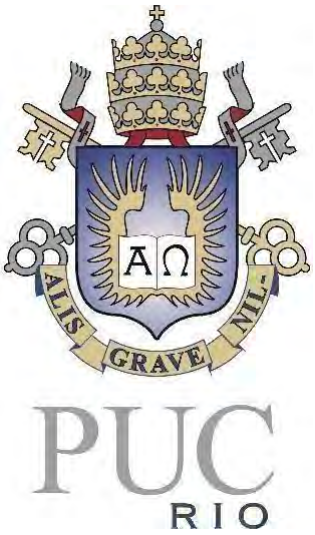

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As opiniões expressas neste trabalho são de responsabilidade única e exclusiva do autor.

Motivation

The exit of the United Kingdom from the European Union, commonly known as Brexit, is an engaging case study for any graduating economist, due to the variety of economic related aspects that this episode generated and the different viewpoints that can be addressed. Coming from a British related family, the production of this thesis means combining my heritage with one of my greatest interests, Economics. My objective, through this monograph, is to reassess the knowledge acquired throughout the course, composing a final paper that synthesizes the subject and its aspects, via an in-depth analysis of the literature available.

Acknowledgments

I will be forever grateful for my family, that supported me throughout my life giving me all the conditions and emotional support that enabled me to arrive at this moment. Thank you for always being present in the moments when I most needed.

A special mention to my girlfriend and friends, who have been of the utmost importance giving me strength, backing me on moments where I doubted myself and providing distractions when necessary.

To all my teachers, from kindergarten to university, who filled me with knowledge and have a crucial contribution in my achievements. Special thanks to all the teachers from the Economic's Department of PUC-Rio and Yvan Bécard for the orientation on this work.

Summary

I. Introduction

Brexit formally initiated in June 2016, when the referendum poll stunned the world with 51.9% voting to exit the European Union. (The Electoral Commission [2016]). After the delayed activation of Article 50 of the Treaty on the EU, the procedures for the United Kingdom's exit began in March 2017. The negotiations of the terms, according to European legislation would have a deadline of up to two years, but that was extended due to anticipated parliamentary elections. Finally, in December 2020, the United Kingdom and the European Union signed the Trade and Cooperation Agreement (TCA), specifying the terms of relationship between the country and the economic bloc, which came into force in January 2021.

During the period pre-Referendum until the introduction of the TCA, a widespread of academic publications related to a variety of topics, with different approaches were produced. They can be split into three different types: historical case studies of the economic consequences of joining the EU, simulations using computational general equilibrium models and reduced-form evidence based on estimates of how EU membership affects trade [Sampson, T. (2017)].

Most of these studies worked with three possible scenarios a Soft Brexit, Free Trade Agreement and Hard Brexit. The first, considered that negotiations between the United Kingdom and the European Union would be successful, the country would remain in the Single Market being excluded only from the Customs Union. Therefore, trade costs for the bloc would only increase because of non-tariff barriers, such as quantitative restrictions and anti-dumping measures. The so-called four single market freedoms, free movement of goods, capital services and people would still be in place, as they are in Norway, Iceland and Lichtenstein. In the bilateral agreement scenario, which is the current situation, customs tariffs would also remain at zero, but the costs for trade would increase. There would be stricter control on the borders and a greater number of non-tariff barriers, due to the exclusion of the United Kingdom from the Single Market, as Switzerland case, for example. In the worst scenario of all, in which there would be no agreement, the regulations of the World Trade Organization would form the basis for any commercial exchange between the country and the economic bloc. For the purpose of this work only the estimates regarding the bilateral agreement will be considered.

Brexit has materialized into a process not an event. Dhingra et al. (2022), emphasizes that the models from the studies made from pre-Referendum period to the TCA did not consider

that the effects of leaving the European Union would occur in slow-paced phases, resulting in lags with different consequences for different sectors of the economy. Therefore, we can break up this process into three different phases.

The first phase begins with the Referendum result, in which the anticipation of the impact due to uncertainties, mainly affected the population's income and private investment. these effects materialized before any agreement was signed, that is, their causality is intrinsically linked to uncertainty. The second phase, which began with the TCA's adoption in January 2021 saw the effective application of the new customs barriers and protocols, bringing an end to the transitional period. However, here the impact of Brexit on trade between the United Kingdom and the European Union must be meticulously calculated because the bilateral agreement was established approximately nine months after the Covid-19 epidemic, which disrupted global trade. Isolating Brexit effects from the consequences of the global health crisis is a difficult task for researchers, but not impossible as we will see during this work. Finally, the third phase concerns the structural changes that will take place in the British economy in the long term. This work will emphasize the first and second phase, but it hopes to give a better understanding of the effects to come for the UK in the future.

II. Benefits and costs of EU membership

Before scrutinizing the effects of Brexit on GDP growth it is important to briefly examine the undeniable benefits and inequitable costs that UK's economy has enjoyed since joining the EU in 1973.

According to Campos, N. et al (2019), the percentage difference between UK's GDP per capita and the EU founding members average (France, Germany, Italy, Netherlands and Luxembourg) was 45 per cent in 1950. The Treaty of Rome, signed seven years later, launched the European Economic Community (EEC), establishing a common market based on the free movement of goods, people, services, and capital, by then the difference between UK's GDP per capita and EU founding members was short of 27 per cent. In 1967, the gap had reached 14 per cent as can be examined in the graph below.

Chart 1. Percentage difference between the UK GDP per capita and the EU founding members' average between 1950 and 2016

Notes: The dotted vertical line represents UK's entry in the EU.
Source: Campos et al. (2019)

Different reasons can be accounted for this significant fall in a short period of time, like the collapse of the Bretton Woods system, but unfortunately, they are not the objective of this work. The dotted horizontal line highlights UK's admission in the EU, coincidentally, the difference was practically zero ate that time. Since 1973 until the year of the Referendum, the difference remained reasonably stable, which undeniably shows that joining the EU had an influence on rescuing UK's GDP per capita decline, vis-à-vis it's European neighbours.

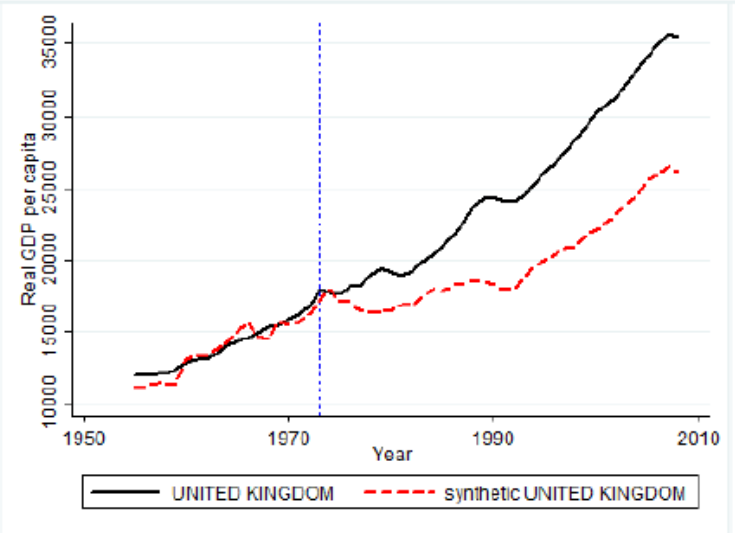
Taking this event from another perspective, Crafts, N. (2016) research on the benefits of EU membership relies on productivity growth, which is a consequence from increased market competition and foreign direct investment (FDI). The more open to trade a country is, i.e the lower tariff and non-tariff protection, the more domestic businesses must increase investments in productivity or risk losing competitiveness to import goods and services. The author uses a gravity model (a full explanation is provided in Section IV pg. 41), which estimates the volume of trade between two countries as a function of variables such as GDP, population, distance, common border, common language and so on. After quantifying the effect on joining the EU on international trade, Crafts uses the elastic relationship developed by Feyrer, J. (2009) relative to the effect of trade in level of income, which indicates that 1 per cent decline in trade reduces income between around 0,5 per cent and 0,75 per cent. His findings are that joining the EU raised UK's trade by 21.1 per cent, by using Feyrer's estimation Crafts concludes that EU membership raised national income between 10,6 per cent and 15,8 per cent.

As mentioned before, Crafts' attributes this considerable effect down to two factors: the effect of trade openness on productivity and also market access to FDI. Theoretically access to bigger markets make business specialize in the production of goods and services in which they have a comparative advantage. Therefore, firms can benefit from economies of scale and higher production, either by expanding or by investing abroad. Bigger market's increase competition, which drives productivity inside businesses, creating an incentive on maximizing efficiency, minimizing costs, and increasing innovation. There is also knowledge spillover effect which increases with trade flow, that allows domestic firms to update their own technology when importing products from abroad. Another means to the same end is by FDI which enables businesses to enjoy technology networks and successful innovations from abroad.

Campos, N. et al. (2019), using a different approach: the synthetic control method. This statistical method consists of comparing a treatment group that has gone through an intervention and a counterfactual which is synthetically constructed by a weighted combination of variables, which will be used as control to evaluate the effect of an intervention or shock to the economy. In this case, the intervention is the UK's membership, the treated group is the UK and the control group is a weighted combination of other countries chosen to better match the UK's economy based on growth rate of real GDP, GFCF, trade on goods and services, inflation rate and other variables. Their estimate is that EU membership singularly increased UK's GDP per capita to 8.6 per cent within ten years. Also, as depicted below, the difference between UK and synthetic

UK does not diminish over time, meaning that benefits from joining EU are permanent.

Chart 2. UK's Real GDP per capita versus its synthetic counterfactual



Notes: The blue dotted vertical line represents UK's entry in the EU.
Source: Campos et al. (2019)

Although using very different econometric approaches Crafts (2016) and Campos et al. (2019) arrive in similar figures when comparing the effects on EU membership to the UK's economy, 10,6 per cent increase in national income, and 8,6 per cent increase in GDP for the latter. With that in mind, we must remind ourselves of the difference between gross national income (GNI) and GDP. GDP measures the value of goods and services produced domestically including national output, expenditures, and income (OECD. "Gross Domestic Product"). GNI equals GDP plus wages, salaries and property income of the country's residents earned abroad and at home. It also includes net taxes and subsidies receivable from abroad. (OECD. "Gross National Income"). Furthermore, the two researchers both agree on the two main channels from which the benefits derived: trade openness and financial integration.

The opposing force to some of the benefits mentioned above are the conditions that derive from the EU membership. They were consistently, and successfully, promoted by the 'Leave' campaign in order to raise public awareness towards the negative side of being a member-state of the world's most integrated economic bloc. The costs advocated by 'Leave' supporters can be split into four different categories: trade constrains, permissive immigration, inefficient regulation and net budget contribution to the EU. Trade and immigration factors will

be discussed further on, where provided evidence from academic studies shows in fact that, the benefits significantly outweigh any sort of costs the free movement of individuals, goods and services could inflict in the UK's economy. For now, regulations and budget contribution will be assessed below.

First, regulations influence a wide variety of areas, but ultimately, if efficient, they amend negative externalities and market failures which lead to an unhealthy economic growth. Open Europe (2015) lists more than fifty EU-regulations which are believed to be inefficient and hinder national productivity and output and estimate that they cost yearly 0.9% of UK GDP. However, half of this estimate comes from two regulations directed at reducing carbon dioxide emissions and limiting working hours [Sampson, T. (2017)]. Brexit would mean the UK won't need to bear with EU legislation anymore, yet relaxing regulations in such areas as environment and labour is known to be politically and sociably challenging due to their strong support from the public. Moreover, Craft's work asserts that the UK has been one of the countries with lowest levels of industry regulation in the world. In 2013, OECD indicators Product Market Regulation (PMR) and Employment Protection Legislation (EPL) were, respectively, the second and third lowest in the world. As per the fiscal contribution to the EU, HM's Treasury (2013) estimate it cost yearly an average of 0.5% of UK GDP. Therefore, being optimistic towards the benefits Brexit would bring, the cost of EU membership adds up to around 1.4% of UK GDP. Throughout this work we will see that this cost is completely offset by the benefits UK enjoyed when it was a member of the economically integrated bloc.

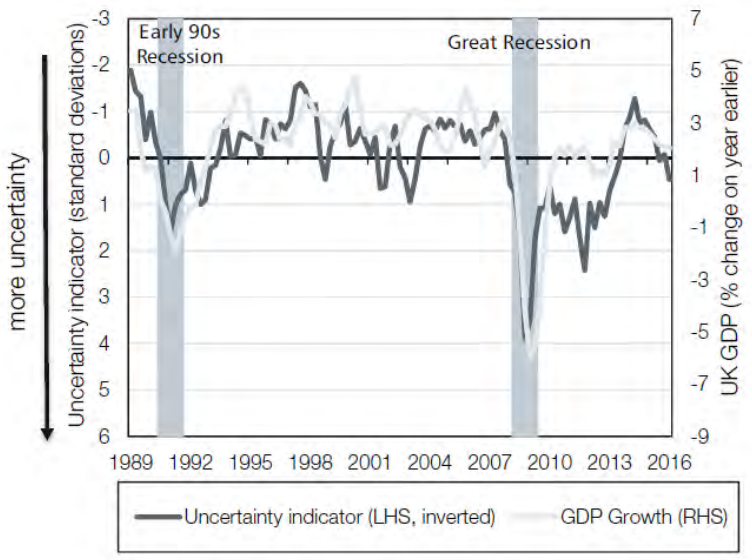
III. Uncertainty & GDP growth

Now that the benefits and costs of EU membership have been introduced we can proceed to examine hand-selected academic publications made on Brexit. These can be separated into two different categories: ex ante and ex post studies. Ex ante studies estimate the impact of Brexit before the event actually took place, while ex post publications analyse the already visible impacts of Brexit, and forecasts where the UK and its economy could be headed. According to Busch et al (2016), there are three different groups within ex ante publications: studies based on ex ante macroeconomic models, studies based on ex ante trade models and non-model studies that rely on literature review to make rule of thumb assumptions and estimations based on the prior two.

Published one month prior to the pole, "HM Treasury analysis: the immediate economic impact of leaving the EU" is a government funded study that uses a macroeconomic model to arrive in a conclusion for Brexit short term effects. It is based on three key factors that would drive transformation on UK's economy in the short run: the transition effect, uncertainty effect and financial conditions effect. This analysis covers the impact from the start of the third quarter of 2016 to the end of the second quarter of 2018.

The transition effect starts to exert an influence in the aftermath of a vote to leave. Firms, big or small, reduce investment spending and start cutting jobs in the short term, rationally expecting lower external demand and investment in the future. Consequently, this effect would result in lower incomes, reducing household expenditure. The uncertainty effect could be questioned at first sight, because the Referendum result would have settled the issue of EU membership. Nonetheless, many aspects of UK's international and domestic economic policies would be put on hold, and until the new trade agreement and other arrangements between both parties became clearer to the public, there would be a significant rise in uncertainty. In response, expenditure cuts from both firms and households would be expected, lowering the overall output of the economy. The image below shows a clear correlation between uncertainty and GDP growth in the UK, highlighting two events, the nineties recession and 2008's financial market crisis, where GDP growth plummeted following a rise of uncertainty.

