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ESRI SPECIAL ARTICLE

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G. Murphy

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IRELAND AND BREXIT: MODELLING THE IMPACT OF DEAL AND NO-DEAL SCENARIOS¹

*** Adele Bergin, Philip Economides, Abian Garcia-Rodriguez and Gavin Murphy**

ABSTRACT

This Article attempts to quantify the macroeconomic impact of Brexit on the Irish economy. Given both the political and economic uncertainty, we consider a range of alternative scenarios. We focus on the most well understood channels through which Brexit will affect Ireland, namely through lower trade, incorporating the impact of tariff and non-tariff measures, and the potentially positive impact of FDI diversion to Ireland. Our approach, and the main contribution of this paper, is to build up estimates of each of these channels from a range of recent micro-economic studies, so our estimates are anchored in the empirical literature. We then use these micro-estimates to calibrate macro scenarios; specifically we generate alternative paths for the UK and international economy using the NiGEM global model and assess the impact on Ireland using the COSMO model. Overall, in each scenario, the level of Irish output is permanently below where it otherwise would have been were the UK to decide to remain in the EU.

1. INTRODUCTION

Following the result of the UK referendum in June 2016 and the invocation of Article 50 of the Treaty on the European Union in March 2017, the UK is due to leave the EU at the end of March 2019. While a Withdrawal Agreement and Political Declaration were agreed between the UK and EU in November 2018, the UK House of Commons failed to approve it in January 2019. At the time of writing, the political impasse means that there is a wide range of possible outcomes. In addition to the heightened political uncertainty, there is also uncertainty as to the economic impact of Brexit in whatever form it eventually

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takes as there is no precedent of a country leaving a major trading block such as the EU.

While there is a strong consensus that leaving the EU will have a negative impact on the UK, there is no consensus on the duration, composition or scale of the impact on the UK economy. Empirical studies make different assumptions around each of these components so, even if they are considering broadly similar overall scenarios, there can be variation in estimates of the ultimate economic impact.

This Article attempts to quantify the macroeconomic impact of Brexit on the Irish economy under a range of scenarios. In terms of the impact, existing evidence indicates that Ireland will be hit relatively hard compared to other EU countries given its close economic relationship with the UK. Our previous analysis of Brexit (Bergin et al., 2017b) used scenarios from the National Institute of Economic and Social Research (NIESR) based on their NiGEM global econometric model to assess the impact of Brexit on Ireland's trading partners and the wider international economy, and then examined the effect of these changes in the international economy on Ireland using the COSMO model of the Irish economy. We use the same overall modelling framework in this Article but we follow a different approach. We focus on the most well understood channels through which Brexit will affect Ireland, namely through lower trade incorporating the impact of tariff and non-tariff measures, and the potentially positive impact of FDI diversion to Ireland. Our approach, and the main contribution of this Article, is to build up estimates of each of these channels from a range of recent micro-economic studies, so our estimates are anchored in the empirical literature. We then use these micro-estimates to calibrate macro scenarios; specifically we generate alternative paths for the UK and international economy using the NiGEM global model and assess the impact on Ireland using the COSMO model.

Given both the political and economic uncertainty, it is prudent to consider a range of scenarios. We consider three scenarios which we describe as *Deal*, *No-Deal* and *Disorderly No-Deal*. To estimate the economic impact of each scenario, we compare them to a counterfactual scenario where the UK remains in the EU. In the *Deal* scenario, the UK makes an orderly agreed exit from the EU. This involves a transition period covering the years 2019 and 2020, and a free trade agreement between the UK and the EU27 thereafter.² In the *No-Deal* scenario, the UK exits the EU without a deal but there is an orderly period of adjustment for trade. Ultimately, WTO tariff arrangements will apply to goods trade, there will be non-tariff measures, and services trade will also be negatively impacted. In

² The *Deal* scenario is based on the Withdrawal Agreement wherein the short-run impact of Brexit is more limited. This scenario is also broadly consistent with a short extension of Article 50.

the *Disorderly No-Deal* scenario, the UK exits the EU without a deal and there is an additional disruption to trade in the short-run, above that considered in the *No-Deal* scenario. In each scenario, some of the negative trade impact is partially offset by FDI being diverted to Ireland.

Overall, our scenario results suggest that in the long run (after ten years), the level of real output in the Irish economy would be 2.6 per cent, 4.8 per cent and 5.0 per cent lower in the *Deal*, *No-Deal* and *Disorderly No-Deal* scenarios, respectively, compared to a situation where the UK stays in the EU. The magnitude of each of these shocks is considerable and will have negative effects throughout the economy on the household sector, the labour market, firms and the public finances.

There is uncertainty around when the ultimate trade and FDI impacts of Brexit will impact the UK and Ireland. As such, there is arguably more uncertainty about the short-run impact of Brexit as it depends crucially on how smooth any transition to the new trading arrangements will be. Our scenario results indicate that by 2020, the level of real output in the Irish economy would be 0.6 per cent, 1.2 per cent and 2.4 per cent lower in the *Deal*, *No-Deal* and *Disorderly No-Deal* scenarios, respectively, compared to a situation where the UK remains in the EU.

The remainder of the Article is structured as follows: Section 2 reviews the existing literature on the impact of Brexit from both an international and Irish perspective, Section 3 describes our approach to estimating the impact of Brexit on Ireland, Section 4 discusses the macroeconomic impacts of each scenario and Section 5 provides concluding remarks.

2. EXISTING EVIDENCE

The size of the UK economy and its substantial interlinkages with the European and broader international economy suggest that the impact of Brexit could be considerable. Since before the 2016 referendum, most research on Brexit has focussed on the impact for the UK. Many studies have been macroeconomic in nature and, while they have employed different approaches and assumptions, there is almost a complete consensus that Brexit will reduce economic activity in the UK below where it otherwise would have been. More recently, there has also been a surge in the micro-economic literature examining how Brexit may impact the UK and other economies. These studies examine, for example, how tariff and non-tariff measures affect trade and can take account of differences in tariffs and non-tariff measures at a much more granular level, in terms of products and sectors, than macroeconomic models generally allow for. This expansion and deepening of the literature ultimately means that there is a better understanding

of how Brexit may impact the UK and other economies, and also that there are more reliable estimates available that can be used to calibrate scenarios in macroeconomic models. This section briefly discusses this literature and focusses on the latest studies that attempt to capture the channels through which Brexit will impact the UK and other economies.

2.1 UK macroeconomic findings

Following the UK's vote to leave the EU, a significant body of research has sought to estimate the potential consequences of Brexit for the UK economy. The NiGEM macro-econometric model of the NIESR has been used in many studies including by NIESR itself, HM Treasury, and the OECD. As a multi-country model it is suited to modelling the potential Brexit related changes in trade etc. Simulations using other modelling approaches have also been employed including Computable General Equilibrium models (LSE/CEP), DSGE models (European Commission), and Bayesian estimated models (IMF).

Given the ongoing uncertainty surrounding the future relationship between the UK and the EU, the standard approach in these studies is to present a range of scenarios. In earlier Brexit studies, these scenarios broadly reflected three potential outcomes. First, the UK would agree to join the European Economic Area (EEA) and maintain access to the EU Single Market. A second possibility explored was that the UK and EU would form a free trade agreement. Third, the UK and EU would impose a standard WTO arrangement whereby 'most favoured nation' (MFN) tariff terms are applied, in a situation where both parties fail to reach an agreement (see, for further discussion, Sampson, 2017; HM Treasury, 2016; Dhingra and Sampson, 2016). Since November 2018, the proposed Withdrawal Agreement and Political Declaration on plans for the future UK-EU relationship has enabled more recent studies to distinguish between a deal outcome, as set out under the terms of the Withdrawal Agreement, and differing forms of a 'no-deal' outcome, where WTO tariff rates are applied to UK trade. Given the proximity to the exit date, recent no-deal analyses have focused on the potential impact of a disorderly Brexit and the additional trade frictions that could be introduced (e.g. Bank of England, 2018).

In modelling these scenarios, studies vary in terms of the range of economic channels that are analysed. While the trade and FDI impacts are the most important, consideration has also been given to the potential impacts of uncertainty in the short-run, to productivity impacts associated with lower trade and FDI, to migration and to EU budget contributions. Notwithstanding differences in modelling techniques, variation in scenario estimates of the overall economic impact generally reflect different assumptions around the timing and

magnitude of changes in each of the modelled components (Tetlow and Stojanovic, 2018).

With respect to time horizons, the majority of studies on the impact of Brexit on the UK have tended to focus on the long-run impact on the UK economy (Tetlow and Stojanovic, 2018). From a modelling perspective, this is understandable as the evidence points towards changes in trade and FDI patterns in the longer term, although there is no consensus on the timing of these changes or whether the scale of these changes will be gradual or more sudden in nature. Many of the short-term impacts of Brexit are primarily driven by uncertainty including exchange rate fluctuations which are difficult to accurately quantify.

