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The Potential
Macroeconomic
and Sectoral Consequences
of Brexit on Ireland

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ECONOMICS DEPARTMENT

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ABSTRACT/RÉSUMÉ

The Potential Macroeconomic and Sectoral Consequences of Brexit on Ireland

This paper provides estimates of the potential effects on exports, imports, production, factor demand and GDP in Ireland of an exit of the United Kingdom (UK) from the European Union (EU), focusing on trade and FDI channels. Owing to the high uncertainty regarding the final trade agreement between the negotiating parties, the choice has been made to assume a worst-case outcome where trade relations between the United Kingdom and EU are governed by World Trade Organization (WTO) most favoured nation (MFN) rules. In doing so, it provides something close to an upper bound estimate of the negative economic impact taking into account the potential for some firms to relocate to Ireland. Any final trade agreement that would result in closer relationships between the United Kingdom and the EU could reduce this negative impact. The simulations use two large-scale models: a global macroeconomic model (NiGEM) and a general equilibrium trade model (METRO). These models are used to quantify, both at the macroeconomic and the sectoral level, two key channels through which Ireland would be affected: trade and foreign direct investment. The simulation results highlight that the negative effect on trade could result in Ireland's GDP falling by 1½ per cent in the medium-term and around 2½ per cent in the long-term. The impacts are highly heterogeneous across sectors. Agriculture, food, and some smaller manufacturing sectors experience the largest declines in total gross exports at over 15%. By contrast, financial services exports increase slightly. The modelling suggests that any positive offsetting impact to the trade shock from increased inward FDI to Ireland is likely to be modest.

This Working Paper relates to the 2018 OECD Economic Survey of Ireland (www.oecd.org/eco/surveys/economic-survey-ireland.htm)

JEL classification: C68, C10, B17, F13, F14, F47,

Keywords: Ireland, Brexit, international trade, European Union, sectoral economic effects, computable general equilibrium model, NiGEM macroeconometric model, METRO model, foreign direct investment.

Les possibles conséquences macroéconomiques et sectorielles du Brexit sur l'Irlande

La présente note contient des estimations de l'impact potentiel que la sortie du Royaume-Uni de l'Union européenne (UE) pourrait avoir sur les exportations, les importations, la production, la demande de facteurs et le PIB en Irlande, l'accent étant mis sur les échanges et l'IDE. Du fait des incertitudes très élevées entourant l'accord commercial qui sera finalement conclu entre les parties à la négociation, il a été fait le choix de retenir comme hypothèse l'issue la moins favorable possible, c'est-à-dire une situation dans laquelle les relations commerciales entre le Royaume-Uni et l'UE seraient régies par les règles de la nation la plus favorisée de l'OMC. Cela permet de présenter un scénario se rapprochant d'une estimation haute des conséquences économiques négatives, en prenant en compte la possibilité que certaines entreprises puissent se relocaliser en Irlande. Tout accord commercial débouchant finalement sur l'établissement de liens plus étroits entre le Royaume-Uni et l'UE aurait pour effet de réduire cet impact négatif. Les simulations ont été établies à partir de deux modèles à grande échelle : un modèle économétrique mondial (NiGEM) et un modèle d'équilibre général du commerce mondial (METRO). Ces deux modèles permettent de quantifier, tant au niveau macroéconomique qu'au niveau sectoriel, les deux principaux canaux par lesquels l'Irlande serait affectée, à savoir les échanges et l'investissement direct étranger. Les résultats de la simulation montrent que les

conséquences négatives sur les échanges pourraient faire baisser le PIB de l'Irlande de 1½ pour cent à moyen terme et de quelque 2½ pour cent à long terme. Les conséquences sont très hétérogènes selon les secteurs. C'est dans l'agriculture, l'alimentation et dans quelques secteurs manufacturiers de moindre importance que le recul du total des exportations brutes, supérieur à 15 %, serait le plus fort. En revanche, les exportations de services financiers pourraient croître légèrement. La modélisation montre que si la hausse des entrées d'IDE à destination de l'Irlande devait compenser de manière positive le choc sur les échanges, cet effet ne pourrait probablement être que modeste.

Le présent document de travail concerne l'Étude économique 2018 de l'Irlande (<http://www.oecd.org/fr/eco/etudes/etude-economique-irlande.htm>).

Classification JEL : C68, C10, B17, F13, F14, F47,

Mots clés : Irlande, Brexit, commerce international, Union européenne, effets économiques sectoriels, modèle d'équilibre général calculable, modèle macroéconométrique NIGEM, modèle METRO, investissement direct étranger.

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The potential macroeconomic and sectoral consequences of Brexit on Ireland