Chart 3. Uncertainty and GDP growth, 1989-2016



Source: HM Treasury (2016)

The extent and magnitude of uncertainty levels are directly impacted by the terms of withdrawal and the tone of the negotiations. In the present moment, we know that negotiations were extended by nearly a year, which undoubtedly raised uncertainty, and culminated on the FTA. Yet still, UK are undergoing trade negotiations with countries outside the EU, e.g. the United States, India, Canada and Mexico, that were previously accounted for by having a trade agreement with the EU [House of Commons Library: Progress on UK free trade agreement negotiations]. Additionally, changes in economic policy, domestic regulations and legislation framework are still being made to this date, there is also the Northern Ireland Protocol enquiry, which remains unsolved. To top it off, UK's recent chaotic political scenario did not favour quick and effective measures that could have reduced uncertainty, in fact it only contributed to the effect. The third and final effect is the financial condition. In the aftermath of a vote to leave financial markets are going to reassess the risk on British assets. Naturally, the UK is going to be looked upon as having a bigger risk than in the past, this will lead to a demand for an increase in the premium for lending to UK businesses and households' mortgages. Personal overseas investment will decline and there will be huge pressure on the pound's devaluation consequently raising prices for British citizens.

After analyzing the three effects, the government issued document proceeds to assess these factors, in an effort to quantize them into variables to be later used as inputs in a NiGEM (National Institute Global Econometric Model). NiGEM is a highly elaborated Computable

General Equilibrium (CGE) model. CGE's are one of the most used tools to estimate the impact of an exogenous variable on target endogenous variables such as GDP, consumption, investment, employment, exports, and imports. It is structured with many economic theory equations and includes different countries and sectors linked via channels of economic transactions. The idea is to create a simplified version of the world's economy so it can allow ex ante simulation of one specific impact. The results derive from the difference between two future equilibriums, one where the exogenous variable was accounted for and the other where the simulated shock did not take place.

For Erken H. (2017) NiGEM has three main benefits. "First, the model allows us to assess the impact of several key variables in the short to medium term, such as exchange rate fluctuations, trade flows, foreign direct investment and the labour market. Second, NiGEM ensures that the global trade flows are viewed within a closed accounting setting. Thus, trade flows between countries add up to global trade and possible trade or economic shocks, such as a Brexit, are accounted for via the global world trade matrix. This also means that we can assess what the impact of Brexit has on other countries. Third, NiGEM is an error correction model, which ensures that short-term deviations of GDP from a country's growth potential are made up eventually. So, ultimately, growth is driven by structural factors, such as capital formation, structural employment and labour-augmented technological change. In the short term, GDP is driven by demand:

$$Y = C + I + G + XVOL - MVOL$$

Where *C* is private consumption, *I* is investment, *G* is government consumption, *XVOL* are exports and *MVOL* are imports. Whereas, in the long term, GDP is driven by supply factors:

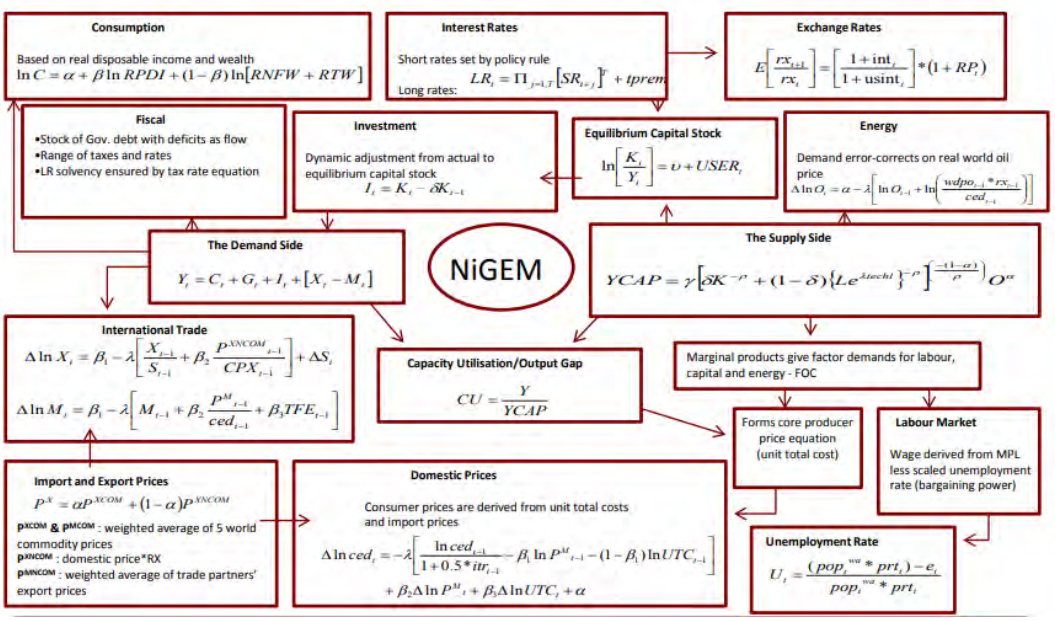
$$YCAP = \gamma\left[\delta \cdot K^{-\rho} + (1-\delta)\left(L_e^{\lambda \cdot TECHL}\right)^{-\rho}\right]^{\frac{-(1-\alpha)}{M^{p\alpha}}}$$

Where YCAP is potential output, K is total capital stock, L total hours worked, M represents oil input, and TECHL labour-augmented technological change. The parameters are either production function parameters or scale parameters. The second equation is based on a constant elasticity of substitution relationship between capital and labour, embedded in a Cobb-

Douglas framework. Any deviations of *Y* from *YCAP* feeds into the price system, which brings demand in line with supply."

However, as is true to all models, there are weaknesses. The model is structurally complex, it requires elaborate data and inputs which allow questionable assumptions to be hidden from within, that end up driving the results. As the effects of each of these features cannot be decomposed and traced from the general effect of the shock because of such complexity, they are sometimes viewed with skepticism and referred to as a "blackbox". Therefore, results depend crucially on how the model is constructed, built on restrictive assumptions that might not always be true in the real world and the data selected. The following image synthesizes the NiGEM model.

Figure 1. NiGEM Simplified Structure Framework



Source: NIESR, Amit Kara presentation (2019)

As can be seen above, the model can be split into two blocks: the consumption (demand) and production (supply) side. The mathematical equations based on economic theory are determinants for the variables such as GDP, exports, inflation, unemployment rate and so on. Also, different countries have their own set of interest rate reaction functions and forward-looking exchange rates. CGE models differ from each other, using different rates at which the variables interact within the model. The proportion of these rates are either based on author assumptions or estimations from esteemed academic research.

HM Treasury's publication depicts two scenarios for Brexit: shock scenario and severe shock scenario. The difference between them is the magnitude of levels of uncertainty and financial market volatility. The first is linked with a negotiated bilateral agreement and the latter, exiting the Single Market, and defaulting to World Trade Organization (WTO) terms. Only the shock scenario outcome will be considered.

The study quantized the impact of uncertainty on UK's economy by constructing an indicator based on six measures that have different approaches to calculating this variable. For example, the GfK unemployment expectation survey, captures consumers' perception of uncertainty, while the Industrial Trends survey captures business perceptions of the matter, and FTSE 100 captures the uncertainty in the eyes of the financial markets. After normalizing and scaling each one of these time-series, they are then combined into a single uncertainty indicator with each measure weighted equally (Figure 3). A Vector Autoregression (VAR) model is used to quantize the change of uncertainty level effects on other macroeconomic variables. A VAR is an econometric model used to capture and isolate the effect that one variable has over all the other variables in the regression over a period of time, capturing both the initial impact and subsequent dynamic effects. The HM Treasury VAR includes eight variables: the uncertainty indicator, consumption, business investment, the GDP deflator, Bank Rate, and three financial risk premia (the household borrowing spread, corporate borrowing spread and equity risk premium).

Figure 2. Specification of the VAR

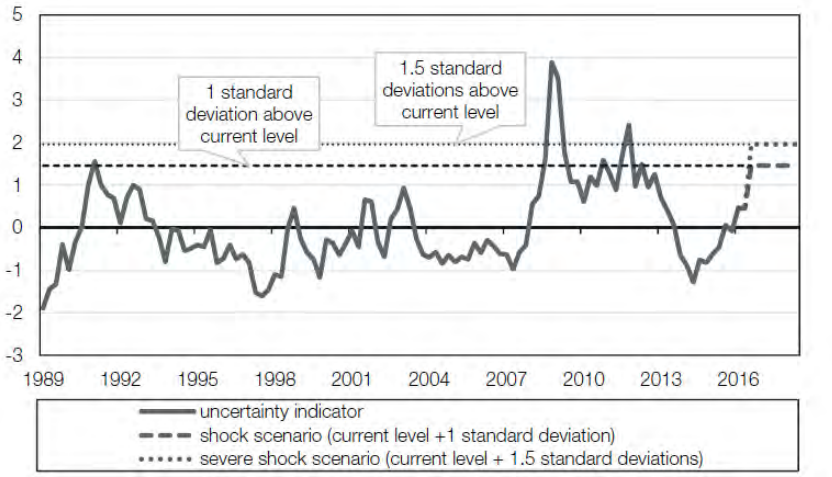
$$\begin{bmatrix} uncertainty_t \\ C_t \\ I_t \\ P_t \\ R_t \\ hhprem_t \\ corpprem_t \\ equityprem_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} uncertainty_{t-1} \\ C_{t-1} \\ I_{t-1} \\ P_{t-1} \\ R_{t-1} \\ hhprem_{t-1} \\ corpprem_{t-1} \\ equityprem_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} uncertainty_{t-2} \\ C_{t-2} \\ I_{t-2} \\ P_{t-2} \\ R_{t-2} \\ hhprem_{t-2} \\ corpprem_{t-2} \\ equityprem_{t-2} \end{bmatrix} + \varepsilon_t$$

Source: HM Treasury (2016)

"Where uncertainty is the level of the uncertainty indicator; C, I and P are consumption, business investment and the GDP deflator, all in log differences; R is Bank Rate, hhprem is the household borrowing spread, corpprem is the corporate borrowing spread and equityprem is the equity risk premium, all in differences. A_0 is a vector of constants and ε_t is a vector of residuals".

Based on the VAR, that used twenty-five years of data, the relationship between uncertainty and overall economic activity and financial market condition can be estimated. Still, to estimate the immediate impact of uncertainty on UK's economy, an assumption must be made regarding the rise of uncertainty due to Brexit. Comparing their synthetic uncertainty indicator with past economic events, the authors of this study proposed that Brexit would increase uncertainty above current levels, equivalent to 1 standard deviation in average over the two year-period for the scenario of the FTA, as can be seen in Chart 4.

Chart 4. Uncertainty indicator (standard deviations)



Source: HM Treasury (2016)

After assessing the effects on uncertainty, transition and financial market conditions, these estimates are inputted into NiGEM. HM Treasury's publication concluded that for the shock scenario, Brexit would result in a recession, inflation spike and a rise in unemployment in the near-term. UK's economy would instantly experience four consecutive quarters of negative growth and two years after the referendum GDP would be around 3.6 per cent lower regarding a vote to remain. Depreciation of the pound is estimated to be around 12 per cent with CPI (Consumer Price Index) inflation rate would be higher by 2.3 p.p. one year after the polls.

With a similar approach to HM's Treasury study, PricewaterhouseCoopers' (PwC) report "Leaving the EU: Implications for the UK economy" finds relatively close results. Also using a CGE model it estimates that by 2020 UK GDP would be 3.1 per cent lower under an FTA scenario than if the EU membership was maintained. The average annual real GDP growth rate would fall by 0.8 p.p. relative to the counterfactual, which is projected to grow in average 2.3 per cent per annum. The framework of this study considers five initial channels that would

impact the economy: uncertainty, trade, migration, regulations, and fiscal contributions. As before, the focus will be on the uncertainty channel due to its higher influence than its peers in the short-term. Trade and migration will be discussed in following sections, whereas regulations and fiscal contributions have already been briefed.

The report accounts uncertainty to three key factors: sovereign and corporate credit risk, sterling depreciation and business confidence. Rising costs of capital in the UK after a vote to leave is a natural market correction, due to the loss of access to EU Single Market which impact export earnings and puts pressure on import prices reducing business earning and returns from investment. Brexit would mean a riskier scenario for the UK, higher probability of default, hence investors demand higher risk premiums, so the cost of debt rises. Sterling depreciation would also be expected due to the potential selloffs of UK assets and capital outflows, in addition to a concerning rise on UK public account deficit. Finally, business opportunities would be offset with doubt. British firms would be likely to postpone investment projects and employment decisions due to the lack of predictability and confidence over their own future.

Although PwC report uses the same econometric approach to estimate Brexit's effects, both have a different method on how uncertainty is quantized and inputted into their respective models. Instead of using a VAR model fed by surveys on uncertainty, this study focuses on Credit Default Swap spreads and how much credit risk premium on UK corporate debt would increase in a Brexit scenario regarding the counterfactual of remaining in the EU. The CFA Institute describes credit default swap (CDS) as a "contract between two parties in which one party purchases protection from another party against losses from the default of a borrower for a defined period of time." Therefore, the credit risk premium can essentially be measured by the price the seller of a CDS protection receives.

Using the Eurozone crisis as a benchmark for highly uncertain periods, the authors, based on observed CDS spreads, assume that the average cost of debt in an EU exit scenario, regarding the counterfactual, would increase, by 50-bps (basis points) while the cost of equity would have a 20-bps increase in the near-term. These assumptions are considerably different from the ones found on HM's Treasury release, which assessed an average increase of 130-bps for cost of corporate debt, 40-bps for cost of government debt and 120-bps for cost of equity for the short run. This simple comparison highlights one of the main issues regarding Brexit simulations, uncertainty effect is a muddled variable to predict. While it is crucial element for

any estimation of Brexit consequences, it's magnitude and influence over the economy is overwhelmingly hard to evaluate due to its nature of imperceptibility.

Chart 5. CDS spreads on UK 5-year corporate and sovereign debt

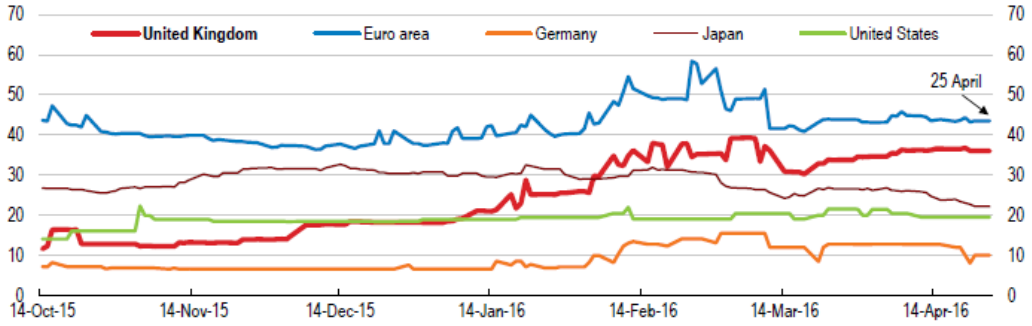
Source: Thomson Reuters, PwC analysis (2016)

Nevertheless, this complex challenge does not stop researchers from estimating uncertainty and its effects. PwC report deduced that in a FTA scenario, uncertainty would be responsible for 1,9 per cent GDP cost relative to the counterfactual of a non-exit by 2020, while trade and migration would account to costs of 0,5 per cent and 0,8 per cent, respectively, with regulations and fiscal channels having 0,1 per cent positive effect. Although it states that the duration of the uncertainty effect would only be felt in the short-term, until negotiation of an exit agreement comes to a closure and the adjustments are made to abide the new term, uncertainty also has a long-term effect. Even if the effect dissipated in a near future, which has already been argued that it didn't, uncertainty would mean a setback for the British economy, for example, reducing investment and employment in the present, equals permanent smaller capital stock and level of productivity in the UK.

Another important ex-ante publications briefly worth mentioning is the OECD report "The Economic Consequences of Brexit: A Taxing Decision". Like the others, it details the main channels that will influence British economy in a favourable exit outcome: uncertainty, financial conditions, trade, foreign direct investment, migration, deregulation, and fiscal contribution to the EU. Assessments of these variables are later used as inputs in a CGE model. The approach on uncertainty and financial conditions is very much alike. The report emphasizes the difference in CDS spreads for government bonds between the UK, the Euro area, the United

States, Germany, and Japan. Looking at the chart X, one can see the increasing value of risk premium of UK gilts leading up to the Referendum, in comparison with the relative stability of the other sovereign bonds.