The short-term estimates of the impact of Brexit on the UK economy suggest significant deviations from the baseline of 'remain'. By 2020, deviations in the level of real UK GDP range from -1.7 per cent under a Norway-like (EEA) deal (Ebell and Warren, 2016) to -5.6 per cent in the case of no deal (IMF, 2016). A more recent NIESR study, accounting for the proposed terms of the Withdrawal Agreement, sits within this range at -2.2 per cent by 2020, following a two-year transition period (Hantzsche et al., 2018).

A strong consensus has also emerged regarding the negative effect the UK's withdrawal from the EU will have on its economy in the longer term (generally considered to be after ten to 15 years) (HM Treasury, 2016; HM Government, 2018; IMF, 2018b; Kierzenkowski et al., 2016; Hantzsche et al., 2018; Vandenbussche et al., 2019). Table 1 shows the estimated long-run impacts range from -0.1 per cent under a 'liberal Customs Union' (Oxford Economics, 2016) to -10.5 per cent under a 'disorderly' no-deal scenario (Bank of England, 2018). Among free trade agreement (FTA) scenarios, the average long-term loss to UK GDP relative to a remain baseline is 3.7 per cent. Various WTO (no-deal) scenarios indicate an average relative loss of 6.0 per cent.

TABLE 1 COMPARISON OF RECENT STUDIES ON THE LONG-TERM IMPACT OF BREXIT ON THE UNITED KINGDOM

Study	Scenario	GDP % Change Relative to Base
Bank of England (2018)	Deal + FTA	-1.5
	Deal + Backstop	-3.8
	No Deal	-7.8
	Disorderly No Deal	-10.5
HM Treasury (2016)	EEA	-3.8
	FTA	-6.2
	WTO	-7.5
HM Government (2018)	EEA	-1.4
	FTA	-4.9
	No Deal	-7.6
IMF (2018)	FTA	-3.1
	WTO	-6.2
Kierzenkowski et al. (2016)	WTO/FTA (Optimistic)	-2.7
	WTO/FTA (Central)	-5.1
	WTO/FTA (Pessimistic)	-7.7
NIESR (Hantzsche et al., 2018)	Deal + FTA	-3.9
	Deal + Backstop	-2.8
	No Deal	-5.5
Oxford Economics (2016)	Liberal Customs Union	-0.1
	FTA	-2.8
	WTO	-3.9
Vandenbussche et al. (2019)	Norway Deal	-1.2
	No Deal	-4.5

2.2 Irish macroeconomic findings

Much like the research on the impact of Brexit for the UK, an increasing number of studies have examined its potential implications for the Irish economy. Similarly, a consistent finding is that Ireland will be negatively affected relative to a situation where the UK remained in the EU. Moreover, international comparative studies indicate that the impact for Ireland could be more pronounced relative to other EU countries (Vandenbussche et al., 2019; Kierzenkowski et al., 2016; IMF, 2016; Dhingra et al., 2016a). This particularly high degree of exposure is not surprising given how deeply integrated the Irish and UK economies are. In 2015, Irish exports to the UK accounted for 14 per cent of total cross-border goods exports and 20 per cent of total service exports. Imports from the UK are also significant, representing 26 per cent of total cross-border goods imports and 10 per cent of service imports. The Irish economy has also benefitted from a long established common labour market with the UK, predating EU membership.

More recently, Chen et al. (2018) examine relative differences in the potential regional impacts of Brexit and they find that among the EU28 Member States, only regions in Ireland face local GDP exposure levels similar to UK regions.³ The study suggests that primary activities such as agriculture, forestry and fishing are more at risk in the Border, Midland and Western region of Ireland whereas the construction and services sectors are more exposed in the Southern and Eastern region of Ireland.

Focusing on the potential macroeconomic impact, Table 2 summarises the existing findings on the long-term (generally considered to be after ten to 15 years) impact of Brexit on Ireland.⁴ Bergin et al. (2017b) using the Irish macroeconomic model (COSMO) while drawing on results from Ebell and Warren (2016), find that under an EEA scenario Ireland's output is reduced by 2.3 per cent relative to a no-Brexit scenario; whereas a WTO scenario would result in a relative reduction of output by 3.8 per cent. This compares to an estimated 3.2 per cent decline in GDP under a no-deal scenario published by the Central Bank of Ireland (2016) using a Bayesian Vector Autoregression model. Copenhagen Economics (2016) using a CGE model produce estimates at the upper end of the spectrum, with the loss in GDP ranging from 2.8 per cent under an EEA agreement to 7 per cent under a 'No-Deal' simulation.

In the context of heightened concerns of a potential UK exit without any deal or transition arrangement, the Central Bank of Ireland (2019) simulated the implications of a disorderly Brexit on Irish GDP, relative to a baseline scenario of continued EU membership. In the first year alone, a 4 percentage point reduction in GDP growth occurs. In the long run, GDP is estimated to fall by 6 per cent as a result of a disorderly Brexit relative to a remain scenario. Arriola et al. (2018), in a two-stage process, use their general equilibrium trade model (METRO) to quantify the impacts of tariffs and non-tariff measures under a WTO scenario on trade before incorporating these effects into NiGEM to establish the macroeconomic impact on Ireland. They estimate a 2 to 2.5 per cent relative decline in Irish GDP over the long run.

³ Members are disaggregated regionally at the NUTS 2 level, resulting in 28 members being split into 252 regions. National levels of GDP exposure to Brexit find that trade-related exposure of the UK economy is 4.6 times greater than the rest of the EU whereas in Ireland's case it is only 1.2 times greater.

⁴ These studies differ with respect to both baseline scenarios and the assumptions underpinning alternative Brexit outcomes. As a result, the impacts are not directly comparable and only enable establishing a range of potential impacts.

TABLE 2 COMPARISON OF RECENT STUDIES ON THE LONG-TERM IMPACT OF BREXIT ON THE IRELAND

Study	Scenario	GDP % Change Relative to Base
Arriola et al. (2018)	No Deal	-2.3
	EEA	-2.3
Bergin et al. (2017b)	FTA	-2.7
	WTO (No Deal)	-3.8
Copenhagen Economics (2016)	EEA	-2.8
	FTA	-4.3
	No Deal	-7.0
Conefrey et al. (2018)	No Deal	-3.2
Central Bank of Ireland (2019)	Disorderly No Deal	-6.0
	FTA	-2.5
IMF (2018a)	No Deal	-4.0
Vandenbussche et al. (2019)	Norway Deal	-1.3
	No Deal	-5.7

2.3 Recent literature: trade impacts

The recent focus on estimating micro-founded impacts of tariff and non-tariff measures on trade patterns is an important development in the Brexit literature (Lawless and Morgenroth, 2019; Cappariello, 2017; Arriola et al., 2018). These approaches generally seek to identify the economic costs of Brexit through directly applying trade frictions (such as tariffs and non-tariff measures) to micro-level data. Such estimates are likely to be more appropriate than the use of gravity model estimates to gauge the size of trade impacts which have been regularly used in macro-modelling exercises.

Gravity models estimate how much additional trade in goods and services happens between EU members (compared with countries that are not members) while accounting for differences in the size of economies, distance and other relevant factors. These studies generally find a positive effect on trade associated with EEA and EU membership. To calibrate a trade shock in macro-models, studies often simply reverse the value of these estimates. As summarised in Hantzsche et al. (2018), gravity model estimates suggest a reduction in bilateral UK-EU goods trade of between 25 and 65 per cent, and a reduction in UK-EU services trade of 19 to 65 per cent. This is a very wide range of estimates. Although the range largely reflects the particular trade agreement that is assumed and difference in samples, there is often wide variation in estimates of specific types of trade agreements (and the range of estimates associated with different types of trade agreements sometimes overlap). It can be argued that this approach lacks the precision needed to make a convincing estimate of the impact of EU membership on trade. Furthermore, assuming that the impact of leaving the EU is symmetric (i.e. reversing the value of estimates from gravity

models implying that all of the estimated trade gain associated with EU membership is lost) may excessively simplify the impact of increased trade frictions.

In this context, Lawless and Morgenroth (2019) provide an important alternative approach to quantifying the potential product, sectoral and aggregate impacts of applying WTO tariffs on UK-EU Member States' bilateral trade flows. Under the assumption that the full tariff amount would be incorporated into the price, they show that the impacts of tariffs significantly differ across countries due to variation in sectoral trade exposures.⁵ In their analysis, they show that WTO tariffs vary significantly by product, ranging from zero up to 75 per cent in the case of water pipe tobacco. At a sectoral level the average tariff rate ranges between zero and 50 per cent, with the Food, Clothes, and Tobacco sectoral aggregates in particular being highly exposed.