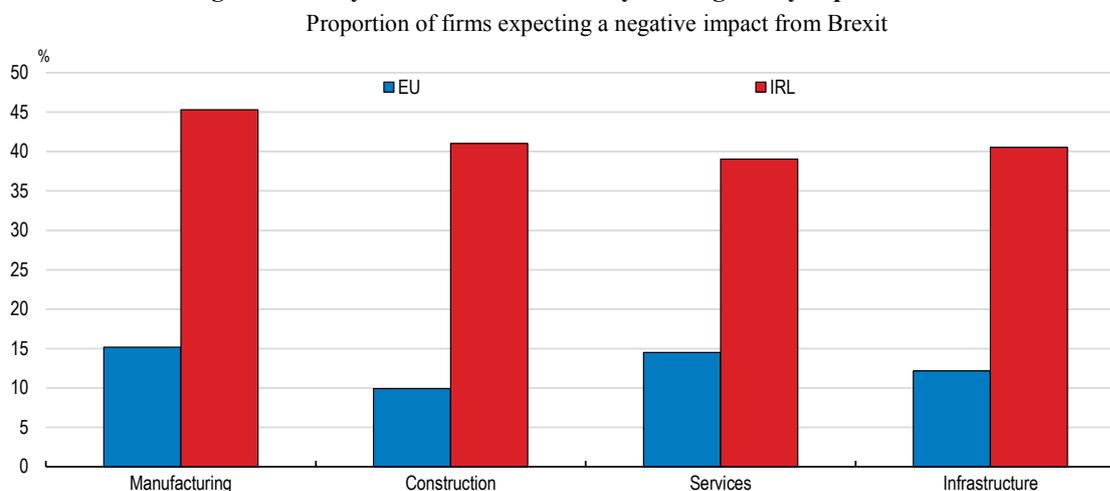
By Christine Arriola, Caitlyn Carrico, David Haugh, Nigel Pain, Elena Rusticelli,
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1.1. Introduction and key findings

Ireland's prosperity has been built on a high degree of trade and financial openness. A by-product of this is that domestic income and employment levels are very sensitive to external shocks (Lane, 2017). While increased global integration over recent decades may have amplified the transmission of economic shocks across countries, Ireland may be even more exposed than other small open economies given relatively large net external positions and externally set monetary and exchange rate policy. Indeed, recent empirical analysis highlights that the impact on the Irish economy of exogenous shocks is relatively high (O'Grady, Rice and Walsh, 2017).

In this context, a key task for Irish policymakers is to prepare for potential external disruptions that could transmit to the domestic economy. At present, the most discernible of these is the planned departure of the United Kingdom from the European Union (EU; OECD, 2017a). Ireland and the United Kingdom have a very close relationship in terms of trade, financial flows and labour markets, meaning that significant changes to agreements governing current arrangements could have large effects on the Irish economy compared with many of their EU counterparts. Indeed, a relatively high proportion of Irish businesses believe that "Brexit" will impact upon them negatively (Figure 1).

Figure 1. Many Irish firms believe they are negatively exposed to Brexit



Source: EIB Investment Survey.

1. Authors are listed in alphabetical order and are members of the OECD Economics Department and Trade and Agriculture Directorate. The authors would especially like to thank Dorothee Flaig (OECD Trade and Agriculture Directorate) and Alberto Pandiella Gonzalez (OECD Economics Department) for peer-reviewing the paper. They would also like to thank Ken Ash (OECD Trade and Agriculture Directorate), Alvaro Pereira, Pierre Beynet, Sven Blondal and Yosuke Jin (OECD Economics Department) for comments on earlier drafts, Paula Adamczyk for statistical assistance and Heloise Wickramanayake for editorial assistance.

Since the rules governing the future economic relationship between the United Kingdom and the European Union are highly uncertain, a scenario frequently applied in empirical work related to Brexit (e.g. Kierzenkowski et al., 2018; Bergin et al., 2017; Lawless and Morgenroth, 2016; Dhingra et al., 2017; Bellora et al., 2017; Vandebussche et al., 2017), supposes that trade relations between the EU and UK default to the World Trade Organisation's (WTO) Most-Favoured Nation (MFN) rules. Relative to current arrangements, this corresponds to an increase in tariff and non-tariff barriers on Irish trade with the United Kingdom. Such a scenario could be the result of a disorderly conclusion to negotiations and can be considered something close to a worst case outcome. In this paper, this scenario is implemented in two distinct modelling approaches in order to quantify both the macroeconomic and sectoral impacts on Ireland. The shock is principally chosen because it is associated with an existing tariff schedule and hence reduces the degree of judgment needed to formulate the shock. Consequently, the results give something close to an upper bound estimate of the size of the negative economic effects on Ireland without representing a judgment about the most likely outcome of Brexit negotiations.

The medium and long-term economic impacts are modelled considering two main transmission channels – trade and foreign direct investment - using stylised calibrated shocks. First, the OECD METRO trade model is used to quantify the consequences of the imposition of WTO MFN rules on trade between the United Kingdom and Ireland. The trade outcomes from METRO, as well as calibrated shocks to foreign investment are then combined to construct the overall simulation in the NiGEM macroeconomic model². In addition, the productivity impact of the declines in trade openness, R&D and managerial quality that occur under the scenario are incorporated in the medium and long-term simulations in a way that is consistent with past work (i.e. Égert and Gal, 2016; Kierzenkowski et al. 2016).