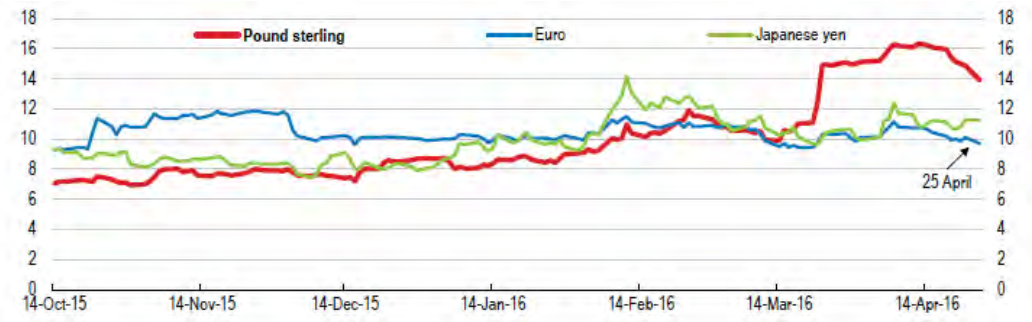
Chart 6. CDS spreads for 5-year sovereign bonds, basis points



Source: OECD (2016)

It also adds on uncertainty instruments by the analyses of sterling depreciation and economic policy, while touching on previously mentioned arguments regarding business confidence. OECD's report points out the increasing devaluation of the pound in the face of the USD and the Euro six months prior to the polls, while implying that the market expects further depreciation by comparing the cost of the pound, euro, and yen's three-month options. As per the Corporate Finance Institute "A currency option refers to a derivative contract that gives the buyer the right but not the obligation to sell or buy currencies at a specified exchange rate within a specified time frame. They are useful for investors to hedge against unfavourable movements in exchange rates". The chart below depicts the exchange rate volatility from three-month options, pared to the USD, in percentage.

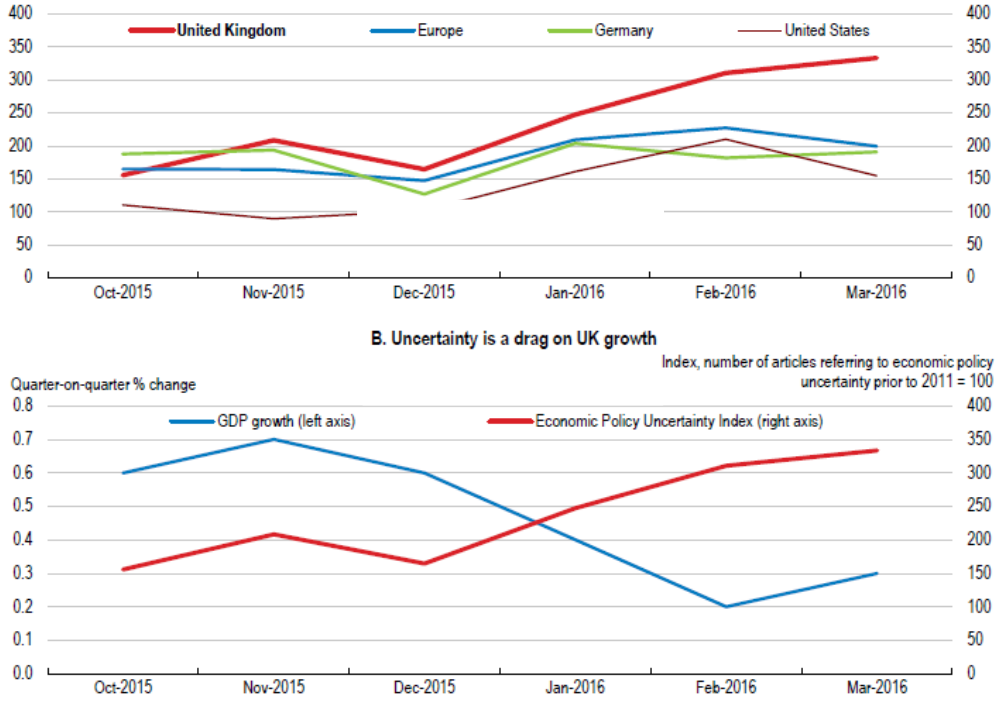
Chart 7. Implied exchange rate volatility from three-month options, currency to the US dollar, percent



Source: OECD (2016)

Coherently, three months prior to the Referendum the sterling line detached itself from its peers because the market was already pricing and protecting itself from an even sharper weakening of the British currency in case of an exit. Thus, even before it was official, the uncertainty and pessimistic expectations around Brexit were already a negative impact over UK's economy. Another channel the report used to measure uncertainty was by the Economic Policy Uncertainty (EPU) index. The index is calculated based on how many articles of selected newspapers from each country, contain the terms economic or economy, uncertain or uncertainty and policy relevant terms, such as, policy, tax, budget, deficit, regulation, and Bank of England. After summing all articles from the different newspapers by month, the series is normalized to mean one hundred and a standard deviation of one prior to 2011. Next charts show the rise of UK's EPU index relative to Europe, Germany, and the United States, while below, a comparison of the index to the NIESR 2016 April estimates for GDP growth.

Chart 8. Index, number of articles referring to the economic policy uncertainty prior to 2011 = 100, below indicator comparison with NIESR estimates of GDP growth.



Source: OECD (2016)

In the near-term OECD's research only considers uncertainty, financial conditions and trade as channels that affect UK's economy. To avoid extensive repetitive information only aspects exclusive to this publication were commented on, while trade will be assessed later. The

results of this study, are again, very similar to the ones mentioned previously. By 2020, real level of GDP would be 3 per cent lower, with annual GDP growth rate reduced in average by 0,8 p.p. over three years, relative to the counterfactual. Also, a 10 per cent depreciation of the sterling against the dollar in 2016, was estimated if an exit took place.

It's not surprising that the forecast of these three publications converge in their estimates for the short-term, ranging from 3 per cent to 3,6 per cent loss of GDP, they use the same econometric approach and treat uncertainty and financial conditions as the main sources of this retracement, although measuring them differently. However, when comparing the estimates with real GDP growth data extracted from the World Bank, for the UK and its peers, questions arise.

Table 1. Germany, France, United Kingdom, Italy and Netherlands real GDP growth from 2011 to 2021

Year	Germany	France	United Kingdom	Italy	Netherlands
2011	3,93%	2,19%	1,46%	0,71%	1,55%
2012	0,42%	0,31%	1,47%	-2,98%	-1,03%
2013	0,44%	0,58%	1,89%	-1,84%	-0,13%
2014	2,21%	0,96%	2,99%	0,00%	1,42%
2015	1,49%	1,11%	2,62%	0,78%	1,96%
2016	2,23%	1,10%	2,26%	1,29%	2,19%
2017	2,68%	2,29%	2,13%	1,67%	2,91%
2018	1,09%	1,87%	1,65%	0,93%	2,36%
2019	1,06%	1,84%	1,67%	0,50%	1,96%
2020	-4,57%	-7,86%	-9,27%	-9,03%	-3,80%
2021	2,89%	6,96%	7,44%	6,64%	5,04%

Source: World Bank data, own compilation

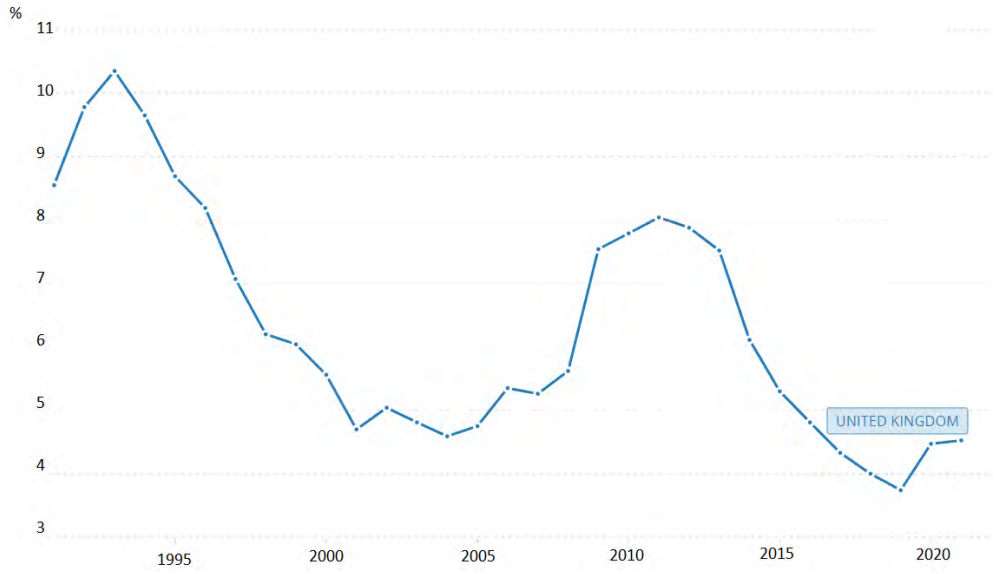
At first glance, the forecasted impact seems non-existent, UK's GDP growth seems to follow its own historical path, without any considerable deviation from its trend, except, of course, for the pandemic impact in 2020. Additionally, when compared to other European representatives, growth appears to be progressing in parallel across all nations. Recalling HM's Treasury study, leaving the EU would immediately mean four consecutive quarters of negative growth, which clearly didn't materialize. PwC and OECD's publications estimated a yearly loss of 0,8 percentage points on GDP growth, relative to a counterfactual. Looking at the data presented in the table, this statement is unlikely because it would represent 2,9 per cent, 2,5 per cent and 2,5 per cent growth rates, in the three years following a non-exit, when a deal had yet to be signed. Thus, when comparing this estimated growth with the trend of its counterparts, it

is reasonable to affirm that the immediate short-term effects were overestimated, despite the consensus found on the publications.

The evidence resonates with Iain Begg's findings in his work "Making sense of the Costs and Benefits of Brexit: Challenges for Economists". He states that in a period of profound uncertainty, generating projections is a difficult task, but more so, in political economy terms, it's a concerning issue since decisions from policy makers are made relying on publications like the ones mentioned. Begg demonstrates this by showing evidence of successive quarterly forecast made by the Bank of England from 2017 to 2018, "being shifted from a sharp slowdown to a trajectory in line with what had been forecast before the referendum result".

Nevertheless, the aforementioned studies were accurate on their estimations regarding the national currency. According to the Bank of England by the end of the third quarter the sterling's real effective exchange rate was around 15 per cent lower than the star of the year. Interestingly, Begg argues that one of the possible reasons for the apparent resilience of the economy not accounted by the studies, lies in the devaluation of the pound. Although this phenomenon has an adverse effect on trade and real income, it would be offset, only in the short-term, by a favourable effect on growth through expenditure switching, that is consumers switching from import products to domestic products, since the difference in prices grew. This is endorsed by the fact that CPI inflation slowly and gradually increased over the months and years post-Brexit, while the exchange rate suffered an instant hit, with the pound plummeting 8% relative to the dollar, one day after the Referendum based on Bank of England data. Begg also points to the large service sector, higher tourist spending and the swift appointment of the new PM responsible for conducting Brexit, Theresa May, avoiding unnecessary political uncertainty at the time, as factors for the economic resilience. Another reason mentioned by Campos (2019) is the collapse in real wage growth due to a weaker currency, increasing growth and resilience by a lower unemployment rate. This short-term dynamic contradicts what we have seen so far, regarding uncertainty and hiring decisions, but is supported by the data extracted from the World Bank. The graph below shows successive decrease in unemployment rate in the three years following the Brexit decision.

Graph 9. Unemployment, total (% of total labor force) (modeled ILO estimate) - United Kingdom



Source: World Bank

At present moment we know that this economic buoyancy was short-lived. Even if the evidence of the three years post-Brexit, shows that its near-term effects were modest because of factors that held a resilience to the economy, the depreciation of the pound and rising inflation led to an increase in the cost of living and reduced investment spending. Signalling worrying times for the future of UK's economy. Additionally, political uncertainty soon kicked back with May's failed attempt on having a majority in parliament by calling a general election in June of 2017 and the successive Brexit deal defeats she suffered in Parliament, during the first semester of 2019, which consequently extended the Article 50 process and delayed EU exit. Therefore, my hypothesis is that the ex-ante models weren't so off the mark after all, the problem was the timing of the effects. This opinion is embedded with the statement made in 2017 by Andy Haldane, Chief Economist of the Bank of England from 1989 to 2021. "I think, near-term, the data, the evidence we've been accumulating since the referendum, has surprised to the upside. There's been greater resilience, in particular among consumers and among the housing market, than we had expected. Has that led us to fundamentally change our view on the fortunes of the economy looking forward over the next several years? Not really. This is more a question, I think, of timing than of a fundamental reassessment of the fortunes of the economy."

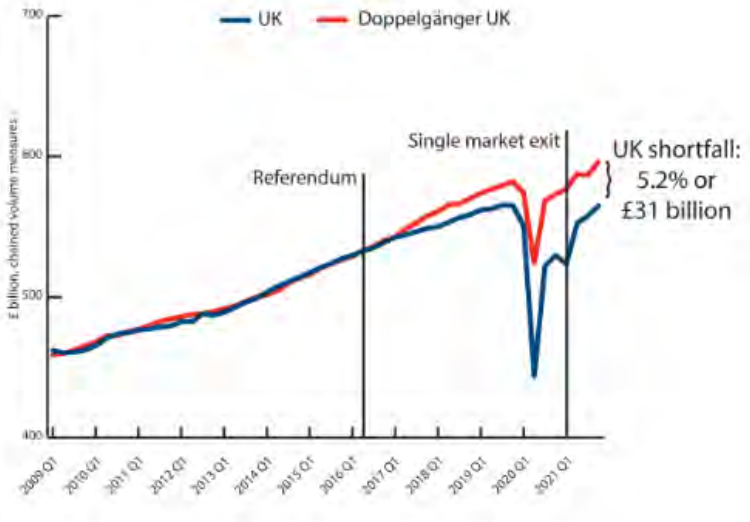
Unfortunately, data collected from 2020 onwards is warped with the global disruption of trade because of the pandemic and the energy and commodities price hikes due to the war in Ukraine, making the previous hypothesis nearly impossible to validate. Economists and

researchers were faced with a complex task on measuring and disentangling Brexit effects from the coronavirus and war implications, and studies made before the health crisis and the conflict did not account for these events, drawing up longer-term estimates somewhat inconsistent with reality. However, the already mentioned synthetic counterfactual method present itself as a suitable mechanism to dissect both events and their consequences. By virtue of its nature, the counterfactual should incorporate the coronavirus and warfare effects suffered by the countries worldwide, that combined assemble the synthetic UK, leaving the difference between the UK and its fabricated counterpart a consequence of Brexit.

The Centre of European Reform (CER) has published a research based on this method that is updated quarterly by its author John Springford. The synthetic counterfactual is built by an algorithm that minimizes the difference between the UK and the donor pool, based on GDP per capita, inflation rate, the share of trade and investment to GDP, the share of industrial production in gross value added and the average years of schooling of the adult population. The process is run from the start of 2009 up until the end of 2011, this period is known as the training period, which is when the algorithm uses the data to calibrate the weight of each country that makes up the counterfactual, based on all the indicators above. From the start of 2012 to the second quarter of 2016, the quarter of the Referendum, the matching process takes place, controlling the algorithm only by GDP level minimizing the "root mean squared prediction error". What the author means by this term is the standard deviation of the residuals, or prediction errors which are the difference from the real data to the estimated regression line, in this case the synthetic counterfactual. The standard deviation of the residuals is a measure of how spread out the prediction errors are relative to the regression function, the more concentrated the data is around the estimation the more accurate the model will be. Therefore, by minimizing the root mean square error, the author is guaranteed to have the best possible fit for his estimation in terms of level of GDP.