In terms of aggregate impacts, Lawless and Morgenroth (2019) find that EU to UK goods exports would be reduced by 30 per cent while UK to EU goods exports decline by 22 per cent. Interestingly, while Ireland makes up 5 per cent of UK imports, it would represent close to 20 per cent of the total EU tariff impacts under a WTO MFN tariff scenario. The projected fall in Irish goods exports to the UK is 31 per cent (4 per cent fall in total Irish exports) and UK goods exports to Ireland decline by 28 per cent (1.5 per cent fall in total Irish imports). In terms of trade losses, they find that agricultural and food products, textiles and traditional manufacturing sectors would be most affected.

Notwithstanding the importance of assessing the impact of tariffs, the ending of the UK's EU membership will have significant implications for the non-tariff measures (NTMs) including legal, regulatory and administrative terms under which goods and services can be traded. Integration of the EU Single Market has seen significant agreement by Member States over the years on standards and regulations in regards to, for example, product technical and safety specifications, and health compliance reviews. This has been coupled with agreement on administrative processes including customs declarations and documentary compliance, and border inspections. Membership of the Single Market supports greater trade integration, by reducing trade costs through for instance, the

⁵ It should be noted that quotas on particular imports determine the effective tariff rate. Any within-quota imports face lower tariffs, meaning that the overall effective tariff would likely be lower than the WTO MFN rate. In the absence of the UK's WTO tariff schedule and given that the UK is unlikely to impose EU quotas (due to its smaller size than the EU and its trade deficit in products such as food and pharmaceuticals), this particular analysis has taken the conservative option of applying full tariffs to all trade. As such, the tariff rates imposed should be considered an upper bound to the median tariff rate applied in that analysis.

streamlining of customs processes, and by better regulatory alignment which can facilitate the elimination of market failures arising from information asymmetries.

Studies seeking to quantify NTM effects, including Lawless (2010) and Byrne and Rice (2018), use variations of a gravity model approach to estimate the impact of non-tariff measures on sectoral trade flows. Byrne and Rice (2018) show that the average border time increase associated with leaving the Customs Union is 4.5 hours. This would equate to a 90 per cent increase on current UK waiting times for imports. This is estimated to lead to a 9.6 per cent decline in goods trade between the Ireland and the UK. From an Irish perspective, these transport waiting times are a particularly relevant concern as a considerable proportion of Irish goods (measured in terms of volume) are shipped to (53 per cent) and from (11 per cent) the continent via the UK landbridge (Lawless and Morgenroth, 2017).

2.4 Recent literature: FDI impacts

While the UK's exit from the EU will adversely affect Irish trading activity with significant negative implications for the wider economy, a strong argument can be made that the impact will be offset in part as a result of FDI being diverted into Ireland. As discussed in Barrett et al. (2015), Ireland continues to be one of the most important destinations for FDI in the world. This is attributed to factors such as the presence of a highly educated English speaking labour force, limited barriers to trade and investment due to EU membership and trade agreements with other non-EU countries, a business friendly regulatory environment and a simple corporate tax system with relatively low tax rates. To the extent that these attributes are closely shared with the UK, it opens up the potential opportunity for firms to relocate investment here in order to remain within the EU or undertake new investment that might otherwise have located in the UK (Lawless and Morgenroth, 2016).

Compared to the trade literature, there is limited research to draw on in terms of quantifying the potential impact of the UK's decision to exit the EU on the inflow of FDI into the UK. Ebell and Warren (2016) identify three main approaches that provide useful estimates which can be used to quantify potential FDI inflow effects under alternative EU UK trading arrangements. These include gravity models, synthetic cohorts analyses and regression based analyses assessing the relationship between FDI and openness. Most studies appear to indicate that UK inward FDI will reduce by in the region of 20 to 30 per cent, (e.g. Ramasamy and Yeung (2010), 20-27 per cent; Bruno et al. (2016), 12-28 per cent; HM Treasury (2016), 26 per cent; Campos and Coricelli (2015), 25-30 per cent; Straathof et al. (2008) estimates a 22 per cent intra-EU FDI loss and an 11 per cent non-EU loss).

However, findings in Fournier (2015) would suggest a greater band of uncertainty around the potential impact of Brexit on UK FDI (i.e. 10 to 45 per cent).

In terms of gauging the impact for Ireland, Lawless and Morgenroth (2016) suggest that the stock of Irish FDI would increase by 7.3 per cent assuming a reduction in the UK FDI stock of 27 per cent which is allocated in line with Ireland's current non-UK EU FDI share of 6.9 per cent.

3. SCENARIOS

Our analysis is focused on the most well understood potential impacts of Brexit, namely on trade and FDI. The scenarios are built up from estimates in the empirical literature of the magnitude of the effects on trade, incorporating the imposition of tariffs and non-tariff measures, and on FDI. In contrast, our previous analysis of the potential impact of Brexit (Bergin et al., 2017b) drew on macro scenarios from NIESR (Ebell and Warren, 2016) and did not include the effects of potential FDI diversion to Ireland, whereas in this Article we use recent micro-evidence to calibrate macro scenarios in NiGEM and assess the impact on Ireland using the COSMO model. While these effects may not be exhaustive, there is a consensus that these are the most important impacts. In this section, we describe the particular assumptions that we use to model the main impacts of Brexit on the Irish economy.

3.1 Approach

A key question concerns the range of possible outcomes for the future relationship between the UK and the EU. At the time of writing, there is still considerable uncertainty as to this future relationship. This study focuses on three main scenarios, which we describe as *Deal*, *No-Deal* and *Disorderly No-Deal*, while acknowledging that other outcomes are possible. In order to determine the total potential impact of Brexit on Ireland, we compare these scenarios to a counterfactual or hypothetical base case where the UK stays in the EU.⁶

In the *Deal* scenario, a deal between the UK and EU is agreed which includes a transition period until the end of 2020 during which time the UK continues to abide by all existing EU rules and regulations. In the longer term a free trade agreement is agreed between the UK and the EU27. This scenario is based on the Withdrawal Agreement. While the Withdrawal Agreement does not fully specify

⁶ To the extent that existing forecasts, such as those regularly undertaken by the ESRI, Department of Finance Central Bank, etc., have already incorporated some Brexit scenarios, directly adjusting these forecasts for the impacts described in this paper would constitute an over-adjustment as the base case here is the UK remaining in the EU.

the future relationship between the UK and EU, it is consistent with a high degree of alignment between the UK and EU. Hantzsche et al. (2018) interpret the Withdrawal Agreement as including no tariffs, fees or quantitative restrictions on goods trade, and deep but not full regulatory alignment thereby leading to more trade frictions than EU membership. While there are no specific provisions for services in the Withdrawal Agreement, the Political Declaration looks for the EU and UK to conclude ‘ambitious, comprehensive and balanced arrangements on trade in services...’. Hantzsche et al. (2018), interpret this as implying more frictions than EU membership. It is also possible that Article 50 will be extended by some time to ensure that a deal can be agreed between the UK and EU that can be ratified in the UK parliament. While an extension of Article 50 may lead to some additional uncertainty in the short-run, the ultimate economic impact will be close to the *Deal* scenario considered in this paper.^{7, 8} The short-run effects of this scenario are more limited. In the *No-Deal* scenario, the UK exits the EU without a deal but the adjustment to the changed relationship between the UK and EU occurs in an orderly fashion. However, WTO tariff arrangements will apply to goods trade, there will be non-tariff measures, and services trade will also be negatively impacted. In the *Disorderly No-Deal* scenario, the UK exits the EU without a deal and there is an additional disruption to trade in the short-run. In each scenario, some of the negative trade impact is partially offset by FDI being diverted to Ireland.

We adopt a two-step modelling approach to estimate the potential impact of Brexit on the Irish economy. In the first step, we apply shocks to the UK economy using the NiGEM global model of the National Institute of Economic and Social Research to generate estimates of the impact of Brexit on the UK and the wider international economy. Several studies have used the NiGEM model in their analyses of the economic impact of Brexit (e.g. Ebell and Warren, 2016; Ebell et al., 2016; Hantzsche et al., 2018; HM Treasury, 2016; Kierzenkowski et al., 2016), as it is a multi-country model with explicit trade linkages that makes it very suitable for modelling the impacts of changes in trade policy. Then, in the second step, we incorporate these international impacts into COSMO, the ESRI’s model of the Irish economy,⁹ to gauge the impact on Ireland.¹⁰ We also incorporate the

⁷ This scenario assumes a relatively close ongoing relationship between the EU and UK. We have also considered a scenario whereby a deal is agreed but the eventual relationship between the UK and EU is less close.

⁸ This, of course, assumes that following an extension of Article 50 a deal is agreed between the UK and EU that is ratified by the UK parliament. If, after an extension of Article 50, this does not happen it would imply reverting to a no-deal scenario.