The empirical set-up is novel in the context of the existing research evaluating the economic effects of Brexit on the Irish economy. This is for three main reasons:

- The sectoral disaggregation of the METRO model allows the differential impact on the sectors of the Irish economy to be quantified. Notably, METRO has a particularly rich trade structure that takes into account important trade diversion effects arising from changes in relative prices between countries and estimates production and employment impacts at the sectoral level. This provides an indication of the regional impacts of the simulation, which is important given that even mild economic consequences at the aggregate level can mask significant regional effects (Rusticelli et al., 2017).
- Much of the existing work that uses macroeconomic models to quantify the impact of Brexit model the trade channel using a calibration based on singular, historical episodes of trade disruption. METRO is a large and detailed general equilibrium model of trade that allows the simulation of complex trade policy scenarios. The use of this detailed trade model to capture the trade channel in combination with a global macroeconomic model to capture effects from uncertainty, productivity and exchange rate changes allows more channels to be illustrated (i.e. both trade and FDI) than would be possible with a trade or macroeconomic model in isolation.
- The analysis looks at the effects of applying the WTO tariff schedule and a rise in non-tariff measures (NTMs) on *both* UK exports and imports. This enhances the modelling of the impact on Ireland as there is now both an indirect effect stemming

2. Further information about METRO and NiGEM is provided in Section 5

from the impact on UK demand of changes in UK exports to the world, and also a direct effect from new tariff and NTM restrictions on Irish exports to the United Kingdom. The extension to include NTM's on UK imports, and thus Irish exports, is important as these barriers are particularly significant in some sectors where Ireland trades intensively with the United Kingdom, such as agriculture and food.

On the basis of the illustrative shock using both the METRO and NiGEM models, the **main findings** are:

- Irish exports to the United Kingdom fall by around 19%. The results from METRO suggest that sectors with a high reliance on the United Kingdom as an export market and whose products would face a relatively large increase in import barriers are severely affected. For example, exports to the United Kingdom of the Irish agriculture and food sector would fall by 30% and its production would contract by 14%. The impacts across regions within Ireland are likely to be unevenly distributed.
- The trade shock, along with changes in the euro exchange rate and uncertainty incorporated in the NiGEM model, would reduce Ireland's GDP by between 2-2½ per cent after 10 years.
- The offsetting effect on GDP from increased FDI in Ireland (that would have otherwise been directed to the United Kingdom) would be modest relative to the impact from the trade disruption, based on the results from NiGEM.

These findings are specific to the models used, the detailed assumptions made and judgments employed to calibrate the shocks.

The remainder of this paper is structured as follows. Section 2 outlines the economic linkages between Ireland and the United Kingdom. Section 3 discusses previous analyses of the impact of the United Kingdom exit on the Irish economy. Section 4 specifies the shocks used in the analysis. Section 5 provides a description of the models used. Section 6 presents the results and Section 7 concludes.

1.2. The Irish and UK economies are highly integrated

The Irish and the United Kingdom economies are deeply integrated across several dimensions. These include in trade and the labour market, specifically through migration.

1.2.1. Trade

The United Kingdom remains Ireland's largest trading partner

Although its share has declined from over 50% in the 1970s, the United Kingdom is still a significant destination country for the export of Irish goods and services. In 2014, the United Kingdom accounted for 17% of total Irish exports, 15% of total goods and 20% of total services exports.³ The United Kingdom is also an important source of imports for the Irish economy, accounting for 17% of total imports, 28% of goods and 10% of services.⁴

3. 2014 figures for Ireland are frequently used throughout due to the large revisions made to key Irish economic indicators in recent years. See OECD (2018) for a discussion.

4. These figures are sourced from the Central Statistics Office External Trade Statistics and are not directly comparable with those in Figure 2 which are used to gain a cross country comparison on a consistent basis.

The Irish economy is one of the most integrated in the global economy; the most recent KOF Index of Globalization that measures economic, social and political globalisation ranks Ireland fourth after Switzerland, the Netherlands and Belgium (Ruane et al., 2013 and Gygli 2018). Exports to the United Kingdom still account for a sizeable share of GDP despite the large decline in the share of total exports; Irish goods exports to the United Kingdom accounted for 7% of Irish GDP in 2014. The vast majority of exports to the United Kingdom are destined for markets outside Northern Ireland.

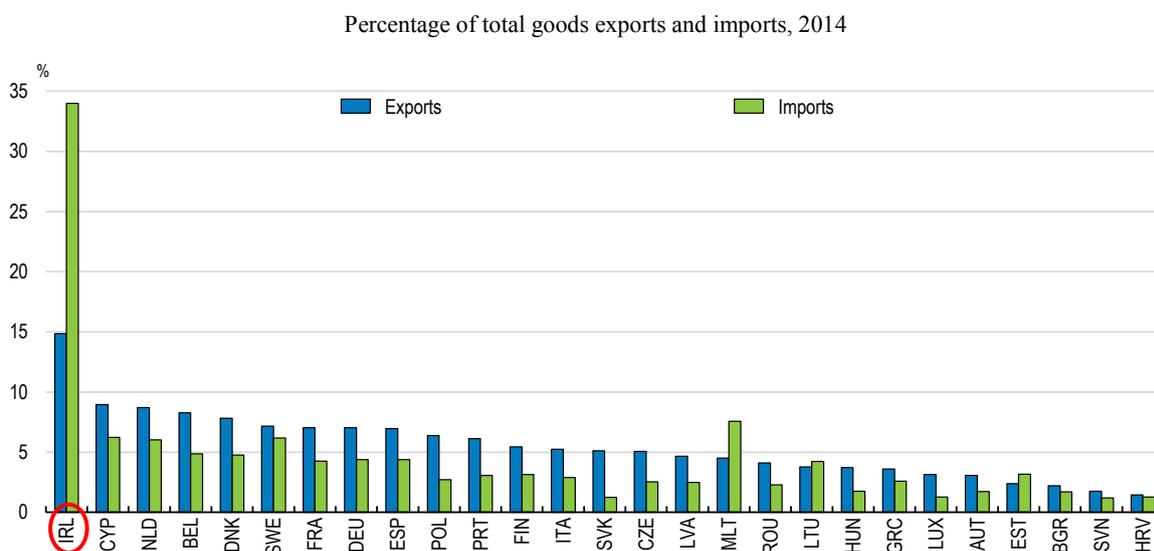
The United Kingdom is a major source of intermediate goods for Irish firms