The synthetic UK is made up of 22 countries, United States (31 per cent), Germany (15 per cent), New Zealand (14 per cent), Norway (8 per cent) and Australia (5 per cent), the remaining countries represent less than 5 per cent of the counterfactual. The results of the study point to a 2,9 per cent gap of GDP between the UK and its counterpart by the fourth quarter of 2019, before the pandemic hit, and a huge 5,2 per cent difference at the end of 2021. Thus, it implies that the UK has suffered far more from the consequences of the health crisis than its peers due to Brexit, as can be seen in the graph below.

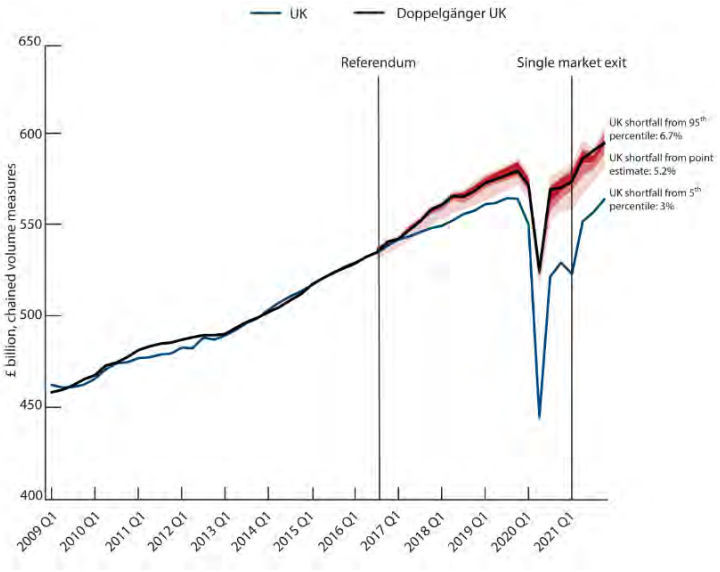
Chart 10. UK GDP versus its synthetic counterfactual



Source: Springford (2022)

Springford shows a concern that the results found might be overemphasized because of the substantial weight of the United States. By running robustness tests, which are an examination of "how certain core regression coefficient estimates behave when the regression specification is modified by adding or removing regressors" [Lu W. et al. (2014) Robustness checks and robustness tests in applied economics] the author can structurally validate his estimations. When removing the Unites States from the donor pool the result is a UK shortfall of 4,9 per cent, very similar to the original result. Furthermore, the graph below shows the result using the 5% weakest donors and the 5% best donors from the twenty-two countries donor pool, and the results prove to be robust.

Chart 11. GDP estimate confidence intervals



Source: Springford (2022)

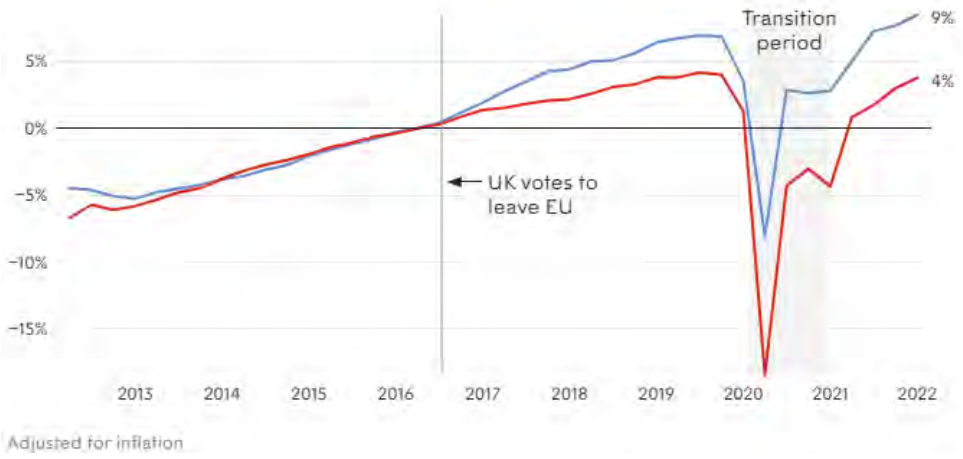
Interestingly, although using completely different data and methods the CER publication results are very much in line with the findings of PwC and OECD research, the difference is under 0,2 per cent of GDP, relative to the cost of Brexit by the end of 2019. However, according to this synthetic counterfactual method, Brexit did not have an immediate impact on GDP, as was thought by the general equilibrium methods, instead the cost only started timidly showing itself around one year after the Referendum, slowly increasing until the start of the pandemic. It is alarming but non-surprising, to see that this gap continuously escalated and culminated during the pandemic and its global trade disruption. The timing of the health crisis coincides with the transition period that begun on 31st of January 2020 and the actual exit on 31st of December 2020 [House of Commons Library - Brexit Timeline], when Brexit trade barriers and bureaucracy effects started to unfold, as we shall see in the next section. Also, the lagging effects of Brexit uncertainty, relative to consumption and investment, were building up as each year passed contributing to increasing the gap. Finally, the weaker pound made real income deteriorate, which also consecutively slowed down the national economy throughout the years after the Referendum, more on this aspect will be seen on Section V.

All these aspects, and further Brexit implications, summed up made UK's economy far more vulnerable to the pandemic effects than it would have otherwise been without the EU exit. Even ending its Covid-19 restrictions earlier than its peers, the UK's economy lags behind when compared to other European countries as can be seen in the following charts.

Chart 12. UK GDP growth compared to other EU countries, GDP index (2016 Q2 = 100)

Source: OECD data, Investment Monitor compilation

Chart 13. UK and EU GDP per capita growth since Q2 2016



Source: OECD Data, New Stateman compilation

In the next sections, Brexit effects on trade, inflation, capital outflow and migration will be examined with the purpose to determinate what are the implications of the EU exit to the UK's economy.

IV. International Trade & Models

The EU is UK's largest trade partner, responsible for 43,1% of UK total exports and 52,9% of UK total imports in 2016, beating by far the second largest trade partner, United States, responsible for 19,1% of total exports and 11,2% of total imports and its third largest trade partner, China, with 3,5% of total exports and 7,0% of total imports [ONS – Geographical Breakdown of the Current Account, The Pink Book (2022)]. The EU's converged destination of UK's trade on goods and services, combined with the fact that the UK will now be treated as a third country, i.e. as a non-member, dealing with each member-State at their own specific regulation framework. From the period during the Referendum result until the introduction of the TCA, Brexit affected trade through two channels: the shift in expectations about future trade policy, and the depreciation of sterling following the referendum [Dhingra, S. et al (2022)]. The first channel will be discussed in this Section, while the second in Section V. Furthermore, before examining each one of these effects, plus the impact of the TCA, it is necessary to understand how Brexit influences UK-EU trade generally.

Exiting the EU Customs Union means the UK would now have to bear with tariffs and quotas, otherwise non-existent, in order to export goods to other EU members, while imported goods coming from the EU would suffer the same expense. On the bright side, UK won't be subjected to EU's common external tariff to non-EU countries and would be able to set its own tariffs accordingly. Tariffs are taxes charged on goods produced outside the national border, which can be specific, a fixed sum per unit imported, or *ad valorem*, a percentage of the value of the product. Quotas, in the other hand, limit the volume or value of imported goods, they can be applied to a specific country or a specific product entering a border. Nowadays, quotas are rarely used because most World Trade Organization (WTO) members have agreed to end this practice, but tariff-rate quotas, which restrict to a certain amount the volume or value of a specific good at zero or a reduced tariff-rate, are commonly employed by countries trading on WTO terms.

Fortunately for the UK, a free trade agreement was struck with the EU, implying zero tariffs and zero quotas on all goods that comply with the rules of origin, overseen by the EU [European Commission – The EU-UK Trade and Cooperation Agreement (2021)]. However, despite the TCA being a better option than a 'no deal' scenario, it still brings regulatory, logistical, and administrative barriers to UK trade, which negatively affect industries, especially

small businesses and those who are not used to filling trade paperwork and dealing with customs border control [House of Lords – Beyond Brexit: Trade in goods (2021)].

Rules of origin (ROO) are requirements made to determine the origin of a product, more specifically, inflicted on goods that include components produced in more than one country. ROO is set at product level and based on one of four criteria: whole obtained, value-added, change in tariff classification and specific production process. They can also be used in combination for a given product. ROO prevent firms exporting products that contain a significant share of foreign production activity outside the geographical borders of the agreement, thus, benefitting from preferential trade. Almost half of the world's trade in goods is accounted to intermediate products [UNCTAD - Trends in International Trade (2021)], and research has found that the aggregate value added to export ratio for the median country is roughly 70% [Johnson et al. (2012)].

The UK and most EU countries are deeply integrated with global supply chains, meaning a vast and varied network of producers, buyers, and manufacturers link both economies and the rest of the world. Being a member of the EU granted UK goods to flow freely across all members of the Single Market without any obstacles, which helped build and fed these supply chains making them grow in capillarity and complexity, which increased UK trade intensity throughout the years. Therefore, British businesses reliant on foreign intermediate goods in their production process, about half of which are imported from the EU [García-Herrero, A. et al (2016)], either attempt to reorganize their supply chains, to minimize impacts, or endure hard losses from Brexit, because even if the ROO are satisfied there are many other non-tariff barriers. Also, proving origin can be a costly process, to such an extent that there is evidence of businesses opting to pay taxes rather than going through the cost of bureaucracy and paperwork to meet the requirements [Office for Budget and Responsibility – Brexit and the OBR's forecasts (2018)]. For this reason and the ones that will follow, most imports of intermediates will be more expensive due to Brexit, which implicates in a deterioration of competitiveness for UK exporting businesses and higher prices for British consumers.

The negative consequences of Brexit aren't limited only to supply chains, their businesses (e.g., automotive industry, manufacturing industry) and consumers, like the ROO other non-tariff barriers (NTB's), also bring burden to a range of businesses. There are

regulatory barriers, that occur due to divergences in British and EU regulation and affect areas such as safety, health, and environment standards. For example, UK's agricultural, fish, medicine, military, and other goods now must be licensed by the appropriate EU regulatory body, in most cases, or certified by a UK control body that is recognized by the European Commission, in order to be exported to the EU. [European Commission – The EU-UK Trade and Cooperation Agreement (2021)]. Other examples of NTB's are administration costs, custom checks, and anti-dumping duties. Administration costs were naturally expected to rise the moment the transition period ended, because British businesses trading with the EU now must bear with customs procedures and paperwork: submitting import and export declarations, registering the economic operation and identification number of goods, overgoing complicated and varied value-added tax (VAT) rules in different EU jurisdictions, claiming and proving eligibility for no-tariff charges, are only some of the new concerns for British exporters. This will also discourage EU producers to trade with the UK. All UK-EU trade is now subject to custom checks, which assesses whether the correct tariff rate was applied, if ROO is valid, if the product meets the current legislation standards, causing border hold-ups, delaying logistics and increasing costs. Finally, by leaving the Customs Union the UK is now vulnerable to anti-dumping duties, that is, if the EU deems a British good to cause unfair competition with its local products because the price is lower that domestic costs of production, it can charge tariffs and decrease UK exports. The HM Revenue and Customs estimated in 2019 that all these new implications would amount to a cost for domestic exporters of around £15 billion a year, this figure has been updated to £25 billion a year with more recent estimates. Furthermore, during the first seven months after the introduction of the TCA, around 30 per cent of UK goods exports to the EU that could have entered under a zero-tariff did not do so [Ayele, Y. et al (2021)]

So far, focus here has been on goods, yet trade in services ought to be a major concern with post-Brexit developments. UK is a specialized service production economy, representing 80% of all UK businesses and contributing to around 80% of the UK's total jobs, gross output, and value-added (Douch et al. 2020). The service sector accounts for 46% of UK total exports in 2019, which are expected to surpass goods in the next decades. Furthermore, the UK is the second largest exporter of services in the world, by value, and is viewed as a world leader in various service activities such as financial services which combined with professional and business services make up for more than half of UK service exports [House of Commons Library – Trade in services and Brexit (2019)].

Chart 14. UK exports as a percentage of GDP, 1948-2018

Source: ONS

The EU is the destination of 41% (£24 billion) of all UK service exports, [House of Commons Library – Statistics on UK-EU trade (2019)] which cover a range of different activities such as the ones already mentioned, plus travel services, transportation, telecommunications, and others. Trading services is a lot more complex than trading goods which makes it harder to examine from Brexit perspective. First, services can be traded via the internet, in person, if the client travels to the supplier or vice versa, and through subsidiary companies located abroad. The nature of this matter makes tariff barriers and border customs useless, so countries instead have to use NTB's such as impediments to online payment, regulations, licensing and professional qualification to perform certain activities, immigration restrictions and other behind-the-border requirements to prevent and control providers from selling services abroad [House of Commons Library – Trade in services and Brexit (2019)].

When the UK was a member of the Single Market it enjoyed belonging to the most integrated area for trade in services in the world. British firms or citizens could establish and run their businesses anywhere within the twenty-seven Member States, providing services originated in the UK, i.e. both UK and EU consumers could acquire any service produced in the Single Market. The free movement of people combined with mutual recognition of professional qualification meant that UK's specialized service economy could flourish and continued to grow as it had in the previous years.

Unfortunately, Brexit puts a big question mark around how service providers will react, now that access conditions have been restrained and are still undergoing changes. For instance,

before exit any British or UK-located financial institution had the right for ‘financial services passport’, meaning it could establish a branch in any other EU member, from which it could supply cross-border banking to all other twenty-seven countries or even serve all from within the UK. Granting EU businesses full access to integrated banking services provided by UK located financial institutions such as bank loans, fund raising through a capital market bond, fund raising corporate advice, buying foreign currency, and providing risk management on foreign exchange exposure and interest rate movements. This meant that the UK, specifically London was selected as the location for many financial businesses, including non-European firms, because it served as the main gateway to access the EU market which helped maintain its historic status as the financial hub for European businesses.

Surprisingly, the TCA did not provide a comprehensive free trade arrangement around financial services, in fact, this is true for most services, it instead focused on traded goods and other matters such as energy and environment. The document containing over one thousand and two hundred pages has the term ‘financial services’ appearing six times whilst ‘fish’ appears sixteen [Hall, S. (2020)]. Like other comparable agreements, such as the ones EU holds with Canada and Japan, the service provisions in the TCA tend to simply lock in the liberalization that already existed with non-EU trade partners, instead of establishing equivalence agreements and mutual recognition, (e.g. professional certification to perform certain activities) that would maintain the pre-existing market access that the UK has enjoyed [Dhingra, S. et al (2022)]. Equivalence agreements are unilateral, non-negotiable determinations that allow certain sectors of financial services market access in areas that the EU judges UK regulation to be equivalent to its own. Such agreements are time-limited and can be revoked with just thirty days’ notice. Since the TCA, only two very specific equivalence agreements were granted by the EU and progress on further negotiations has been limited due to the NIP disagreement [Hall, S. et al (2021)].