⁹ See Bergin et al. (2017a) for a full description of the mechanisms and behaviour of the model. In COSMO, sectors are defined based on the Supply and Use Input-Output Tables from the Central Statistics Office. A sector is defined as traded if at least 50 per cent of total final uses (excluding change in stocks) are exported. The aggregate government sector comprises those sectors in which at least 50 per cent of total final uses (excluding changes in stocks) are used by the government as consumption. The non-traded sector comprises the remaining sectors.

¹⁰ Specifically, in COSMO the international economy is largely exogenous, reflecting the small open economy nature of Ireland, so we incorporate key international variables from NiGEM. These variables include interest rates, effective

likely impact of Brexit on FDI to Ireland using the same approach as Lawless and Morgenroth (2016). While the FDI effect is expected to have a positive effect on Ireland, the positive impact is outweighed by the negative trade effect.

There is one main difference to the modelling approach adopted compared to our previous assessment of the impact of Brexit on Ireland (see Bergin et al., 2017b) and to the Central Bank of Ireland (2019), and that is we calibrate our own estimate of the trade shock associated with Brexit. There is a consensus in the literature that the largest impacts of Brexit (on the UK, EU and Ireland) will be through the trade channel. The most common approach in macro-modelling exercises, to gauge the size of trade impacts, is to draw on estimates from gravity models. Here, we move away from gravity model based estimates where possible and draw on the recent micro-economic literature to calibrate potential trade shocks (described in detail in Section 3.3) which then incorporate into the NiGEM and COSMO models using the approach described above.

3.2 The counterfactual scenario

To capture the potential impact of Brexit, we compare the various Brexit scenarios to a counterfactual baseline where the UK remains a member of the EU. There is some evidence to suggest that the performance of the UK economy has already been affected by the decision to leave the EU, implying that overall UK growth has already fallen below where it otherwise would have been since the referendum. This is largely attributed to the impact of uncertainty on business investment decisions, the depreciation of Sterling and the downgrading of future growth prospects (see, for example, Born et al., 2018; Bloom et al., 2018). NIESR construct a counterfactual scenario whereby, should the UK decide not to leave the EU, there would be some unwinding of these negative effects (Hantzsche et al., 2018). We import this international baseline into COSMO to generate a counterfactual baseline.

3.3 Assumptions

Trade

NIESR (Hantzsche et al., 2018) construct various Brexit scenarios with detailed assumptions for the UK concerning reductions in trade, FDI, EU budget contributions, migration and productivity.¹¹ Previous research suggests that the main economic impact of Brexit on most countries, and especially for extremely open economies such as Ireland, is likely to transmit through the trade channel.

exchange rates, oil prices, competitor prices, trade-weighted world demand (for Irish exports) and conditions in alternative labour markets.

¹¹ In the scenarios that follow, we implement alternative trade shocks in NiGEM, while keeping other UK assumptions the same as in Hantzsche et al. (2018).

Therefore, the assumptions made about the long-run change in UK-EU trade as a consequence of Brexit are crucial to assessing the impact of Brexit. NIESR (Hantzsche et al., 2018) draw on various estimates from the empirical literature based on gravity models (including Baier et al., 2008; Ebell, 2016; van der Marel and Sheperd, 2013; and Ceglowski, 2006) and assume in a no-deal scenario that the long-run reduction in UK-EU bilateral trade as a result of Brexit will be 56 per cent. They consider separate estimates for goods and services and take account of the share of goods and services in total UK-EU trade, which is 68.3 per cent and 31.7 per cent, respectively (Hantzsche et al., 2018). This study employs a more direct approach to examining potential trade impacts of various Brexit scenarios by focussing on the imposition of tariffs and non-tariff measures.

In a no-deal scenario, the UK is assumed to revert to trade under WTO most-favoured-nation status after the UK leaves the EU at the end of March and so goods trade will be subject to tariff and non-tariff measures and services trade will be impacted by regulatory measures. We draw on several studies to calibrate each component of the shock and use these micro-founded estimates to generate an alternative trade shock.

Lawless and Morgenroth (2019) examine detailed trade flows between the UK and all other EU members and match over 5,200 products to WTO tariff rates applicable to external EU trade. Their analysis accounts for differences in trade patterns across countries as well as differences in tariffs and in the responsiveness of demand for different products to price changes. They find a total reduction in UK-EU goods trade of 22 per cent with different impacts across countries. We use these estimates to calibrate a shock to goods trade.

While Lawless (2018a) shows that there is a strong correlation between tariff and non-tariff measures, for our purposes we draw on the empirical literature to develop a micro-founded estimate of the potential impact of non-tariff measures on goods trade. We use Smith et al. (2018) estimates of non-tariff costs associated with the UK's exit from the EU and combine them with the sectoral median trade elasticities obtained from Imbs and Mejean (2017)¹² to derive Brexit related NTM impacts on goods trade.^{13,14} This is similar to the approach

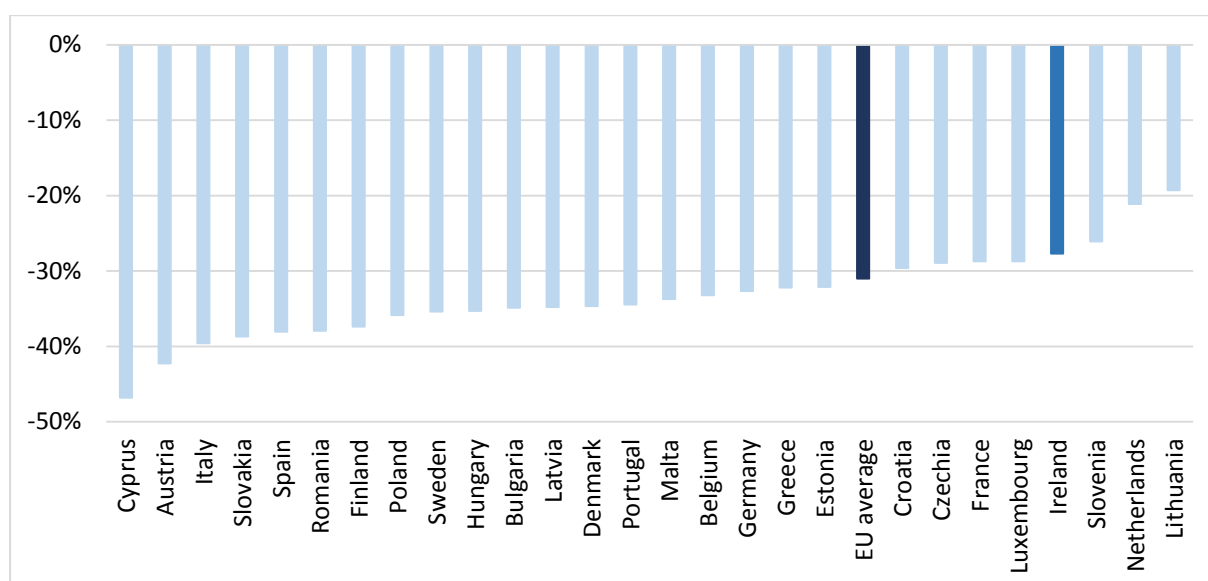
¹² Smith et al. (2018) define their sectors using classification GTAP (Global Trade Analysis Project – product classification) while Imbs and Mejean (2017) define their sectors at the ISIC (International Standard Industrial Classification) two-digit level. In our analysis, both classifications are matched to six-digit HS (Harmonized Commodity Description and Coding System) product export data taken from Comtrade using concordance tables from World Integrated Trade Solution (WITS) database of nomenclatures: wits.worldbank.org/product_concordance.html.

¹³ The Smith et al. (2018) estimates of non-tariff costs associated with the UK's exit from the EU are based on newly estimated product level ad valorem equivalent rates of a number of NTMs (Cadot et al., 2018). Smith et al. (2018) construct trade weighted costs of two types of NTM (i.e. sanitary and phytosanitary measures, and technical barriers) faced by non-EU countries exporting into the EU which are then summed together to give a total NTMs cost. The increase in the non-tariff related costs associated with the UK's exit from the EU to a WTO MFN arrangement is assumed to be half of the total NTM cost. This assumption is influenced by earlier research by Berden et al. (2013).

used by Lawless and Morgenroth (2019) to quantify tariff increases on goods trade.