Import figures also highlight that the United Kingdom is a major source of intermediate goods used in production by Irish firms (Barrett et al., 2016). In terms of business linkages in 2015, there were approximately 90 000 firms in Ireland that recorded intra-EU acquisitions of goods from the United Kingdom (Revenue 2016, 2017). In terms of value added, Ireland is highly integrated in global value chains, with exports relying to a large extent on intermediates imported from abroad (OECD 2013). A tariff imposition on this trade would not only disrupt production chains but also significantly add to administrative burdens, with as much as nine times more firms in Ireland with goods that would need to be inspected by customs (Revenue 2016, 2017). The authorities have noted that the current customs infrastructure would not be able to cope with the additional volume of controls needed (Revenue 2016, 2017).

Ireland is much more reliant on the United Kingdom than other EU member states

Ireland has relatively high trade exposure to the United Kingdom given that the share of Irish goods exports destined for the United Kingdom is on average 10 percentage points higher than other EU member states (Figure 2). For Irish goods imports, the share deriving from the United Kingdom is 30 percentage points higher, on average, than that of other member states. This higher reliance on the United Kingdom in terms of goods imports and the deep supply chain linkages between the two economies mean that the trade disruption for Irish imports could be as significant as that on the export side (Barrett et al., 2015).

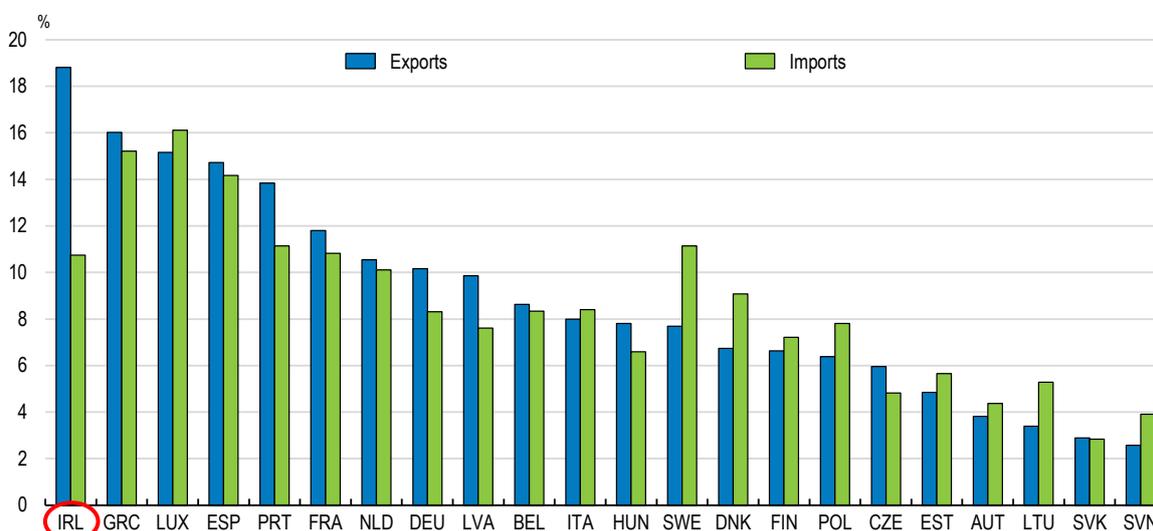
Figure 2. Share of goods exports-to and imports-from the UK



Source: International Monetary Fund Direction of Trade Statistics.

Ireland also has a high percentage of exports in services going to the United Kingdom compared with other EU member states (Figure 3).⁵ On services imports, the share coming from the United Kingdom is less striking, though is still above average.

Figure 3. Share of services exports to and imports from the United Kingdom as a per cent of total services exports and imports (2014)



Source: OECD International Trade in Services Statistics (ITSS).

5. Not all member states are shown due to data availability.

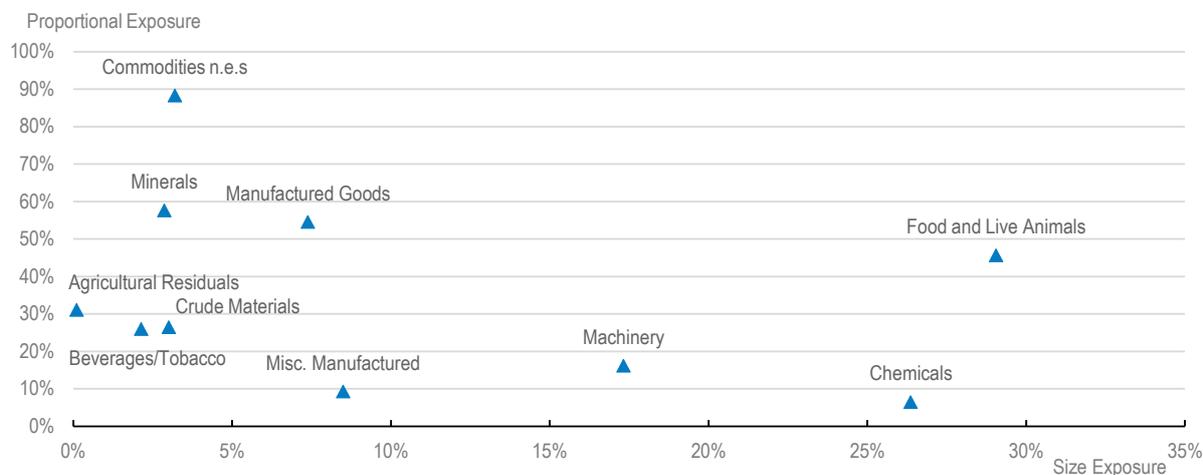
Some sectors of the Irish economy are highly reliant on UK trade