Therefore, the wide range of licensed banking services provided by UK-based firms are now strictly limited, besides license is only available in a few EU jurisdictions and the cost of having a branch overseas has substantially increased [UK Finance (2021)]. The same parallel can be established for most service businesses, with business-travel restrictions and no mutual recognition, British suppliers have borne the loss of a significant share of their respective markets. To say all this was completely unexpected wouldn’t be true, since the Brexit poll result some large businesses were already making provision to switch headquarters and operations to

an EU member State. Nonetheless, the unveiling of a comparable "Hard Brexit" for the service sector intensifies the movement away from the UK, and consequently capital flows, FDI and high-qualified labour exodus, which its effect will be discussed on the next sections. Banks Morgan Stanley and JP Morgan have announced plans to increase their Paris and Madrid operations, and Barclays has relocated the head of its Mergers and Acquisitions activity from London to Milan [City AM]. In addition, with the UK unbound from EU regulations, policymakers can freely make changes to the country's regulatory framework. The government has already signalled intention to 'tailor' regulation on areas such as financial services, which diverge from the EU legislation, making it less likely further equivalence agreements will be reached [Hall, S. et al (2021)].

According to World Bank data, in 1972, one year before joining the European Economic Community, trade intensity (openness), an indicator that measures exports plus imports as a share of GDP, was equal to 41 per cent, by 2019, it had reached 63 per cent. Between 2019 and 2021, UK trade intensity plunged by 8 percentage points, considerably more when compared to countries with similar trade profiles, such as France, which experienced a 2-percentage point drop. Furthermore, the UK is the only large European country to experience a fall in openness since 2020, with openness declining 1 percentage point. France, for example, saw openness rise by 4 percentage points [Dhingra, S. et al (2022)]. Although we cannot single out Brexit as the only culprit for this drop, the fact that the UK hasn't retrieved its level prior to the pandemic as the other major economies have, combined with the lagging GDP growth relative to its peers, seen in Section III, raises awareness around UK's trading future.

Chart 15. Trade intensity of GDP, 2016-2022

Source: OBR (2022)

As mentioned in the start, the overview provided above on how trade in goods and services have been impacted by Brexit, will allow a better understanding of the studies we will examine below. When discussing the studies related to Brexit-trade there are cautions to have in mind. First, it is a hard task for researchers to disentangle Brexit from the supply shocks that affected trade worldwide, and the shifts in demand across products and destinations due to the pandemic. For instance, for some reason, after the coronavirus outbreak, EU import demand fell relative to the rest of the world, thus, British exports to the EU, relative to non-EU, may have declined naturally and not because of Brexit related reasons [Freeman et al. (2022)]. Second, trade data tends to be relatively volatile and is revised frequently, rendering any initial conclusions subject to change in the future.

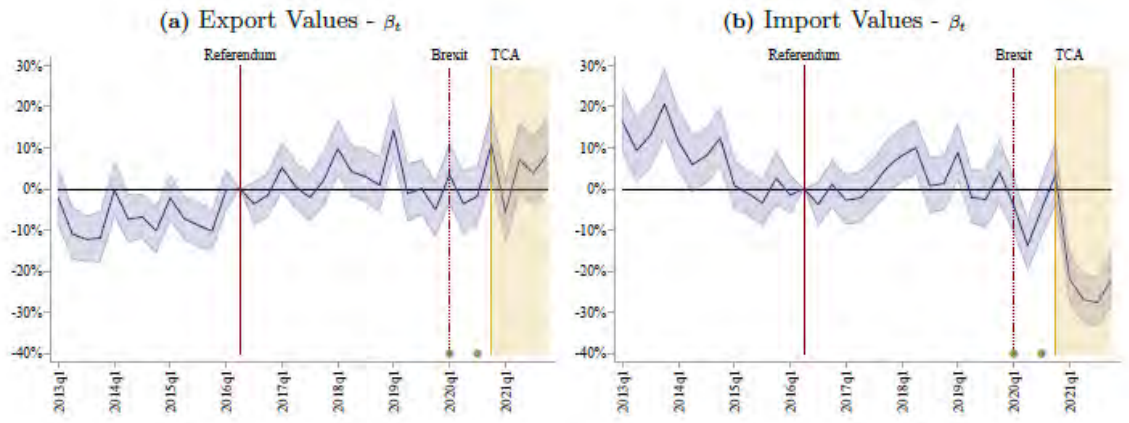
Freeman et al. (2022) uses a difference-in-differences event-study methodology to analyse how trade has been impacted through Brexit. This approach allows social scientists to imitate experimental research using observed data at their disposal. They estimate the differential effect an event has on a 'treatment group' versus a 'control group', that doesn't experience the event, by examining the average change in the outcome variable for the 'treated group' compared with the 'control group', over a period of time [Angrist, J. D. et al (2008)]. The authors compare growth in UK-EU trade relative to UK trade with the rest of the world and growth in US-EU trade with countries other than the UK. By using this particular method, they guarantee that changes in exporter supply and importer demand conditions in the UK and abroad, can be measured, isolating Brexit effect on UK-EU trade. To be certain that sectoral changes do not bias their estimates, the researchers run tests for around 1200 products.

The first result is that the there is no statistically significant evidence of disruption in the UK-EU trade, relative to UK's trade with the rest of the world, prior to the implementation of the TCA. The second result is that after the TCA, the value of UK imports from the EU fell around a quarter, relative to the value of imports from non-EU countries, yet the value of exports declined temporarily then regained their previous level, meaning there is no sign of a significant change in the geography of UK exports. This is a surprising outcome, since the UK postponed the requirement of full custom checks for EU imports until 2022, whilst no such benefit was given to UK exporters [The initial impact of Brexit on UK trade with the EU – OBR (2021)].

The chart below depicts the findings, for each quarter, from the start of 2013 to the end

of 2021, the authors plot the estimated percent change in the UK-EU trade relative to UK trade with the rest of the world, compared with the second quarter of 2016. The shaded grey area shows the 95% confidence interval for the estimates, indicating the degree of uncertainty about their precision. The two green icons along the horizontal axis indicate the first and second wave of Covid-19.

Chart 16. UK trade value with EU relative to non-EU



Notes: Panels (a) and (b) plot the estimated percentage changes in UK exports and imports with the EU versus the rest of the world relative to 2016 Q2. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

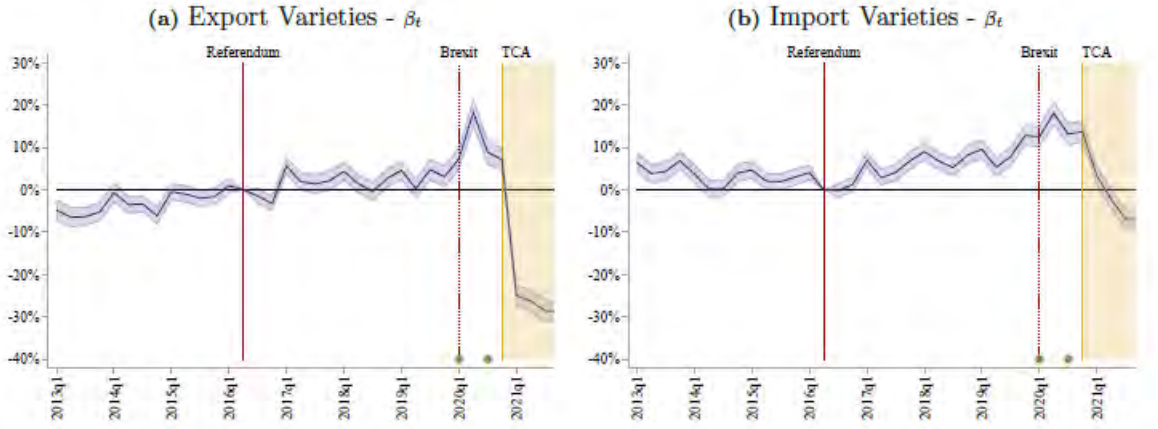
Source: Freeman et al. (2022).

The authors' hypothesis for the first result is "that trade flows seem relatively unresponsive to anticipated, yet uncertain, increase in trade barriers". This affirmation contradicts other two well respected studies within the academic circle of Brexit matters, published after the Referendum, and before the official exit and its terms. Crowley, M. et al (2018) and Graziano, A. et al (2018) both agree, using different approaches, that Brexit's uncertainty over future policy between the UK-EU relationship reduces trade flows and trade participation. Additionally, Graziano's research finds evidence that UK imports, from the EU, are more sensitive to uncertainty, when compared with UK exports from the EU, which seem to be confirmed when looking at their respective trends in Chart 16, over the period prior to Brexit. His work also calls attention to higher uncertainty reducing investment by increasing the option value of waiting to act, referencing Bloom, N. et al (2014), and concludes that if trade agreements decrease policy uncertainty, consequently stimulating investments [Handley et al (2015); Carballo et al. (2018), then the opposite, Brexit, may lead to fall in investments. The decline of investments may not have such a significant impact over a small period, like the one examined in Freeman's research, but most importantly, business investment will, at aggregate

level, positively influence both trade with the EU and non-EU, thus, Freeman's approach wouldn't be able to capture this uncertainty effect, as it is based on a difference-in-difference method.

However, Crowley's publication finds that although uncertainty does lead to a decline in UK-EU trade, this fall is only significant in terms of trade activity, i.e. number of UK firms exporting, but does not generate the same impact on the value of UK exports in the first year following a change in trade policy, which is very much in line with Freeman findings in his third result. Intrigued by the difference in responsiveness to the TCA regarding the value of exports and imports, Freeman estimates the effects of Brexit on the number of trade relations (or export varieties), using the same difference-in-difference approach. The results show that after the TCA the number of export varieties with the EU are 30 per cent smaller relative to the rest of the world, while for imports the effect is significant, but much smaller. He states that this reason is driven by the exit of small British exporters' low-value trade with the EU, due to the increased fixed costs brought by the TCA through NTB's previously mentioned. Below, the same chart used for export and import value, shows the difference on number of trade relations.

Chart 17. UK trade diversity with EU relative to non-EU



Notes: Panels (a) and (b) plot estimated percentage changes in the number of UK trade relationships with the EU versus the rest of the world relative to 2016 Q2. A trade relationship (or variety) is defined as a CN8 product traded with a partner country in a quarter. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

Source: Freeman et al. (2022).

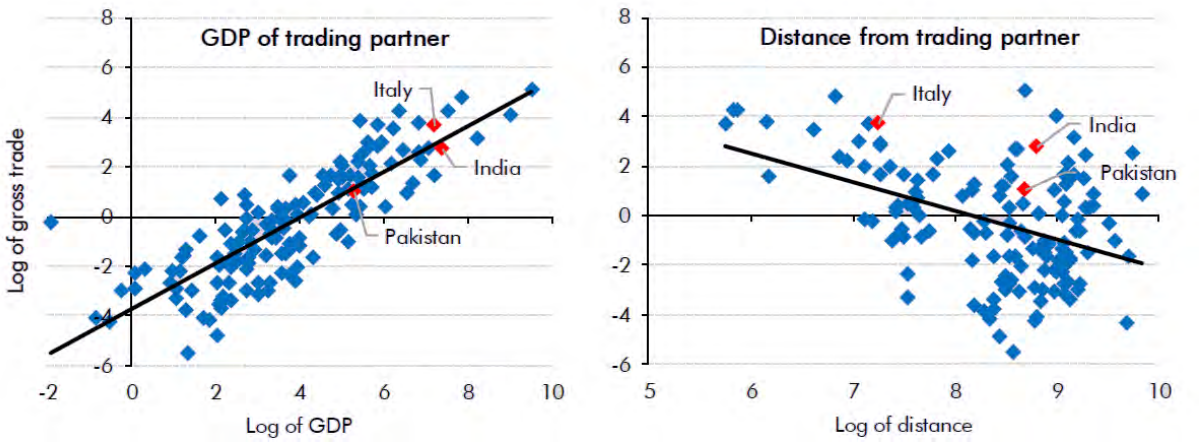
Using a sample of over 1200 products, Freeman also finds a substantial variation in how the TCA has affected this range of products. Observing the foreseen fact that exports to the EU declined, relative to the rest of the world, for products with higher EU trade barriers. When

classifying his sample into capital, intermediate and consumption goods, his research shows that "value of UK exports to the EU, relative to the rest of the world, increased under the TCA for capital and, to a lesser extent, intermediate goods, but there was an offsetting reduction in exports of consumer goods. By contrast, the decline in the UK's relative imports from the EU is broad-based across all three types of goods." It is surprising to find not only the resilience, but increase, in capital and intermediate exports' value, relative to non-EU. Nonetheless, as the author himself states, this evidence is only based on a one-year sample, so results can be biased by temporary changes as businesses take time to adjust to new terms.

Chapter III covered three main studies that were conducted before the Leave vote won the polls, they all used the same approach, CGE modelling, and found similar results for the short-term. During the same period, another research, using a different model, was published by authors Gianmarco Ottaviano, Swati Dhingra, and John Van Reenen, who worked together, representing the Centre of Economic Performance (CEP) to build a study, releasing updates every other year, which provide great insights when compared to the previous three. Their study used a modern quantitative trade model, which is a new class of trade modelling, that has a central equation based on a special form of gravity equation. A proper definition of these two models is required and will be provided below, followed by the results of this study and comparisons to the ones that used CGE models.

Gravity models are a widely used econometric approach when estimating the impact of trade agreements on trade flows between two countries. The term 'gravity' is a reference from Thomas Newton's physical law of gravity: "the force of gravity between two objects is proportional to their masses and inversely proportional to the square distance between them". A similar empirical relationship can be established to examine international trade flows. The value of trade between two countries tends to increase the higher their GDP and tends to decline the more distant they are. For instance, the value of UK's trade with India is nearly six times larger than trade with Pakistan, while their distance to the UK is practically the same, India's GDP is nine times higher than its neighbour. India's GDP level is comparable to Italy, yet because Italy is closer to the UK, trade is twice as higher than with India. Gravity models capture this relationship by regressing bilateral trade against GDP, distance and trade cost variables. The dynamic explained above is illustrated in Chart 18, where the log of UK's gross trade with countries, represented by blue and red rhombus, is compared with the log of GDP and the log of distance. [Brexit and the OBR's forecasts – OBR (2018)]

Chart 18. Gravity in UK trade: the effects of size and distance



Source: IMF data, ONS data, OBR compilation

Apart from GDP, distance and trade costs other variables such as common language, common border, population size or if the countries had a colonial relationship in the past, which are used to improve the fit of the regression. The effect of trade agreements can be measured by including a dummy-variable, i.e. a numerical variable that, in this example, would take values of one or zero, to represent if a country is or is not a member of a trade agreement. Therefore, if trade flows increases when this dummy is equal to one, relative to when it is zero, being a member of a given trade agreement has a strong explanatory power regarding trade between two countries. By controlling for other variables in the regression, gravity models can isolate the effect of a given trade policy. Due to this reason, they were widely adopted to examine Brexit influence on trade, including HM's Treasury study for the long-term which will be commented on further on. Nevertheless, as is true with any model, gravity models have weaknesses. Unlike CGE models, they do not include the interaction between sectors and markets, plus the fact they are only limited to explaining trade flows, with no concern as for welfare and employment [Busch, B. et al (2016)].