These estimates imply that UK-EU goods trade could be reduced by a further 31 per cent (average impact across countries), around 1.4 times the effect associated with tariffs alone, bringing the total impact on UK-EU goods trade to around 53 per cent. In terms of the aggregate effect, this impact is substantial. It is also worth noting the variation in the impact on a country-by-country basis. This variation reflects in part differences in sectoral trade patterns (i.e. trade structure) between the UK and EU Member States which results in some countries being more exposed to larger NTM increases. As shown in Figure 1, UK exports to Cyprus, Austria and Italy would be relatively adversely affected by the implementation of the NTMs, with potential falls of 47, 42, and 40 per cent respectively. UK exports to Slovenia, Netherlands and Lithuania would be the least negatively affected. Interestingly, the NTM impact on UK exports to Ireland would be just below the EU average of 31 per cent.¹⁵

FIGURE 1 IMPLIED UK-EU TRADE REDUCTIONS ASSOCIATED WITH NON-TARIFF MEASURES



Source: Authors' Estimates.

which estimated that the potential reductions to NTMs from a transatlantic trade deal could be in the region of 50 per cent.

¹⁴ To undertake our assessment of the non-tariff measures implications for trade we assume that Brexit related NTM costs fully feed in to prices.

¹⁵ We applied the same approach to assess the impacts of NTMs on Ireland's trading activity with the UK. We find that applying the OECD's assumed post-Brexit NTMs increases under a WTO type scenario (Smith et al., 2018) would reduce Irish exports to the UK by 28 per cent. In terms of the sectoral contributions, the Chemical, rubber, plastic products; Meats products; and Other processed foods sectors would experience the largest decreases, making up 60 per cent of the overall decline. Irish imports from the UK would reduce by 24 per cent. The Chemical, rubber, plastic products; Motor vehicles and parts; Machinery and equipment n.e.c.; and Other foods sectors would see the largest reductions contributing approximately 60 per cent to the overall decline in Irish imports from the UK.

At a sectoral level, the size of the reduction in the share of UK exports would vary significantly. The sectors which would experience the largest falls in exports are Motor vehicles and parts; Chemical, rubber, plastic products; Machinery and equipment n.e.c.; Wearing apparel; and Transport equipment n.e.c., contributing close to 80 per cent of the total decline in UK-EU exports. In general, the larger effect on these sectors can be explained as a combination of the level of their exports, with higher non-tariff measures and a relatively elastic sectoral price response.

Turning to the potential Brexit impact on services trade, in terms of a no-deal scenario, reverting to WTO tariffs provides a reference point to base scenarios for goods, yet there is no comparable benchmark for the magnitude of trade impacts for services. Service trade restrictions are determined by non-tariff measures such as recognition of standards, permissions etc. which are harder to measure. Lawless (2018b) using a gravity model approach finds that EU membership has increased services trade by around 26 per cent.¹⁶ We use this estimate to calibrate a shock to services trade.

Overall, the micro-based estimates for the reduction in goods trade including tariff and non-tariff measures and the estimate of the reduction in services trade imply a reduction of around 44 per cent in UK-EU trade in the long run, accounting for the share of goods and services in UK-EU trade. While this estimate is broadly consistent with NIESR's (Hantzsche et al., 2018) assumption of a reduction in UK-EU trade of 56 per cent, it is roughly a quarter below the trade impact that they assume. We prefer this approach as it provides a more direct estimate of the potential impact on trade as a result of Brexit. We adopt this long-run trade assumption in our *No-Deal* and *Disorderly No-Deal* scenarios.

NIESR consider two scenarios associated with a deal. In one scenario, which they describe as 'Deal + Backstop', they assume that total UK-EU trade will fall by around 30 per cent in the long run. They reduce, in particular, their estimate for the fall in goods trade, which they assume to be 25 per cent, as the backstop in the Withdrawal Agreement would keep the whole of the UK in a single customs territory with the EU and this will, on balance, have a much larger impact on goods trade. In the second scenario, which they describe as 'Deal + FTA' the long-run impact on overall trade is assumed to be 46 per cent and, again, most of the

¹⁶ This estimate is considerably below that of Hantzsche et al. (2018). Given the questionable assumption that is often incorporated in macro-models that the extra trade associated with EU membership (based on estimates from gravity models) would completely unwind as a result of Brexit, we prefer this lower estimate to calibrate a shock to services trade.

adjustment is for goods trade, which they assume to fall by 40 per cent. As both of these assumptions are based on estimates from gravity models, we use the lower bound estimate of 25 per cent for goods trade from the studies NIESR use to calibrate their goods trade shock. We leave our estimate for services trade unchanged from the *No-Deal* scenario so overall this implies a long-run average reduction in UK-EU trade of 24 per cent. As a sensitivity check, we also consider a scenario whereby the average long-run reduction in UK-EU trade is 30 per cent, around one-quarter higher than what we consider in our main *Deal* scenario.

Foreign Direct Investment

Our analysis of the macroeconomic impact of Brexit on the Irish economy includes the potential diversion of some FDI from the UK to Ireland. In aggregate terms, the UK is expected to lose around a quarter of its FDI inflows in the event of a No-Deal Brexit and 21 per cent in the case of a deal (see Ebell and Warren, 2016, for a summary of the relevant literature). Ireland is already an attractive destination for FDI. In 2016, according to Eurostat, Ireland's stock of FDI represented 5.6 per cent of the total stock of FDI of the EU, whereas the equivalent figures for GDP and population were 1.8 per cent and 0.9 per cent, respectively. Furthermore, Ireland and the UK share a number of similarities, in terms of economic structure, language and legal system etc. that make it reasonable to assume that Ireland could act as a competitive alternative destination for FDI. For example, Davies et al. (2016) find perceptions of Ireland and the UK as being similar in terms of alternative locations for FDI, in particular among non-EU investors and in the services sector. In this case, Ireland would be able to capture a significant portion of FDI spillovers from the UK relative to the size of the country.

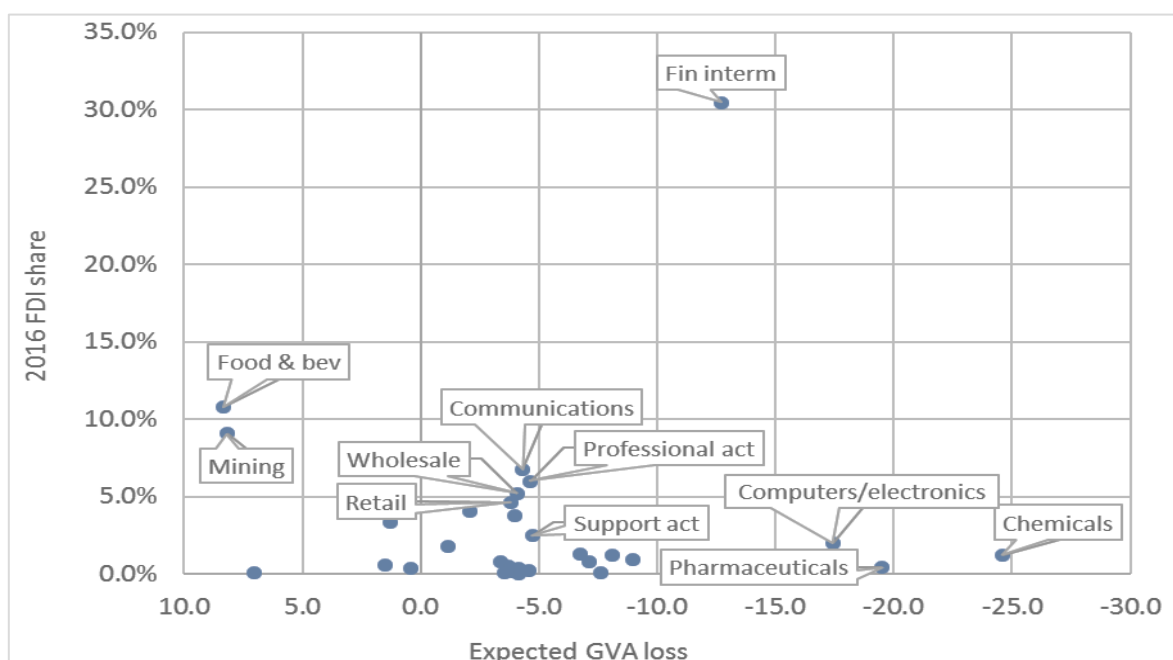
Our approach of estimating the FDI effect for Ireland follows closely with that of Lawless and Morgenroth (2016). The methodology is refined somewhat by estimating the potential losses for the UK and gains for Ireland at a sectoral level (NACE Rev. 2). We calculate sectoral FDI losses for the UK by combining sectoral data on UK FDI stocks and expected sectoral losses. We use the sectoral distribution of Ireland's non-UK EU FDI stocks to determine the share of FDI inflows (from the UK or diverted from the UK) by sector. These sectoral gains are aggregated and converted to inflows of additional FDI in COSMO.