Another important aspect of the trade relationship between Ireland and the United Kingdom is the high exposure of certain Irish business sectors (Figure 4). In 2015, both the food and live animals sector and the chemicals sector, which includes pharmaceuticals, accounted for over 25% of Ireland's goods exports to the United Kingdom. However, the food and live animals sector was much more reliant on exports to the United Kingdom, with almost half of the sector's total exports going to the United Kingdom. The chemicals sector, by contrast, sent under 10% of its total exports to the United Kingdom, reflecting a relatively high level of global diversification (Department of Finance, 2016a).

Goods trade with the United Kingdom is very concentrated in a few product types (Barrett et al., 2015), with 11 of the 15 most UK-exposed products in the EU being Irish exports, predominantly in the agriculture and food sector (Department of Finance, 2017). It is these types of low value, high volume products which are more difficult to transport that are most likely to face the biggest burden from the imposition of customs controls (Barrett et al., 2015).

In terms of the trade exposure of specific sectors in Ireland relative to other member states, as discussed in Department of Finance (2017), Irish sectors are generally in the upper range of the most exposed sectors of any member state across both goods and services exports. In the exposed food and live animals sector exports to the United Kingdom account for a greater proportion of Ireland's total exports than they do for any other member state (Figure 5). There is also a comparatively high exposure in smaller manufacturing sectors (Department of Finance 2017). An important additional feature of the United Kingdom-exposed sectors of agriculture and food and smaller scale manufacturing sectors also tend to be concentrated in regional and rural labour markets in Ireland and have comparatively low profit levels. They are also those sectors that would face some of the highest tariffs under a WTO schedule (Department of Finance, 2016a).

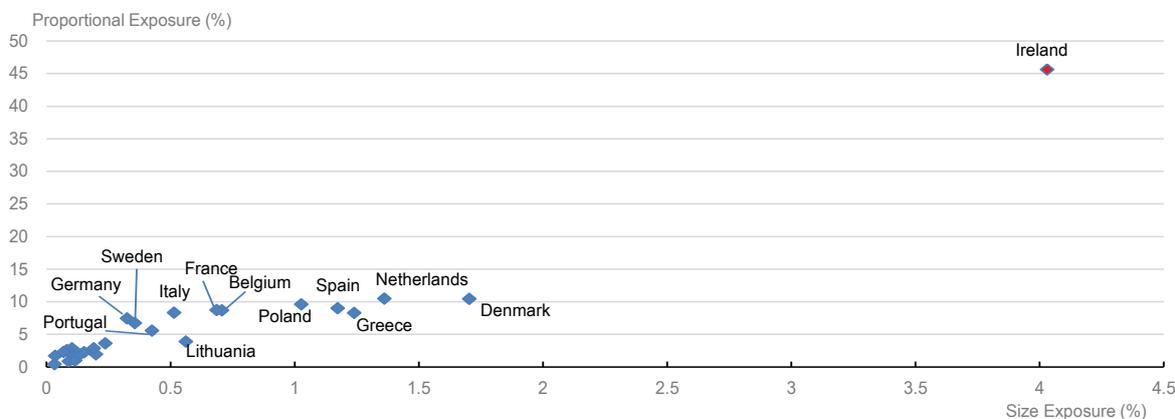
Figure 4. Share of each sector in Irish goods exports to the United Kingdom, and the proportion of goods within each sector that goes to the United Kingdom⁶



Note: Size exposure is the per cent of Ireland goods exports to the United Kingdom accounted for by a sector of the Irish economy. Proportional exposure is the per cent of a sector of the Irish economy’s global exports accounted for by exports to the United Kingdom.

Source: Central Statistics Office External Trade Data and Department of Finance analysis (Department of Finance, 2016a).

Figure 5. Proportion of agriculture and food exports as a share of total goods exports and the share of goods within this sector going to the United Kingdom (2015)⁷



Note: The horizontal axis reflects agricultural and food exports to the UK as a share of total goods exports to all destinations. Proportional exposure of a sector in a country is the per cent of a sector’s global exports accounted for by exports to the United Kingdom.

Source: UNCTAD Statistics External Trade Data and Department of Finance analysis (Department of Finance, 2017).

6. The composition of the sectors is taken from Department of Finance, (2016a). The pharmaceuticals sector is included in the chemicals sector. The food and live animals sector can be taken as a proxy for the food and agriculture sector in the present paper.
7. Hungary, Slovakia, Slovenia, Latvia, Finland, Malta, Estonia, Czech Republic, Croatia, Luxembourg, Romania and Bulgaria are clustered in the figure, with a proportional exposures of less than 5% and size exposures of less than 0.5%.