Modern quantitative trade models, or new quantitative trade models (NQTM's), were originated as a consequence of CGE trade-models' extensive complexity. NQTM's is a reduced CGE model, so that only the most important and straightforward equations are postulated. The central equation is based on a special form of a gravity equation, yet despite this, the model can measure how changes in trade barriers influence welfare. The central equation expresses a positive relationship between trade flows and welfare, due to fact that more available substitutes for domestic goods and a larger range of product variety, both having a positive effect on

welfare. A key parameter for this model is trade elasticity, i.e. the likelihood a consumer purchases an imported good instead of domestic one, when imports become relatively cheaper because of a drop on tariff barriers. The higher the elasticity the more trade will be created. However, because higher trade elasticity implies that consumers consider imported goods as substitutes for domestic goods, the welfare gains due to increased trade are limited, when compared to a scenario where trade elasticity is lower and foreign goods are valued over domestic ones. In this case, increased trade flows will have a larger and less limited impact on welfare, due to product variety. The advantages of NQTM's are similar to CGE's, for instance, the possibility of including trade in intermediates, different form of market structures, multiple countries and sectors, with the addition of being more compact and transparent. Therefore, they are easier for experts to understand how parameters and assumptions impact results, because fewer parameters and assumptions are required, hence, reducing the 'blackbox' issue mentioned earlier in this paper. Nonetheless, much alike CGE modelling, NQTM's are still a theoretical exercise, meaning that assumptions, like choice of market structure and how firms respond to incentives, can strongly influence the results. Furthermore, NQTM's (and CGE's) are static in nature and generally do not include dynamic effects on economic growth [Busch, B. et al (2016)]. For an in-depth comparison between CGE and NQT models Eddy Bekkers' (2017) work provides a detailed difference between the two modelling approaches. He resumes his work by stating that "NQT models are a special case of CGE models by stripping the model of savings, investment, and capital, eliminating different types of taxes and the transport sector, and collapsing various choice nests to Cobb-Douglas".

The CEP study uses a NQTM model to estimate the impact of Brexit, considering two scenarios: an exit with a trade agreement and an exit on WTO terms. It presents three main channels that increase UK-EU trade costs: higher tariff on imports, higher NTB's, and the exclusion of the UK in future EU agreements that will drive the bloc into deeper integration and a reduction of NTB's within. The study's results find that in the FTA scenario there is a decline of 1.3 per cent in GDP, relative to the counterfactual of not leaving the EU. This is significantly different to HM's Treasury, PwC and OECD's FTA scenario estimations, which used CGE modelling, deeming a loss in the range of 3.1 per cent to 3.6 per cent of GDP, relative to the counterfactual of a non-exit. Regardless, it should be stated that PwC, OECD, and CEP built their models to estimate Brexit's impact by the start of 2020, considering that by March 2019 Brexit would have officially occurred, in other words, their estimates consider that UK would have been trading on FTA or WTO terms for a period close to one year.

Although it uses a reduced-form CGE model, the main reason for the disparity, is that CEP's study doesn't take effects from increased uncertainty into account. They argue, using Joseph Steinberg's work as evidence, that uncertainty costs due to Brexit are very small compared to the other channel effects, thus, do not include in their modelling. Steinberg (2017) uses a dynamic general equilibrium model and shows that the welfare cost of uncertainty surrounding Brexit is less than a quarter of a percent of the overall welfare cost of an exit. He compares the magnitude of effect to be the same as the welfare cost of businesses cycles in macroeconomic activity that occur year after year. At the end of Section III, by analyzing UK GDP historical data and comparing it to its peers, it was concluded that HM's Treasury, PwC and OECD's estimates had overestimated the uncertainty and transition effects. In comparison, results from Steinberg's and CEP's work are similar to the real data observed, from the second quarter of 2016 up until the outbreak of the pandemic, regarding Brexit effects.

Figure 3 shows a comparison of the four studies examined, published before the Leave vote won the polls. It has already been commented that regarding the near-term, the estimate that came closer to the developments post-Referendum is that of CEP. However, it was also observed that, excluding HM's Treasury, all consider the short-term horizon to be at the start of 2020 and that Brexit would take place one year before, thus, trade effects could have been overestimated, since there were no changes regarding trade barriers until the introduction of the TCA. While, this might be true for the CEP study, for PwC and OECD the trade-effect may have not been so overestimated after all, because their research uses non-trade CGE models, which do not incorporate trade relations in a differentiated way. More specifically, CGE non-trade models only include total UK exports and imports and related overall average trade barriers. This means that effects over changes on trade costs with specific partners, like the EU, can only be roughly estimated and a certain degree of arbitrariness is necessary [Busch, B. et al (2016)]. The hypothesis above is supported by comparing PwC and CEP on the impact of Brexit via trade until 2020. As mentioned before, CEP research only considerers trade as a key negative impact in the short-term, so trade-effects are responsible for the total estimation, 1.3% of GDP, whereas PwC considers three negative channels, uncertainty, migration and trade, which have respectively a cost of 1.9%, 0.8% and 0.5% of GDP. CEP estimate of trade-effects is nearly three times as large as PwC during the same period, showcasing the difference incorporating trade relations in detail has on the overall estimate.

The short-term results of these studies have been discussed thoroughly, yet up until this

now, the long-term estimates were not commented on. For the purpose of this work, the long-term offers much more from a comparative perspective over studies, rather than a precise foresight of what Brexit effects will actually materialize into, since 2030 is still seven years ahead.

Figure 3. Comparison of Brexit forecasts

	OECD	CEP/LSE		HM Treasury		PwC	
	WTO / FTA	FTA	WTO	FTA	WTO	FTA	WTO
Near term (2020)*							
GDP	-3.3%	-1.3%	-2.6%	-3.6%	-6.0%	-3.1%	-5.5%
GDP cost per household	-£2,200	-£850	-£1,700	-£2,400	-£4,000	-£2,100	-£3,700
Longer term (2030)							
GDP	-5.1%	-6.3%	-9.5%	-6.2%	-7.5%	-1.2%	-3.5%
GDP cost per household	-£3,200	-£4,200	-£6,400	-£4,300	-£5,200	-£600	-£1,800
Transmission channels							
Short-term uncertainty	X			x	x	x	X
Change in trade with EU	X	x	x	x	x	x	X
Productivity effect from trade	X	x	x	x	x		
Change in FDI	X		x	x	x	x	X
Productivity effect from FDI	X		x	x	x		
Reduced migration	X					x	X
Gain from deregulation	X					x	X
Lower contribution to EU budget	x	x	x	x	x	x	X
Model type	NiGEM	Reduced form model		NiGEM		CGE model	

Notes: HM'sTreasury near term horizon is due in the end of second quarter of 2018, while CEP estimates are relative to a one-year change

Source: Dr. Angus Armstrong, edited

As mentioned, PwC and OECD studies are based on CGE non-trade models, yet HM's Treasury estimate for the long-term is made using a gravity model, thus, the research includes differentiated trade relations. Also, both CEP and HM's Treasury's long-term work include effects of trade specialisation, hardly covered in PwC and OECD, which allow countries to specialise in their areas of comparative advantage, reducing the cost of goods, services and intermediate inputs. Moreover, excluding PwC, productivity effects are introduced in the long-term estimates, which will be touched upon in the next paragraph. In the long-term, by introducing new transmission channels the results variability is significantly higher. Analyses that include differentiated trade relations and trade specialisation are more sensitive to Brexit,

as is true to studies that consider productivity effects via trade and FDI. Gains from regulation and lower contribution to EU budget have already been briefed to be unsignificant, relative to the costs, and even studies that include these factors, agree that their effects are irrelevant when compared to other factors. Finally, FDI and migration will be examined in Sections VI and VII, respectively.

There are a number of studies which have found a significant correlation between trade openness and higher productivity [Bekaert (2011); Crafts (2012); Melitz (2013)], the same positive relation is true for foreign investment as they interact with each other. These studies, overall state four key factors to explain the correlation. First, a higher exposure to imported goods and services creates a bigger competition between firms, which are then incentivized to improve productivity facing the risk of losing their market share. The effort is generally directed to investment in the use of new technologies, which will lower firm costs. Second, the increased competition leads to a better allocation of resources. For instance, investment is attracted to higher productive firms while least productive firms are forced to leave the market. Third, openness provides a wider selection of intermediate goods. Thus, domestic firms have access to higher quality or lower cost inputs, which improve efficiency. Finally, openness allows businesses expansion to foreign markets, scaling and specializing their production, and raises the probability of knowledge spillovers, reducing the distance of technological frontiers, both of which boost productivity levels.

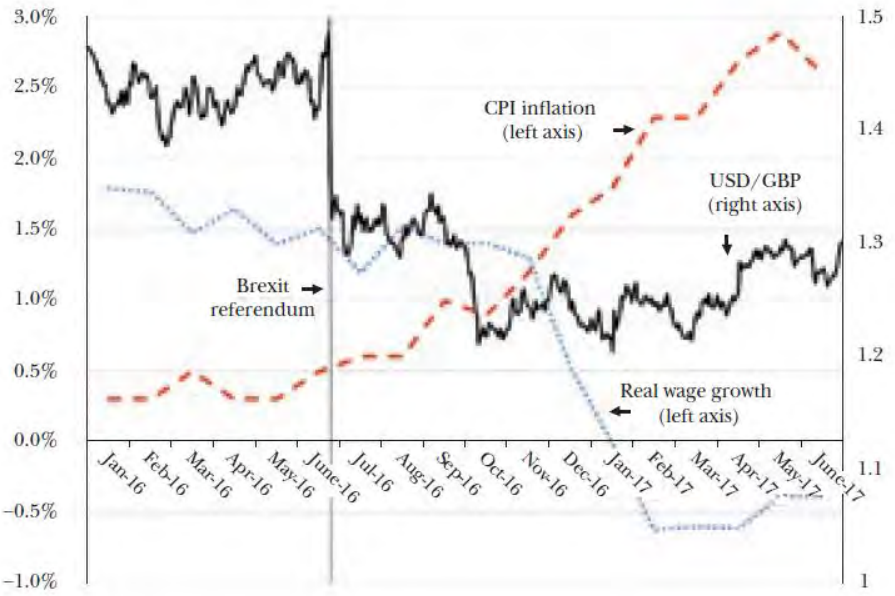
The question that arises is: how does an economic scientist include productivity effects in their estimation? The answer is with dynamic analyses. All the short-term estimates, each with their own approach, were made using a static general equilibrium model, which means the estimate, or to better phrase it, the new equilibrium of the economy was found considering that the nature of the economy remained fixed in the given time interval. The objective in this type of modelling is to measure the contemporaneous difference between the initial and final equilibrium by observing the behaviour of endogenous variables, such as, trade flows, prices, production, investment, and so on. Whereas with dynamic general equilibrium models, there is also a concern on the transition, throughout time, of the economic system, from the initial to the final equilibrium. Three of the most important dynamic factors are capital accumulation, productivity and technological change. Therefore, dynamic analyses allow economists to examine how Brexit changed investment rate, production rates and technological investments, and in turn, how the change in these conditions affected the new equilibrium. Unfortunately,

dynamic models still are a mixed blessing, despite modelling reality more precisely than static models, they are computationally more difficult to solve and existing algorithms may not be able to arrive at an equilibrium, due to their complexity [Piermartini, R. et al (2005)]. Nevertheless, based on recent research, dynamic effects may double or triple the size of the static effects [(Bloom, N. et al (2014); Sampson, T. (2016)] and due their undeniable significance in the real world, all three studies direct efforts to incorporate them in their long-term estimates. In fact, the authors from across the publications do it in a very similar fashion, utilizing elasticity functions that determine the degree of which trade (and forward FDI) affects productivity. CEP uses Feyrer, J. (2009) estimates which have already been mentioned in this work, OECD elasticity functions are based on Egert, B. et al (2016) study, while HM's Treasury has a more inelastic parameter, estimating a 1% decline in trade, lowers productivity by 0.2% to 0.3%. The non-inclusion of the productivity effect is the main reason why PwC long-term estimate differs so much from its peers and, based on the arguments that have been presented, it is probably underestimating Brexit effects.

V. Consumer Prices & Inflation

The financial and currency market immediately responded to the Referendum result. The day after the announcement FTSE 100 stock market index dropped by 3.8 per cent [Breinlich, H. et al (2022)] and the pound plummeted by 7 per cent of its value, according to the Bank of England. Prior to the polls, OECD research observed data directing to some anticipated market movements in pricing the possibility of an exit, yet the magnitude and instant market corrections, followed by further deterioration, are evidence that the Leave vote's probability was underestimated and not fully priced at financial markets. Furthermore, the forward-looking nature of markets persisted negatively regarding the UK, with sterling's value fluctuating at around 10 per cent over following years after the Referendum [Dhingra, S. et al. (2022)]. The sharp and persistent impact puts pressure on the economy's prices via the pass-through effect, i.e. the ratio at which prices increases due to a variation in the exchange rates. The quicker the pass-through effect materializes into the higher prices, the more likely growth in nominal wages won't react accordingly, which result in lower family incomes, consequently jeopardizing growth output. The graph below shows how exchange rate, inflation and real wage growth reacted immediately after the Referendum, which will be discussed in this chapter.

Chart 19. UK Exchange Rate, Inflation and Wage Growth

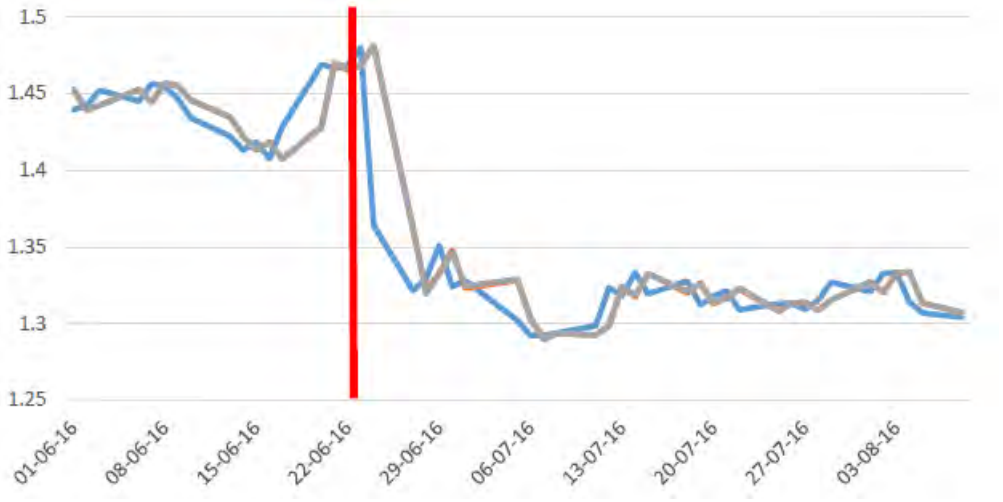


Notes: USD/GBP data is end-of-day rate froom Bloomberg, CPI inflation I annual change in CPI from ONS and wage growth is annual change in seasonally adjusted Regular Pay from ONS.

Source: Sampson, T. (2017)

Plakandaras, V. et al (2017) provides an enlightening study regarding the immediate effects of Brexit towards the British pound. The authors use five different time-series methods to examine the pound-dollar exchange rate, before the result of the polls. Additionally, they include a factor in their estimations that measures uncertainty, supported by the UK EPU index developed by Baker, S et al. (2015), which is the same used in the OECD research, presented in Section III. Training of models is made assisted by machine learning technique, which analyses the different models simultaneously minimizing forecasting error, by comparing them to the real exchange rate data before the Referendum. The authors end up with two options that have equivalent forecasting ability and use them to predict the exchange rate, from the day after the polls took place, onwards. Chart 20 shows how close and persistent over time their modelled time-series were from the real data observed, with the blue line representing the actual exchange rate, while the grey and orange, barely able to distinct, depicts the model's forecasts. The authors conclude that there is a two-day lag between their time-series and the real pound-dollar exchange rate, but most importantly, they are able to conclude that the use of the EPU index is extremely significant in predicting the evolution of the exchange rate. Therefore, it can be affirmed that the currency depreciation was unanticipated and driven mainly by uncertainty over Brexit.