The first step of this approach is to profile the current stock of FDI in the UK at the sectoral level and to evaluate which of these sectors would be more affected by Brexit. Figure 2 shows the sectoral shares of UK FDI and the expected losses in GVA by sector. The figure shows that FDI in the UK is heavily concentrated in Services, in particular Financial Intermediation, which represents approximately 30 per cent of total FDI. Other services, which includes categories such as

Communications, Professional Activities and Support Services, account for 16.7 per cent of the total. Other notable sectors include Food and beverages (10.7 per cent), Mining and quarrying (9.0 per cent), and Other manufacturing (6.5 per cent), which includes the manufacture of computers and other machinery.

The impact of Brexit in the case of no deal is expected to vary by sector. We use the distribution of expected sectoral losses of gross value added (GVA) as weights to calculate the expected loss of sectoral FDI. Sectoral losses of GVA can be calculated based on the different price elasticities of the different sectors and the projected barriers to trade in a Brexit scenario, which in turn are used as an approximation for sectoral losses of FDI. Sectoral losses are calculated by aggregating the results of studies that have estimated sectoral impacts of a no-deal Brexit, including HM Government (2018), Felbermayr et al. (2018) and IMF (2018b). The results are shown in Figure 2. In percentage terms, the sectors with largest expected losses are Chemicals and Pharmaceuticals, although both represent a small share of the UK's FDI stock, followed by Financial Intermediation and the manufacture of Computers, electronic and optical products. We apply these implied sectoral losses to the total inward FDI reduction. In absolute terms, i.e. by multiplying the size of the stock of each sector's FDI by its expected loss, the loss of FDI in the Financial Intermediation sector represents almost two-thirds of the total expected loss, due to its importance in terms of FDI and its large expected loss of GVA. Other sectors with large absolute losses are Computer and electronics, Chemicals, Information and communication, and Professional activities.

FIGURE 2 UK FDI SECTOR SHARE AND EXPECTED SECTOR LOSS OF GVA



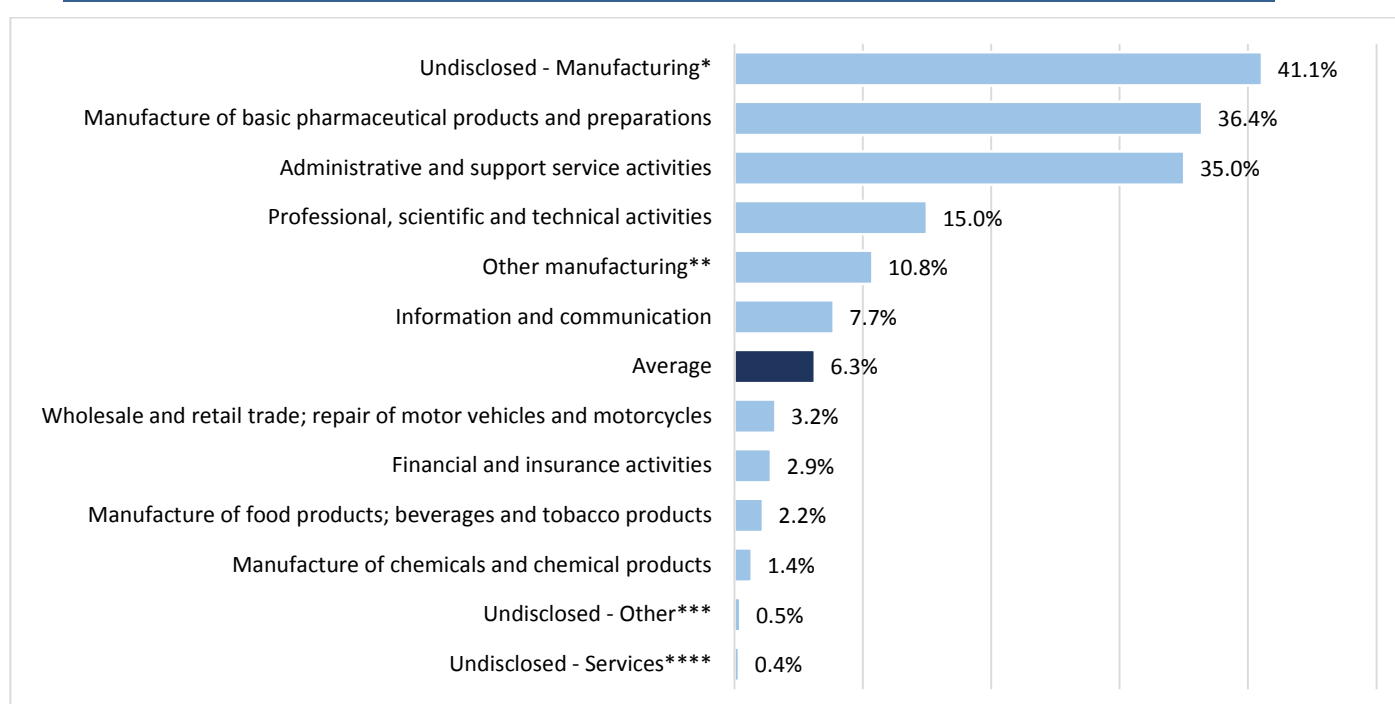
Sources: FDI stocks from ONS and Eurostat and defined as the net stock of inward FDI from the rest of the world; Sectoral losses from International Monetary Fund (2018b); HM Government (2018); and Felbermayr et al. (2018).

After evaluating the UK sectoral level FDI impacts, the next step is to check which sectors in Ireland are in the best position to attract some of this potential FDI from the UK. Our approach is to approximate the attractiveness of each Irish sector by their current share of non-UK EU (EU27) FDI stock. Sectoral Irish FDI data contain some non-standard aggregations because of confidentiality reasons, however we can make some inferences. Figure 3 shows the Irish share of the EU (non-UK) FDI stock. The figure shows that there are three sectors where Irish FDI represents more than a third of the total EU27 stock: Undisclosed manufacturing (including the manufacture of computer and electronic products), Manufacture of pharmaceuticals, and Administrative and support activities (including aircraft leasing). Two other sectors represent a share of EU27 FDI of over 10 per cent: Professional activities (legal, accounting, consultancy and engineering activities), and Other manufacturing (including the manufacture of medical devices).

With these shares acting as proxies for the attractiveness of various sectors with respect to FDI inflows, we can estimate how much inward FDI Ireland would be able to capture from the UK by multiplying the expected UK loss of FDI in every sector by the share of Irish EU27 FDI in that sector. This exercise shows that the potential largest gains would be in the Undisclosed manufacturing sector – mainly computer, electronic and optical products – a sector which combines a significant share of FDI in the UK, a large predicted loss in the UK, and a very high attractiveness to Ireland. The gains in this sector could amount to almost 40 per cent of the total predicted gain. Significant gains could also be achieved in the

Financial Intermediation sector – despite the relatively low attractiveness of Ireland in this sector – due to the size of the projected losses on the UK. Other sectors with potentially important gains include Professional activities, Administrative and support activities, Computer services, and Pharmaceuticals. In aggregate terms, the gain could amount to around €26 billion, which would represent an increase of 3.3 per cent over the current stock of Irish FDI and a capture of 7.6 per cent of the FDI spillovers from the UK following a no-deal Brexit. In the *Deal* scenario, the projected capture would imply an increase of 2.7 per cent over the current FDI stock.

FIGURE 3 IRISH SHARE OF EU27 (NON-UK) FDI STOCK, 2016



Sources: CSO and Eurostat.

Notes: *Manufacture of basic metals and fabricated metal products, except machinery and equipment (C24-25); Manufacture of computer, electronic and optical products (C26); Manufacture of machinery and equipment n.e.c. (C28); Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment (C29-30)

** Manufacture of leather and related products (C15); Manufacture of other non-metallic mineral products (C23); Manufacture of electrical equipment (C27); Manufacture of furniture (C31); Other manufacturing (C32); Repair and installation of machinery and equipment (C33)

*** Agriculture, forestry and fishing (A); Mining and quarrying (B); Electricity, gas, steam and air conditioning supply (D)

**** Transportation and storage (H); Real estate activities (L).

As in Lawless and Morgenroth (2016), we also assume that part of the exports associated to the activity of MNCs in the UK would reallocate to Ireland in a proportion similar to the captured FDI. This reallocation would produce an increase in Irish exports of 2.8 per cent above the baseline (2 per cent in the case of the *Deal* scenario), with a proportional increase in traded sector production because of the additional exports. Due to the uncertainty about the timing of the FDI relocation decisions, we simply assume that the increase in investment, exports and traded sector production is gradual, starting in 2019 in the *No-Deal*

and *Disorderly No-Deal* scenarios and at the end of a transition period, in the *Deal* scenario.