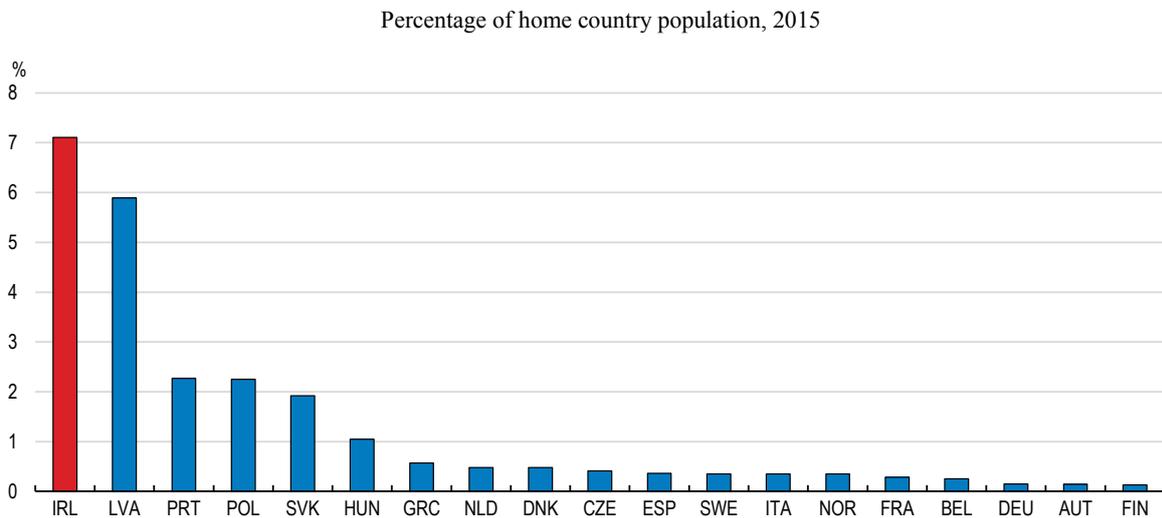
1.2.2. Labour market links

The economic performance of the United Kingdom has a strong influence on Ireland's labour market

While the proportion of Irish emigrants destined for the United Kingdom has fallen over time (Honohan, 1992, and Barrett et al., 2015), Irish nationals comprise the largest foreign born group in the United Kingdom across a sample of EU member states when measured as a percentage of home country population, with almost 400 000 people born in Ireland residing in the United Kingdom (Figure 6), reflecting 7% of the Irish population. Since the global financial crisis, the United Kingdom has remained by far the most popular destination for Irish emigrants, with almost 10 000 departing for the United Kingdom per year over the period from 2009-2013, more than double that of the second most popular destination (Figure 7).

These figures highlight the potentially strong influence of economic conditions in the United Kingdom on the Irish labour market and how this integration has helped adjustments in the Irish labour market. This link has been observed econometrically in a number of studies as an equilibrium relationship between wages and unemployment rates between the two countries: if wages grow in the United Kingdom relative to Ireland or the rate of unemployment in the United Kingdom falls relative to Ireland, this results in increased net migration flows (Barrett et al., 2015). Consequently, a deteriorating performance of the United Kingdom economy can put upward pressure on unemployment rates in Ireland and downward pressure on wages (Barrett et al., 2015). At the same time, given the flexibility of the Irish labour market, such a scenario could add to the supply side of the Irish economy in the medium-term, especially if it results in Irish workers with in-demand skills staying or returning to the domestic labour market (Doris et al., 2014).

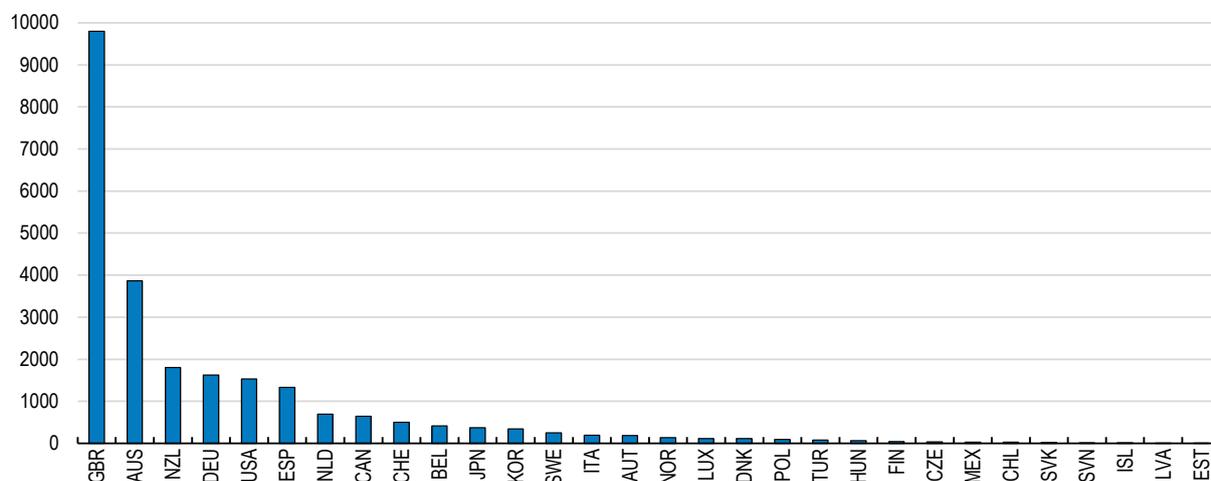
Figure 6. Stock of foreign born population in the United Kingdom by nationality



Source: OECD International Migration Database (MIG).