Chart 20. The evolution of GPB/USD exchange rate versus modelled time-series



Notes: The blue line depicts the actual exchange rate, while the grey line and, barely visible, orange line represent models' forecasts. The horizontal line denotes the date of the Referendum.
Source: Plakandaras, V. et al (2017)

As previously stated, the sterling stabilized in mid-2017 with a 12% devaluation relative to the period just before the Referendum. This was accurately predicted in the Brexit scenarios

by the CGE and reduced-form models, that have been mentioned continuously throughout this work, yet none of them independently examined how and to what extent the exchange rate depreciation determined inflation rate, as detailed as the following publication. Breinlich, H. et al (2019) calls attention to the fact that the decline of the currency value was not caused by a contemporaneous economic condition, but a political event that modified the expectations of the economy. This is a relevant fact for the authors because pass-through depends on what caused the exchange rates' variation [Forbes, K. et al (2018)]. Other important evidence that will support the development throughout their work, are the results found in Goldberg, L. et al (2010), which demonstrates that economic theory suggests pass-through variation across different countries and time, depending on import flows; Chen, N. et al (2018) who defends the currency in which trade is invoiced will affect the pass-through's time-response and magnitude.

The methodology behind Breinlich and co-authors' research is the use of product-level differences in exposure to import costs with the objective to isolate price variation inflicted by the currency's depreciation. In simpler wording, they develop a model that calculates the elasticity of consumer prices to the exchange rate, by grouping similar products that have different shares of foreign production. For instance, let's take the British automotive industry as an illustrative and simplistic example. Bentley, Land Rover and the Mini are iconic domestic car manufacturers, and all of them have a share of imports in their production. Because the Mini imports their car engine parts from a foreign country, it has a 25% share of imports related to its production in the UK, while the Land Rover imports not only their engine, but their tyres and windows, amounting to 50% share of imports, finally the Bentley has a 75% share of imports because its engine, tyres, windows and interior design is fabricated abroad. The question is which of these manufacturers would be more sensitive to a devaluation of the sterling? The Bentley, because of its higher share of production, which is fabricated in foreign countries. Thus, if the pound is now weaker relative to foreign currency, the cost of producing the Land Rover increases more than the Mini and less than the Bentley, if all else remains constant, consequently, increased cost raises consumer prices. This is a very rudimental way of putting what Breinlich and fellow researchers calculated in their model. They use a sample that includes both domestic and foreign goods, plus imported inputs for domestic production, which is the case exemplified above. This allows the model to estimate the overall effect exchange rate has on price of similar products with different exposure towards imports. The study's first result is that higher consumer prices were related with product groups that were exposed to larger import shares and that domestic producer prices increased more in industries where the

share of imported inputs was higher.

Table 2. Import Shares by categories

COICOP Division	(1) Direct	(2) Indirect	(3) Total
	%	%	%
Food and non-alcoholic beverages	29	14	43
Alcoholic beverages and tobacco	11	13	24
Clothing and footwear	41	8	49
Housing, water, electricity, gas and other fuels	1	17	18
Furniture, household equipment and maintenance	25	9	34
Health	27	6	33
Transport	22	18	40
Communication	17	17	34
Recreation and culture	15	12	27
Education	1	4	5
Restaurants and hotels	0	17	17
Miscellaneous goods and services	14	12	25
Aggregate	16	14	29
Standard deviation	0.17	0.07	0.17

Notes: The aggregate import share is a weighted average using 2016 CPI expenditure weights. The standard deviation is unweighted and calculated across 84 COICOP classes.
Source: Breinlich, H. et al (2019)

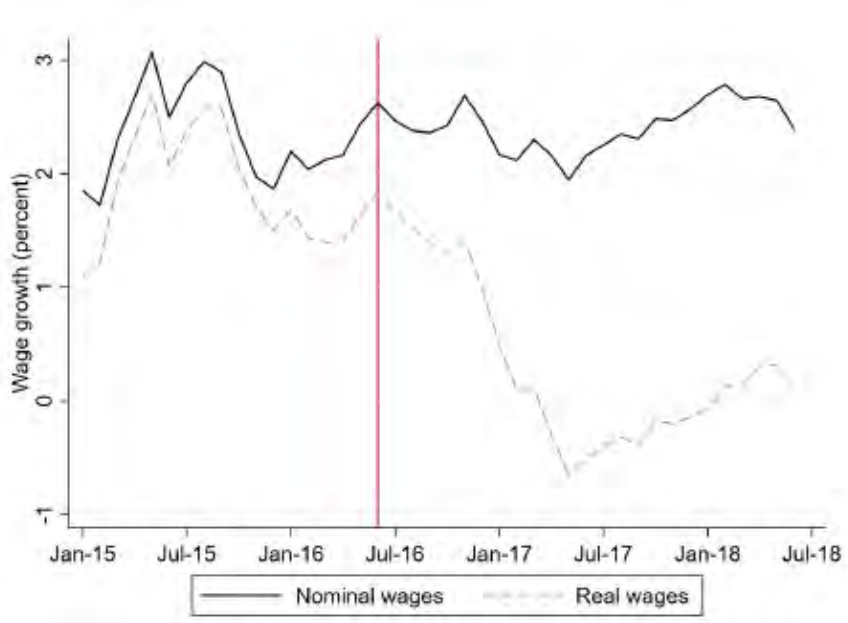
Table 2 exhibits the study's summary of import share across categories defined by the Classification of Individual Consumption by Purpose (COICOP) which is an international reference for household expenditure. Column (1) indicates direct import consumption and column (2) consumption through the form of intermediates, there is noticeable diversification across industries, but in aggregate there is a balance between the form of imported consumption, with total adding up to 29%. From Table 2, we can infer that 'clothing and footwear' probably had the highest consumer price inflation while 'education' the lowest. The second question this publication tackles is the sterling depreciation pass-through on consumer prices, so that the magnitude of consumer price inflation can be evaluated. The authors do this by testing pass-through variation across product groups with different import shares, using quarterly data from the first of 2011 until second of 2018, with CPI inflation by COICOP class as their dependent variable, controlling their regression for Euro area inflation, oil prices and seasonality, so that their estimates are unbiased. The results attest to a complete pass-through effect in the space of two years, which means that the rise in consumer price is equal to the product group import share times currency depreciation. Therefore, since aggregate import share is 29% and considering a 10% devaluation of the pound, the study estimates Brexit increased consumer

prices by 2.9% by June 2018. The study suggests this would be equivalent to a rise in the cost of living for the UK average household of £870 per year.

Since time-horizon concur Breinlich, H. et al (2019) results can be compared with HM's Treasury (2016) estimates. Obviously, the comparison is unfair with the latter because it is an ex-ante assessment, while the former an ex-post study, yet a useful insight can be put together. HM's Treasury publication does not mention a pass-through effect, it jumps to the conclusion that the exchange-rate shock would instantly raise import prices which would lead to a higher inflation at the equivalent rate of the increased import prices. Although Breinlich, H. et al (2019) could not reject the hypothesis of a complete pass-through, which is thought to be due to the significant use of imports in domestic production and because devaluation was caused by an isolated political event, the pass-through effect did not occur immediately. The lagging nature of the effect backed by studies like Chen, N. et al (2018), doesn't seem to have been considered by HM's Treasury, which could explain the apparent economic resilience UK's economy showed immediately after the Referendum. The overestimation on uncertainty pointed at the end of Section IV is closely related to the pass-through effect lagging response, which was not considered HM's Treasury and other studies with the same approach, exacerbating their estimates.

As a consequence of inflation's lingering growth, real wages also weren't immediately affected after the Referendum, thus, consumer expenditure could remain at the same levels as before. Even if uncertainty over the future was negatively impacting business investments, the influence this effect has over the economy is long-term relative to household consumption. As can be seen in the chart below, it was only at the start of 2017 that real wage growth dropped below pre-Referendum level, due to slowly increasing inflation and nominal wage stagnation. During the most part of 2017 until the second quarter of 2018 real wage growth was negative, meaning that workers were experiencing a drop in their purchasing power, more on this will be discussed in Section VIII. Also, a lower real wage is likely to have been the reason of otherwise unexplainable record-low levels of unemployment during post-Referendum seen in Section III, offsetting, in the short-term, workers' reduced purchasing power which would have led to lower consumer expenditure.

Chart 21. Wage growth in the UK



Notes: Wage growth is the percentage change year on year in the three-month average of Average Weekly Earnings - Total Pay. The vertical line indicates the referendum date

Source: ONS, compiled by Breinlich, H. et al (2019)

The evidence provided in this chapter supports the hypothesis that the rise in inflation was driven by higher import prices caused by the depreciation of the pound, which Plakandaras, V. et al (2017) demonstrated was provoked by uncertainty Brexit generated. The lagging pass-through effect is responsible for a short-lived buoyancy of the British economy, which was unforeseen by the aforementioned studies. While the pound did indeed fall as much as expected, after an initial shock to confidence, businesses and consumers seemed to cope with all the immediate negative predicted consequences and unemployment rate even fell slightly [Portes, J. et al (2021)]. As Begg, I. (2017) states the short-term economic resilience has refuted the pessimistic ex-ante assessments, yet there is a very high probability that instead of incorrect estimates Brexit effects may just have been postponed.

VI. Capital Flows & FDI

The UK has traditionally been the gateway for non-EU capital to access EU's financial market, with London representing the bloc's financial centre. This status was held, even though the UK didn't adopt the Euro, thanks to its comparative advantages in the financial sector, such as, tradition, flexible regulation, product diversification, human capital, and language. The influence City of London had over the EU is corroborated in Eichengreen, B. (2019) statement that "more than 90% of the euro-denominated interest rate swaps of euro area banks, three quarters of all foreign exchange transactions, half of all bank lending, and half of all securities transactions in the EU occur in London" [Campos, N. et al (2019)]. However, the loss of 'passporting rights' for UK-based financial institutions, discussed in Section IV, and other barriers provoked by Brexit, put at risk this once uncontested position. Additionally, another troublesome factor was the uncertainty caused before the official exit, when Brexit conditions were still unknown, significantly reducing investment levels. Furthermore, now that the TCA has been implemented businesses are starting to adjust to EU market access restrictions which could lower the return on investment in the UK, reducing attractiveness for FDI. In this section we will discuss how this has affected the business climate and what are the implications for the long-term.

During Sector IV, the negative effects of uncertainty surrounding Brexit from the post-Referendum period to the introduction of TCA were discussed. Bloom, N. et al (2019) uses a monthly survey, the Decision Maker Panel, that collects data of 3.000 different UK businesses in order to assess the impact of Brexit on domestic firms. The authors identify three key results from their study. First, is that uncertainty around Brexit is persistent throughout the 3-year period examined, an uncommonly extended period when compared to historical uncertainty episodes, which normally generate a rapid surge of doubt, that peaks in a short period, then quickly dies down when further information becomes available. Instead, questions around exit conditions, the future of UK-EU trade relationship, immigration policy and new regulation caused uncertainty levels to remain high until the establishment of the TCA. The second and third outcomes are the study's findings on investment and productivity. It reports that the anticipation of Brexit's consequences reduced investment by 11% relative to a non-exit scenario and productivity fell by around 2 to 5 per cent, three years after the Referendum. The authors make two unprecedented takes on productivity, arguing that firms will have to dedicate resources to plan for Brexit and internationally exposed firms are more efficient than their

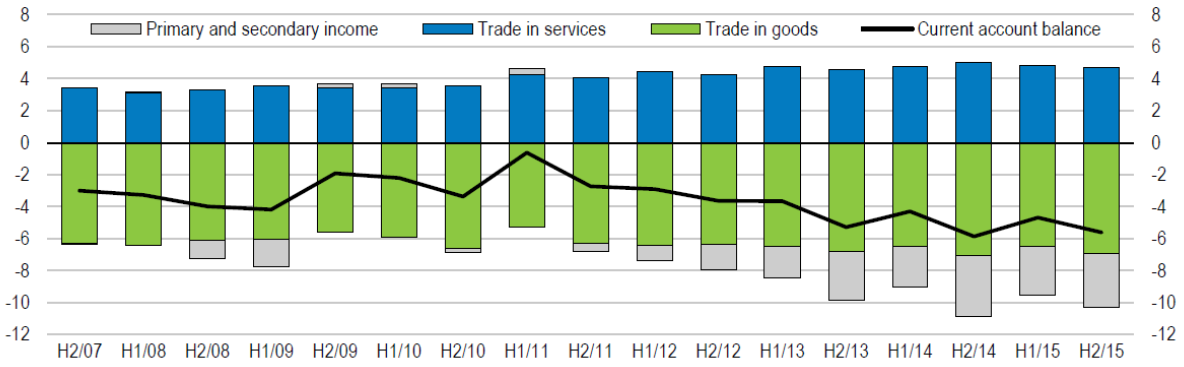
domestic peers, thus, with Brexit effects expected to be harder on the former, productivity drops more than average. For comparisons sake, using completely different methods and data, Springford, J. (2022) synthetic counterfactual approach finds that in five years after the Referendum investment fell by 13.7%. Both investment and productivity implications will leave UK's economy in a worse condition that before with no counter benefits.

FDI's are investments made by individuals or businesses from one country to another. According to the IMF, for an overseas investment to be considered a FDI, the amount needs to surpass 10% of total equity of the company invested. The benefits from FDI are a consensus within economic theory, ultimately providing GDP growth via a higher rate of employment and work-related training, which would in turn increase aggregate demand; higher productivity through training, innovation and knowledge spillover; and higher corporate tax revenue in the host country [Razin, A. et al (2007)]. The expected impact of Brexit on inward FDI flows is significantly high according to CEP, HM Treasury and OECD studies, with estimates ranging from a reduction of 15 to 30 per cent over the next decade. According to data issued by OECD inward FDI flows toward the UK has been plummeting, in 2005 the UK received 19% of global FDI, in 2016, 13% and by 2021 only 2%. However, this does not seem to be only caused by Brexit, since in the recent decades FDI has been redirected to emerging economies like China and Brazil. Also the UK FDI inflows as a percentage of EU member-states have remained above pre-Referendum levels [Dhingra, S. et al (2022)]. Still, the benefits the UK once enjoyed with a high inflow of FDI have shrunken and if the estimates of reduction are to be materialized, UK policymakers will have to figure how to regain attractiveness from investors abroad or face a decline in economic growth.

Nonetheless, the lost benefits from FDI are not the only issue the UK needs to worry about. According to ONS data, at the end of 2019, government debt was equivalent to 85.5% of GDP and current account had an average deficit of 4% of GDP from 2015 to 2019. Having a current account deficit means that the UK is in debt with the rest of the world, or in other words, is reliant on inflows of capital from abroad to finance national debt. A significant share of capital inflows is associated with businesses that benefit from UK's access to the Single Market, mostly in the financial service industry [HM's Treasury (2016)]. Thus, if foreign investors are less inclined to send resources because of Brexit, UK's position is jeopardized. The options policymakers face are grim, they could reduce the deficit of the current account, shrinking the size of the economy by cutting domestic consumption and investment, which in

turn will cause a lower output, raising government debt to an even higher level, increasing the possibility of compromising debt payments, ultimately leading to a worsening of the public finance condition. The other option would be to maintain UK attractiveness for FDI, Razin, A. et al (2007) states that the most common form to do this would be by lowering corporate tax, yet because of the already excessive government debt the UK, it wouldn't be able to give up tax revenue having to offset this by tax raises in other areas. According to the House of Commons Library, only income tax, national insurance contribution and value-added tax are larger contributors than corporate tax, accounting in average for 70% of tax revenue. An increase in any of the three would mean cutting of domestic consumption or savings, which also would shrink the economy, arguably leading to similar issues compared to the first alternative.

Chart 22. Current account balance as a percentage of GDP



Notes: Figures refer to half-yearly data that is calculated as an average of two quarters
Source: OECD (2016)

The vulnerability of UK's position is a key factor to understand Brexit's effects. Besides the reasons above, the UK is extremely reliant on its service sector exports to partially offsetting the deficit caused by goods trade, as can be seen in Chart 22. According to ONS data, in 2014 financial services combined with professional and business services ran a £58 billion trade surplus, equivalent to 3.2% of GDP, whilst the overall trade result was a deficit of £34.5 billion, equal to 1.9% of GDP. Moreover, because of its high profitability, financial services industry total tax contribution, which takes into consideration employment taxes, corporation taxes and VAT, accounts for 10.5% of UK government's total tax revenue, this is equivalent to almost three quarters of public spending on education and close to half of public spending on health [PwC (2019)]. These two circumstances demonstrate the value this industry has for national interest. However, during Section IV it was mentioned that the introduction of the TCA with no provisions for the service sector meant a "Hard-Brexit" for those industries. A recent survey

ran by financial group EY indicated 44% of financial service firms have moved or plan to move operations and/or staff to the EU.