Finally, there are some elements in the FDI literature that suggest that this exercise should be considered as a best-case scenario. We have implicitly assumed that all FDI no longer destined for the UK in case of Brexit will remain in the EU, with Ireland capturing a share similar to its current share of EU27 FDI stock. Given that the EU economy is expected to experience a larger economic loss relative to the rest of the world as a result of Brexit, it may be the case that some of the FDI projects would actually leave the EU, as the EU's market potential is reduced by comparatively more than its competitors. Similarly, the economic impact of Brexit is expected to be larger in Ireland than in the rest of the EU, so it may be the case that the attractiveness of the Irish economy to FDI would be reduced by relatively more than other EU countries due to the loss of market potential, so that Ireland may capture a smaller share of FDI than its current share. Blonigen et al. (2007) use spatial econometric techniques to estimate the importance of nearby third markets, such as the UK, through a measure of surrounding market potential. By accounting for proximity to other large markets, the study finds market potential to be highly influential in attracting FDI. In Ireland's case, as the form of exit intensifies from a 'soft' to 'hard', the domestic growth path could lower directly due to reduced UK demand and indirectly due to effectively poorer market potential in Ireland.

Technical Assumptions

The estimates from the empirical literature around the impacts on trade and FDI are generally based on static estimates of EU membership and so to a great extent apply to the long run (typically assumed to be around ten years after the UK leaves the EU). There is considerable uncertainty about the transition path to the long run. As such, we place a larger emphasis on the long-run impacts as these effects are anchored in estimates from the empirical literature. We broadly follow the approach of NIESR (Hantzsche et al., 2018) in determining short-run dynamics.

In the *No-Deal* scenario, the trade shock is front-loaded with approximately half of the adjustment in trade taking place in 2019 with the remainder of the adjustment taking place over the period to 2028. In the long run, UK-EU trade is 44 per cent below the counterfactual where the UK remains in the EU. The 3.3 per cent increase in FDI inflows to Ireland is assumed to begin in 2019.

In the *Disorderly No-Deal* scenario, we use our estimate of non-tariff measures to capture the fact that there could be an additional large disruption to trade

especially in the short run. Specifically, we increase our estimate of non-tariff measures by a factor of three until the end of 2019 to capture this potential additional disruption. There are many channels through which a disorderly Brexit could impact the economy (including consumer confidence, business investment decisions etc.); the mechanism we use here is additional trade disruption given the importance of trade in determining the overall impact of Brexit. We assume that this additional trade disruption is relatively short-lived so that by 2020 the impact on trade reverts to that in the *No-Deal* scenario. The assumptions on FDI are the same as in the *No-Deal* scenario.

In the *Deal* scenario, the adjustment to the long-run trade impact is more gradual. We assume that an adjustment of 10 percentage points takes place by the end of the transition period (2020 Q4), with another 10 percentage points after the end of the transition period (2021 Q1), and trade adjusts gradually to the long-run impact thereafter. In the long run, UK-EU trade is 24 per cent below the counterfactual where the UK remains in the EU. In this scenario, the 2.7 per cent increase in FDI inflows to Ireland is introduced at the end of the transition period.

4. IMPACT OF BREXIT ON IRELAND

This section presents the results of our modelling of the projected impacts of the UK leaving the EU on the Irish economy, relative to a baseline scenario where the UK remains in the EU. Table 3 summarises the main results for key macroeconomic aggregates under the *Deal*, *No-Deal*, and *Disorderly No-Deal* scenarios across short-, medium- and long-term horizons. We emphasise the long-run impacts for Ireland as there is uncertainty about the timing associated with changes in the future relationship between the UK and EU. Overall, in each scenario, the level of Irish output is permanently below where it otherwise would have been were the UK to decide to remain in the EU. However, the negative impact on Irish output in the long run in the *Deal* scenario is approximately half that of the *No-Deal* scenario.

There are two main channels through which the shock hits the Irish economy; the negative trade shock will serve to reduce economic activity below where it otherwise would have been while the positive FDI shock will help to partially offset some of the overall negative impact. Specifically, the trade shock arising from the imposition of tariff and non-tariff measures would lead to lower activity in the international economy and severely reduce the demand for Irish exports. It would also negatively affect Irish competitiveness on impact. However, we would expect some internal adjustment in the economy that would help to restore lost

competitiveness over time.¹⁷ As a strong substitute for UK-destined investment, the additional FDI that Ireland may attract would boost activity and labour productivity in the traded sector, which would positively impact wages and employment. In each of the *Deal*, *No-Deal*, and *Disorderly No-Deal* scenarios, the same channels and transmission mechanisms are at play but the magnitude and timing of the shocks differ and are smallest in the *Deal* scenario.

In COSMO, output in the traded sector is driven by (trade weighted) world demand for Irish exports and competitiveness which means the shock is initially transmitted to the Irish economy through this sector. As described in Section 3.3, the phasing of the trade shock is front-loaded so, for example, in the *No-Deal* scenario global demand for Irish exports falls by 4.2 per cent compared to the baseline by the end of 2019 and by 7.6 per cent by the end of 2028. Overall, the shock leads to output in the traded sector and exports remaining below baseline values over the medium to long term. In the long run, output in the traded sector is 3.1, 5.9 and 6.1 per cent below baseline respectively in the *Deal*, *No-Deal*, and *Disorderly No-Deal* scenarios.

Across the scenarios, while we would expect lower activity to depress prices, higher import prices lead to the level of consumer prices being above base, by around 0.5 per cent in the *Deal* scenario and 0.9 per cent in the *No-Deal* and *Disorderly No-Deal* scenarios.¹⁸ Table 3 also shows the equivalent impact on the inflation rate for particular years. The loss in competitiveness as a result of Brexit would lead to pressure for some adjustment in prices in the economy. In particular, there would be downward pressure on wages to help improve competitiveness. In each scenario, there is a negative impact on real wages, with the strongest impacts in the *Disorderly No-Deal* scenario. The implied reaction of real wages is stronger than that of nominal wages because consumer prices are also above base in each scenario.

¹⁷ The simulation results from NiGEM suggest that the Sterling-Euro exchange rate would depreciate by around 3.5, 5.5 and 7.5 per cent in the short-run in the *Deal*, *No-Deal* and *Disorderly No-Deal* scenarios respectively. In the long-run, in both the *No-Deal* and *Disorderly No-Deal* scenarios the depreciation in Sterling is closer to 7 per cent, while in the *Deal* scenario it is broadly similar to the short-run result.

¹⁸ This impact is smaller than the results from Lawless and Morgenroth (2018), who report that the effect of the introduction of WTO tariffs and associated NTMs as a result of Brexit could raise the Consumer Price Index by 3.1 per cent. Two arguments help explain this divergence: firstly, COSMO is a general equilibrium model, in which a negative shock to the economy would depress activity and put downward pressure on prices. Secondly, as is mentioned in Lawless and Morgenroth (2018), their methodology does not take account of behavioural changes by consumers, the effect of exchange rate changes or the range of substitutes available, whereas the COSMO model can approximate some of these channels. However, it should be noted that if the availability of substitutes is limited, for example immediately after Brexit in the case of a disorderly exit, in the short term we could potentially observe movements of prices closer to those predicted by Lawless and Morgenroth (2018). Furthermore, if the reaction of prices were to be closer to the one described in Lawless and Morgenroth (2018), we would expect a stronger contraction of internal demand, incrementing the negative impact on GDP by between two- and three-tenths.

The fall in traded sector output (relative to the baseline) results in lower labour demand, which has knock-on impacts for employment and the unemployment rate. In the long run, the unemployment rate is 1 percentage point higher in the *Deal* scenario and roughly 2 percentage points above baseline in the two no-deal scenarios. The increase in the unemployment rate over the long term is in part due to the increasing magnitude of the trade shock over time. As a result of the loosening in the labour market, average wages are lower than in the baseline scenario. This will reduce the incentive to work and have a negative effect on the participation rate and overall labour supply. The combination of lower employment and lower wages leads to lower real personal disposable income for households, and in turn reduces consumption and imports below their baseline levels. As a result of lower domestic demand, activity in the non-traded sector is also negatively impacted, although it takes some time for the effect of the shock to percolate through to the non-traded sector.

With both output and employment below base in all three scenarios, government revenue from taxes will remain below base and the increase in the unemployment rate would lead to higher government spending on welfare payments. The net effect is a reduction in the general government balance (GGB).

Overall in the long run, the level of GDP is 2.6 per cent,¹⁹ 4.8 per cent and 5.0 per cent below where it otherwise would have been were the UK to remain in the EU. Although these are substantial relative reductions in the level of output over the long run, it is important to state that the Irish economy will continue to grow in each scenario but that the growth rate will be lower in the context of Brexit. If we assume the Irish economy would grow by an average of 3 per cent per annum over the long run if the UK stayed in the EU, the impact of Brexit is roughly equivalent to a 0.3 percentage point reduction in the long-run growth rate in the *Deal* scenario and around 0.6 percentage points off the long-run growth rate in the *No-Deal* and *Disorderly No-Deal* scenarios. The short-run impacts are below the long-run impacts in each scenario although they are still quite severe especially in the *Disorderly No-Deal* scenario where the additional disruption to trade leaves Irish output 2.4 per cent below where it otherwise would have been.