Figure 7. Flows of Irish Nationals to Foreign Countries

Annual average 2009-2013, numbers of people



Source: OECD International Migration Database (MIG).

1.3. Existing literature on the impact of Brexit on Ireland

A number of studies have looked specifically at the macroeconomic impact of a UK exit on Ireland. Simulations using an Irish macro-econometric model, taking inputs from UK trade scenarios in NiGEM, show the impact on Ireland could be substantial: Irish output would be 3.8% below what it otherwise would have been after 10 years under a scenario where WTO MFN rates are applied (Ebell and Warren, 2016; Bergin et al., 2017). Other work uses a Bayesian Vector Autoregression (BVAR) model, with a WTO MFN-rate scenario resulting in a 3.2% decline in Irish GDP (Central Bank of Ireland, 2016). Barrett et al., (2015) and Department of Finance (2016b) apply a generic estimate of the impact of a reduction in UK GDP on Ireland, in combination with estimated impacts of a UK exit on the United Kingdom economy, to provide an initial quantification of the economic impact on Ireland.⁸ The estimates in this paper for a WTO scenario differ from those in the existing literature; the reasons for this will be outlined in the results section.

A number of previous studies on the comparative cross-country impact of a UK exit on the EU have estimated that Ireland will be particularly negatively affected relative to other member states (OECD, 2016; IMF, 2016; Rojas-Romagosa, 2016; Dhingra et al., 2016). The most affected sectors in Ireland in terms of employment, production or trade losses would be agriculture and food products, textiles and traditional manufacturing sectors (Lawless and Morgenroth, 2016; Department of Finance, 2016b; 2017, Bellora et al., 2017; Vandebussche et al., 2017, Copenhagen Economics 2018). Despite the decline in the importance of the United Kingdom as a destination for Irish goods over time, the exposure of a number of sectors in Ireland to the United Kingdom actually increased between 2000 and 2015, notably in the agriculture and food sector (Department of Finance, 2017).

This paper contributes to the existing literature in several important ways. In particular, the empirical specification allows for the illustrative Brexit shock to be fed through the two key economic channels through which Ireland will be affected. As discussed, other Ireland-

8. The estimate used is not in reference to a UK exit scenario.

specific studies estimate the impact through the outputs of UK simulation exercises, applying new external scenarios to Ireland. This may not fully capture all of the key channels that will affect the likely outcomes for the Irish economy. An important contribution of this paper is that it contains a detailed analysis of the trade channel, considering the potential impact of tariffs and non-tariff barriers imposed both on the United Kingdom economy, slowing its growth, and also on Irish exports to the United Kingdom. The application of barriers to Irish exports will have a direct impact on the Irish economy and is an additional channel that has not been captured in previous Ireland-focused studies.

In the previous Ireland-focused Brexit literature, the FDI effect considered stems from a fall in FDI in the United Kingdom, which reduces the performance of the United Kingdom economy, adversely affecting economic conditions in Ireland. There is not, however, a specific analysis where FDI relocated to Ireland adds to the productive capacity of the Irish economy. This FDI channel could be a potential positive consequence for Ireland of Brexit and could potentially mitigate some of the negative effects from a disruption to trade (Lawless and Morgenroth 2016b). This change is not captured directly in most scenarios, in contrast to the analysis here.

The literature reviewed also suggests a number of potential sectoral impacts that are further explored using the METRO model. Earlier analysis that relies on UK-only results or qualitative approaches do not capture potentially important trade diversion effects, relative price changes, supply and demand effects in different sectors or value chain effects that are contained in the general equilibrium METRO model. Different sectors may for example face similarly high tariff and have similar UK trade exposure but some may have better market diversion opportunities than others leading to different sectoral export and production outcomes in a detailed multi-country CGE model. The application of the METRO model thus adds significantly to the quantification of sectoral and within-country regional aspects of the potential shock to the Irish economy.

1.4. Specification of the illustrative Brexit shock for Ireland

In the analysis, as in previous OECD studies (Kierzenkowski et al., 2016), the impact of UK exit is simulated without any assumptions being made about a possible transition arrangement with the EU following formal exit in 2019 or before any future trade agreements are reached. Trade relations between the United Kingdom and EU, and thus the United Kingdom and Ireland, are assumed, for illustrative purposes, to default to being governed by the World Trade Organisation's (WTO) Most-favoured Nation (MFN) rules. Additional assumptions about the overall environment are taken from Kierzenkowski et al., (2016) including a sterling depreciation and a rise in uncertainty, including longer-term fiscal outcomes, which is reflected in a rise in the sovereign term premium in Ireland.⁹

The magnitudes of these shocks are outlined in Table 1. In Table 1 the shocks to export volumes and import prices are calibrated drawing on the METRO simulation, in this way the METRO model feeds into the overall scenario simulated in NiGEM. There are a number of assumptions and estimates taken into consideration in assessing the potential magnitude of these channels for Ireland. The sensitivity of the shock magnitudes to these assumptions, particularly for the FDI channel, along with their implications for productivity are discussed below. Both medium and long-term results are specified; given METRO is a

9. The exchange rate is held fixed in the METRO simulation; this channel is modelled through NiGEM.

medium-term model the trade impacts are extended to the long-term using Kierzenkowski et al., (2016).