The introduction of the TCA is expected to end uncertain times, which would arguably help the UK recover from the impacts suffered in investment and productivity, yet with all the information that has been provided so far this seems optimistic. With the loss of Single Market access and 'financial passporting rights' financial services and other service industries will start moving their businesses to the EU and with them their investments. The correlation between national investment and FDI can be exemplified with the following findings. Dhingra, S. et al. (2022) compares the difference between business investment growth three years before the Referendum and three years after the event, while the former showcases a growth of 1.7% a quarter on average, after the Referendum business investment fell by 0.1% a quarter on average. Using the same time-period Breinlich, H. et al (2020) finds that the Referendum result led to a 9% reduction of EU FDI into the UK and a 17% increase of UK FDI into the EU.

VII. Labour Market & Migration

Immigration was at the centre of the Brexit debate. It shaped the UK-EU post Brexit economic and trading relationship because the EU understood that Single Market membership was conditioned to the free movement of people. Whilst one of the main reasons behind the successful 'Leave' campaign, advocated a sovereign immigration policy control rather than being constrained by EU's liberal legislation. Amidst the refugee crisis that struck Europe, peaking in 2015 when more than 1.2 million asylum applicants entered EU borders [Eurostat – Annual Asylum Statistics (2022)], anti-immigrant movements gained significant political strength within Europe and in the UK. Arguably, the EU's failure to handle the refugee crisis did not have a significant direct impact for the UK, relative to other EU member-states included in the Schengen Area. Where no border checks for individuals are necessary, meaning that the refugees admitted by other EU countries could freely move within its members. Still, immigration from both EU and non-EU origin are viewed with skepticism by a large share of British nationals, who look upon immigrants as a cost for the government and competitors for the native workers, taking job opportunities and lowering wages. Ashcroft's (2016) work demonstrates this sentiment. He finds that one third of 'Leave' voters declared that the main reason for their vote was that Brexit "offered the best chance for the UK to regain control over immigration and its own borders", whereas only one in twenty 'Leave' voters said that "when it comes to trade and the economy, the UK would benefit more from being outside the EU than from being part of it".

The EU membership influenced UK's labour market directly via free movement of individuals, immigrant contribution to UK GDP, the fiscal budget and productivity [Petrolongo, B. (2016)]. Most academic studies have argued that the free movement of labour the EU provided has, in aggregate, positively impacted the UK. Wadsworth et al. (2016) specifically finds that there is little to no evidence that immigration has had an economically significant impact on British workers, either in terms of job opportunities or wages. The report compares professional areas in which immigrant share of labour have increased and areas that suffered from job loss opportunities and wage cuts for native workers. They find no correlation between both phenomena. Moreover, the impact on the fiscal budget is positive, rather than negative, meaning that immigrants contribute more with tax revenue than hinder with public spending. According to Dustmann, C. et al (2013), EU-immigrants are deemed to have made a net fiscal contribution of £28.7 billion (2011 prices), between 2001 and 2011. Aside from a lower tax

revenue, which helps reduce the public budget deficit, immigrant workers consume goods and services which increases aggregate demand, thus raising GDP and employment, lifting economic growth.

Bell B. et al (2016) sheds light on two different issues a tighter migration system towards the EU would produce. First, the UK would close itself and lose attractiveness with foreign students who are willing to acquire better education by studying abroad, which will impact future supply of graduates entering the labour market. This phenomenon is not exclusive for students, high-skilled EU-professionals are likely to prefer equal job opportunities in EU member states rather than in the UK, where no work visa and other bureaucracy is required. The second issue lies at the bottom end of the labour market, oftentimes minimum wage jobs are performed by immigrants, so if the supply of low-cost labour ceases, businesses reliant on immigrant workforce may struggle and there might be pressure to raise the national minimum wage. Both issues would negatively impact the output of the British economy.

The post-Brexit immigration system introduced concurrently with the TCA in January 2021 was simultaneously liberal and restrictive. Portes J. (2022) argues that there seems to be a slight shift in the government's policy toward immigrations. Although, there's still the commitment of ending free movement that 'Leave' voters pledged, the new system is softer towards non-EU immigrants than previous arrangements. It improves access to the UK for non-EU professionals, lowering salary thresholds and skill requirements for work visas, but significantly limits the previous conditions EU-professionals enjoyed in UK's labour market, with the free movement of people. Therefore, Portes states that the new policy intent seems less about completely reducing migration, and more about selectiveness and geographical diversity. It gives equal opportunity for EU and non-EU skilled professionals and students, whilst denying entry to lower-skilled migrants.

Yet although the new system is flexible to address labour and skill shortages, in industries such as farming, hospitality and logistics, by reducing the criteria and the costs for visa applications, there still was significant staff shortages in some sectors. For instance, throughout the year 2021, British newspapers informed the scarcity of heavy goods vehicle drivers and poultry workers, which the paper affirms led to a negative supply shock that contributed to the already discussed rise in consumer prices. Nonetheless, it would be irrational to declare Brexit as the main and only reason for this, instead the pandemic was arguably the

biggest malefactor. Sumption M. (2021) demonstrates, based on ONS data, that the pandemic resulted in substantial job losses for immigrants who were forced to go back to their original countries. When the economy and labour market started to recover in 2021, the new immigration system was already in place, altering immigration dynamics. The data provided by ONS and HMRC, show that by June 2021 the number of British jobs carried out by EU professionals was 6% lower than in 2019, while the UK native workforce was 1% lower and non-EU professionals had increased 9% compared to pre-pandemic levels. The simultaneous fall in EU professionals and higher non-EU professionals raises the possibility of whether a substitution of these workers occurred. However, the author states, supported by evidence from the ONS data, that industries that have driven the increase in non-EU labour are not the same ones that suffered falls in employment from EU professionals, except for the agricultural and health sectors. Therefore, the paper arrives to the conclusion that although, in some cases, there is evidence of employers being able to switch from EU to a non-EU workforce, in most reliant immigrant industries this hasn't materialized. This in turn makes these businesses grow at a reduced rate than they otherwise would have done, relative to if free movement had continued. Firms will lose productivity because of a shortage in staff, and prices will increase due to higher wages demanded by more competitive labour market.

So far, this section has covered the implications migration has on labour markets. The following study examines how trade and sterling depreciation combined impacted the British workforce. During Section V, collapse of the pound and its grim consequences were discussed, it was verified that the national currency suffered an unexpected negative shock caused by the Referendum. Costa R. et al. (2019) utilizes the unanticipated exchange rate depreciation as an exogenous variable to study the impact on UK workers through inflation and trade. The authors assert that the sharp decline of sterling's value is a unique opportunity to estimate its influence in labour since other economic shocks that cause currency variation are not as exogenous to the workforce. For instance, exchange rate movements provoked by oil price shocks, have a direct substitution effect between energy and labour, which would cause a biased estimate.

According to theory, higher exports caused by devaluation tend to be beneficial for workforce of exporting firms because of the increase in production, possibly leading to higher wages, although it was proven, when examining trade consequences, that British exporters did not seem to take the advantages their discounted goods and services were seen from overseas. In the other hand, higher imports used to be thought as detrimental to domestic labour because

foreign goods would compete with their production in the internal market, lowering firm's revenue, which would then impact the workforce. However, the paper argues that the significant rise of intermediate goods and services in world trade, mentioned in Section IV and V, have disputed the previous understanding of a negative relationship between imports and workers' well-fare. Besides higher competition a raise in imports can provide cheaper foreign inputs and drive the productivity and output within a domestic firm, having a positive effect on labour. Referring to Grossman et al. (2012) study, the authors imply that import's influence over the workforce has changed with the rise of global supply chains. The impact varies positively or negatively depending on factors such as the cost of offshoring production, the mix of trade partners and the extent of scale economies.

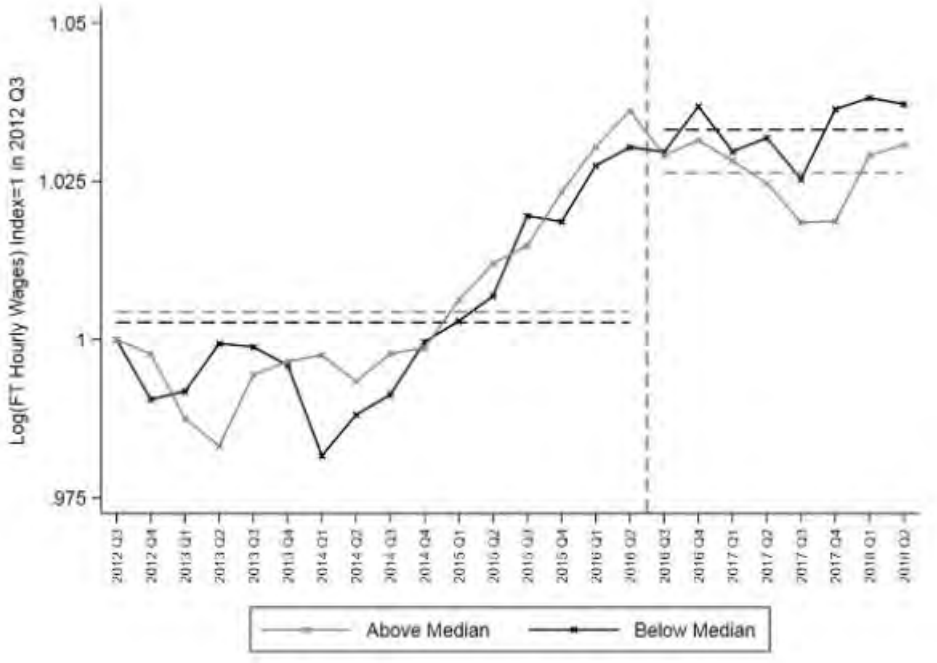
The value of imports and exports differ in their origin and destination because countries are subject to different exchange rates. The same is true for industries, British sectors trading in different world markets were faced with different sterling depreciation. For example, after the Referendum sterling dropped, overnight, by 8% and 6% relative to the dollar and euro, respectively. Thus, it would be expected that the increase/decrease in valued goods and services, immediately after the result, was larger for US-imports/US-exports rather than EU-imports/EU-exports. Costa R. et al. (2019) empirically puts this hypothesis to the test and confirms the foreseeable effect of the exchange rate variation for imports, yet export prices did not vary systematically with the scale of the pound's devaluation, as has been seen in Freeman's (2022) work. Moreover, similarly to Breinlich, H. et al (2019), the study also finds that the hardest-hit businesses are the ones with higher share of foreign inputs. Subsequently, the authors examine how the adjustment of firms towards more expensive intermediate imports impacted worker outcomes such as wages, overtime pay, hours worked, employment, and training.

According to the paper, because depreciation imposed extra cost on industries with no offset from higher exports, UK's labour is worse-off due to Brexit's effect in exchange rates. Although there were no statistically significant effects in total hours worked and employment, empirical estimates find that a 1% increase in the price of foreign inputs led to a reduction ranging from 0.35% and 0.55% in hourly wages and cutbacks ranging from 0.5% to 0.7% in the proportion of workers receiving job-related training. Noticeably, the lower estimates are relative to firms who either have lower shares of intermediates in their production or import from markets like the EU, where currency distortion wasn't as big as relative to the US and Japan. The authors state that these results are one of few in academic research that evidence a

degree of complementarity between workers and intermediate imports in production, which as mentioned before, refuted classical trade theory that higher imports are harmful for the native workforce.

The chart below shows the evolution of real wages. It splits UK labour into two groups, the ones belonging to industries that suffered above-median increased price in intermediate imports and workers belonging to industries that suffered below-median increased price, weighted by currency depreciation. Costa R. et al. (2019), estimates that up until the second quarter of 2018, the above-median workforce had their wages grow 2.7% less when compared to the below-median group. Yet, according to the paper, because consumer prices escalated following the Referendum real wages have not grown for either group. Two years after the vote meant real wage stagnation for the below-median group, whilst above-median workers suffered a significant fall in their earnings, thus resulting in an aggregate decline.

Chart 23. Trends in Real Wages



Notes: Log of average real wages calculated using Labour Force Survey industry weights. The price deflator used is the Consumer Prices Index including owner occupier's housing costs. The gap (and associated standard error) between the horizontal lines showing above/below median averages in the pre-referendum period is 0.001 (0.005) and -0.007 (0.003) in the post-referendum period.
Source: Costa R. et al. (2019)

Lower real wages suffocate aggregate demand which will decrease output and lead to a slower growth in British economy. Additionally, the pronounced estimated impact in work-

related training and education will not only cause a drop in future earnings potential, but perhaps more importantly compromise labour productivity levels which are further compounded by the effects of migration on skill-shortage. According to Rolfe, H. et al (2013) the rise in share of immigrants in UK workforce between 1997 and 2007 increased productivity by a range of 0.27 and 0.40 percentage points. Furthermore, Dhingra, S. et al (2022) expects labour productivity to fall 1.3% by 2030 only considering the TCA effects. The exclusion of productivity effects caused by changes in migration policy and investment levels, undoubtedly underestimate this number. Still, it would be equivalent of a loss of more than a quarter of the last decade's productivity growth.

VIII. Conclusion

The objective of this work was to analyse the most acknowledged academic economic literature on Brexit published before the Referendum comparing their results within, with ex-post findings and with the real data available six years later. Despite the pandemic, which obscured Brexit effects from the virus effects from 2020 onwards, we were able to elaborate important results from the Referendum until the outbreak of Covid-19 and also understand some of the challenges the UK will face in the future.

The first consideration is that the average short-term estimate from the ex-ante studies on Brexit was significantly overestimated regarding their schedule. Although currency depreciation predictions were accurate, the other implications regarding GDP did not materialize by the end of 2019, although some evidence of a slower economic growth was starting to become evident. The UK's economy showed a paradoxical resilience that was not expected immediately after the Referendum, which is thought to be caused by a combined effect of slow pass-through, consumer expenditure switching and decline in real wage growth causing a record low unemployment rate. Therefore, in the very short-term Brexit effect weren't visible or felt by the public, yet they were arguably just slowed down and already arising in the form of lower investment due to uncertainty and reduced purchasing power with a gradual advancing inflation.

The second consideration is that although the ex-ante assessments did not occur in the expected time-horizon, they might not have been askew after all. Unfortunately, the pandemic effects unable us to verify this precisely because it's contaminated data with its consequences. However, when we compare the UK with how other developed European economies recovered from the pandemic, there is a clear sign of economic slowdown. Moreover, when adding to the analyses the ex-post findings, the average long-term estimate of the ex-ante studies seem to be underestimated because dynamic impacts such as capital accumulation and technological change are difficult to be accounted for.

The third and final consideration is that with the introduction of the TCA the new trading conditions with the EU were finally settled. Only two years have passed since, but the negative effects are already visible, trade openness has fallen relative to other countries and whether in value or diversity imports and exports have declined with no apparent counter-benefit.

Additionally, the service industry has been the hardest hit sector facing an arguable “Hard Brexit”, since non-trade barriers such as the loss of ‘financial passporting rights’ have come into place. The service sector is essential to the UK’s economy, employing more than half of the domestic workforce, representing nearly half of trade, closely associated with investment and an important source of tax revenue. The deterioration of this sector will also mean the deterioration of the UK’s economy.

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