¹⁹ As a sensitivity check, we also consider a second deal scenario whereby the average long-run reduction in UK-EU trade is 30 per cent, around one-quarter higher than what we consider in our main *Deal* scenario. In this case, our simulation results show that the level of Irish GDP would be 3.4 per cent below the baseline in the long run.

TABLE 3 **IMPACT OF BREXIT ON IRELAND, CHANGE FROM BASELINE**

	Short-Run (after 2 years)				Medium-Run (after 5 years)				Long-Run (after 10 years)		
	Deal	No Deal	Disorderly		Deal	No Deal	Disorderly		Deal	No Deal	Disorderly
<i>Per cent deviation from Baseline Level:*</i>											
GDP	-0.6	-1.2	-2.4		-1.9	-2.7	-3.3		-2.6	-4.8	-5.0
Gross Value Added	-0.6	-1.3	-2.5		-2.0	-2.8	-3.4		-2.6	-4.9	-5.1
GVA, Traded sector	-0.9	-2.1	-3.9		-2.9	-3.9	-4.5		-3.1	-5.9	-6.1
GVA, Non-traded sector	-0.2	-0.2	-1.0		-1.1	-1.8	-2.4		-2.3	-4.2	-4.3
Consumption	-0.1	-0.2	-0.9		-0.9	-1.5	-2.1		-2.0	-3.5	-3.7
Real personal disposable income	-0.3	-0.6	-1.3		-1.2	-2.0	-2.5		-2.2	-3.9	-4.1
Employment	-0.1	-0.2	-0.8		-0.9	-1.4	-2.0		-1.8	-3.2	-3.4
Labour force	-0.1	-0.1	-0.3		-0.3	-0.5	-0.7		-0.7	-1.2	-1.2
Average wages, nominal	0.0	-0.1	-0.3		-0.3	-0.2	-0.4		-0.3	-0.4	-0.5
Average wages, real	-0.1	-0.3	-0.5		-0.5	-0.7	-0.9		-0.7	-1.3	-1.4
Exports	-1.0	-2.7	-4.7		-3.6	-5.2	-5.9		-4.6	-8.1	-8.3
Imports	-0.8	-1.7	-3.6		-3.1	-4.6	-5.5		-4.5	-8.0	-8.2
Investment	-0.7	-0.3	-2.0		-2.1	-3.6	-4.6		-4.1	-7.7	-7.8
Personal consumption deflator, level	0.1	0.2	0.2		0.2	0.5	0.5		0.5	0.9	0.9
<i>Deviation from Baseline:</i>											
Unemployment rate	0.1	0.1	0.5		0.5	0.9	1.2		1.0	1.9	2.0
Participation rate	0.0	0.0	-0.2		-0.2	-0.4	-0.5		-0.5	-0.9	-1.0
Personal consumption deflator, p.p.	0.0	0.0	0.1		0.1	0.1	0.1		0.0	0.1	0.1
GDP deflator, p.p.	0.0	0.1	0.2		0.0	-0.1	-0.1		-0.1	-0.1	-0.1
General government balance, % GDP	0.0	-0.1	-0.3		-0.3	-0.4	-0.5		-0.5	-0.9	-0.9

Note: * all impacts are in constant prices/real terms unless otherwise stated.

Further considerations

As COSMO is a three sector model, we cannot consider some aspects of Brexit that require a more granular analysis. For example, the results presented above do not explicitly model supply chain effects. Production processes in many sectors are increasingly fragmented across national boundaries, which leaves firms highly exposed to negative shocks between cross-border trade linkages. Brexit could have significant supply chain impacts that would interfere with critical portions of production processes, inhibiting the completion of final products. Vandenbussche et al. (2019) account for global value chain linkages across industries as a key feature of a more detailed trade channel analysis. Under a hard Brexit scenario, they find that GDP in Ireland could decline by 5.7 per cent relative to a situation of continued UK membership. This estimate is stronger, representing how import frictions could have a compounding effect on exporting ability, but remains broadly in line with the estimates presented in the *No-Deal* scenario above.

In addition, this study cannot capture the heterogeneous effect of Brexit at a detailed sectoral level nor by firm size. Using a partial equilibrium approach, Lawless and Morgenroth (2016) and Department of Finance (2018a; 2018b) analyse the impact of Brexit at a more disaggregated sectoral level and find that some sectors, such as agri-food, would be relatively more affected, given both the expected large increase in trade barriers in these sectors and their relatively greater exposure to the UK market. Firms in these sectors, on average, are more likely to be Irish-owned and more labour intensive. Consequently, the negative effects from Brexit could fall disproportionately on Irish-owned firms meaning our analysis could underestimate the loss of employment. Furthermore, Lawless (2010) shows how NTMs tend to have a larger effect on smaller firms across all sectors. While our analysis does not include a regional distribution of the negative impact of Brexit, recent literature would suggest that regions with a relatively large proportion of small, Irish-owned firms operating in certain sectors such as agriculture or food production to be hit harder as a result of Brexit. Department of Finance (2017) finds that the Border and South-West regions to be particularly vulnerable to the negative impact of Brexit.

Furthermore, it is possible that Brexit could divert future EU migration to other EU countries that would otherwise have gone to the UK and it is reasonable to assume that Ireland would experience higher immigration as a result. While our modelled scenarios will result in net immigration being below where it otherwise would have been because of lower economic activity and higher unemployment in Ireland, it is possible that some of this impact will be mitigated by the potential diversion of future EU migrants to Ireland and other EU countries. Barrett et al. (2015) argue that migration can be part of a process of investment in human

capital. Good English language skills are a valuable form of human capital and this factor combined with Ireland's relatively favourable growth prospects (even in the context of Brexit) may mean that potential EU migrants will be willing to move to Ireland in the future if they are no longer able to go to the UK. However, it is difficult to quantify the potential magnitude of this effect with any certainty.

Finally, our analysis assumes no reaction on the part of firms or government that could help to mitigate some of the economic impact of Brexit. As a result, the scenarios presented here could provide an overestimate of the potential impact of Brexit. For example, firms may be able to find substitutes for imports from the UK or diversify into new export markets which could help to reduce some of the losses associated with Brexit.

5. SUMMARY AND CONCLUSIONS

The UK is deeply integrated with the European Union and its decision to exit from this trading block has no parallels in modern history. From a macroeconomic modelling perspective this adds to the challenge (or at least the uncertainty, particularly in the short run) of estimating the macroeconomic implications of any future UK arrangement with the EU Member States including Ireland, as there is no past experience or empirical evidence which can be directly relied upon. However, to the extent that the main potential transmission channels are well understood there is a growing number of papers which have modelled the impact of Brexit. This Article adds to this literature by attempting to quantify the potential economic impact of Brexit on the Irish economy.

International evidence suggests that the impact of Brexit on the UK economy could be substantial given its strong inter-linkages with the European and global economy. There is also evidence to show that Ireland could be relatively more negatively affected than other EU countries, because of the openness of the economy and the fact that the UK is its closest economic partner. The potential impact of Brexit on Ireland will ultimately depend on the UK's new relationship with the EU. However, there is still considerable uncertainty around the likely form that this future relationship will take. As a result, we consider several scenarios to cover a broad range of possible outcomes. We consider three scenarios which we label *Deal*, *No-Deal* and *Disorderly No-Deal*.

Even if the new relationship between the UK and EU is known, there is still uncertainty about the economic impact of Brexit. It is generally accepted that the main channels through which Ireland will be impacted are trade, including the impact of tariff and non-tariff measures, and FDI; however the precise scale of the impacts and their duration is largely unknown. In this Article we draw on the

new extensive Brexit literature to help calibrate these impacts and then incorporate them into a macro-modelling exercise to see how these changes feed through the economy. Our approach is different to others in that we combine the latest micro-level estimates (including new estimates of the impact of non-tariff measures) with macro-level analysis. Our scenario results show that the impacts on the Irish economy are large and Brexit will ultimately negatively impact firms, households, the labour market and the public finances. Overall, across the three scenarios, the fall in the level of Irish output below where it otherwise would have been ranges from 2.6 to 5.0 per cent in the long run, depending on the scenario considered. The short-run impacts are also severe and especially so in the context of a disorderly Brexit, where we assume there would be additional disruption to trade.

There are both upside and downside risks to these estimates. On the upside, to the extent that businesses have been preparing for Brexit and finding ways of reducing trade exposures, this will help offset some of the negative impact. On the downside, the impact of Brexit could be more severe, especially in the short run, if there is a continued period of uncertainty which could impact investment decisions or if there are even larger disruptions to trade.

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