Table 1. The impact of the illustrative Brexit shock on Ireland in the NiGEM Model

Shock channel	Medium and long-term change
Trade	In the medium-term, a 2.5% fall in exports, a 0.2% rise in import prices, due to increased tariff and non-tariff barriers and sterling depreciation vis-à-vis the euro. ¹⁰ In the long term, a fall in Irish exports of 4%.
Foreign Direct Investment	A 3% increase in Ireland's stock of FDI and 0.45% increase in managerial quality in the medium-term with this doubling, to 6% and 0.9% respectively in the long-term.
External Environment	A sterling depreciation against the euro, following Kierzenkowski et al., (2016), and an increase in the term premium 20 bps over the first two quarters by 50 bps over the rest of the medium-term. In the longer-term this falls back to 25 bps.

1.4.1. Trade¹¹

Tariff and non-tariff barriers will increase on both goods and services trade

The use of the METRO model offers considerable advantages over the approaches in much of the existing literature as this model allows the application of tariff and non-tariff barriers at the detailed sectoral level to match a WTO scenario. The model takes into account complex trade diversion impacts and allows the sectoral level impacts on exports, production and employment to be estimated.

Tariffs on goods exported from the United Kingdom are assumed to increase to the importing country's WTO MFN bound rates.¹² At the same time, the United Kingdom is assumed to impose tariffs, equivalent to EU bound rates, on goods imported into the country.

The post-UK-exit MFN bound rates are applied in the model as a mark-up on the current rates, with the mark-up based on the WTO rates found in the WITS-IDB database. The mark-up is computed to increase the applied rate in the database by the same amount as in the WITS-IDB. It is calculated as one plus the percent increase between the effectively applied tariff rate and the MFN bound rate. A mark-up is computed for each sector and for each trading partner. Table A1.3 shows the mark-up applied to each countries ad valorem tariff rate, giving the new tariff rate UK exporters would face in the illustrative shock once the United Kingdom departs the EU. The UK is assumed to apply EU MFN tariff rates (Table A1.2).¹³

In addition to the increase in tariff rates, a UK exit from the EU is likely to raise the non-tariff costs of trade between the United Kingdom and EU member states. Once the United Kingdom leaves the customs union, any introduction of administrative rules, like customs declarations, possible border checks, and health or technical compliance reviews, could increase the cost of trade with the remaining EU countries. Moreover, if there was to be a regulatory divergence between the United Kingdom and the EU, there could be additional

10. Trade is further affected by an appreciation of the euro against the sterling. Exchange rate changes are modelled in NiGEM

11. The impact of tariff and NTM's are simulated in the METRO model (as described in Section 5)

12. For all tariff, non-tariff and mark-up rates applied see Appendix A.

13. While MFN rates apply by definition equally to all trade partners, the differences by country for a given commodity in table A1.3 arise from two factors: 1) the mark-up is applied to applied rates (which may differ from MFN rates), and 2) the aggregations across tariff lines to the commodity level used in the model.

costs to exporters from meeting differing requirements to trade and verifying that requirements are met. These assumed costs would occur on both sides of UK-EU trade and are illustrated by imposing new trade costs related to NTMs. The increase in NTMs related costs on goods, shown in Table A1.5, is assumed to be equal to half the observed trade cost saving from EU market integration (OECD 2011). Overall tariffs rates are between 0.05 and 8% and the increase in non-tariff barriers is between 0% and 41%. This sectoral level of detail and the specific application to Ireland of tariff and non-tariff barriers is an improvement on the existing literature on the impact of Brexit on Ireland.

Services do not face tariffs, but are subject to trade costs stemming from NTM's. New services NTM's are computed as 50% of the increase in tariff equivalents of NTMs faced by the exporter once trade between the United Kingdom and EU member states is governed by MFN status. This is equal to the weighted average of the CEPII import restrictiveness index (Fontagné et al., 2016) across all of a country's trading partners. The rates applied in the simulation are reported in Table A1.4.¹⁴

In the longer-term, any decline in the openness of the Irish economy will have an adverse impact on productivity (Égert and Gal, 2017; Kierzenkowski et al., 2016). This longer-term supply-side effect is considered explicitly in the analysis using NiGEM, where it is modelled as a decline in labour-augmenting technical progress with effects calibrated based on Égert and Gal (2017), with a decline in trade openness of 4 percentage points reducing total factor productivity (TFP) by 1.2% after 10 years. This openness channel is also calibrated from METRO and modelled in NiGEM.

1.4.2. Foreign Direct Investment

The increase in foreign direct investment in Ireland is likely to be modest

While the illustrative Brexit shock will have an adverse effect on the Irish economy through the trade channel, the potential for countervailing influences through other channels need to be considered. For example, any reduction in the ease of EU market access from the United Kingdom as a result of Brexit would make the United Kingdom a less attractive destination for FDI (Barrell and Pain, 1997), and some of this investment could be relocated to Ireland (Davies et al., 2017; Barrett et al., 2015).

The United Kingdom is a leading location for FDI, with the largest inward FDI stock in Europe, and the second largest in the world (Barrett et al., 2015). At the same time, there is a relatively high correlation of observed FDI location choice factors between the United Kingdom and Ireland, suggesting a high degree of substitutability between the two countries (Davies et al., 2016). The reduction in UK FDI has been estimated at between 10% and 45% (Kierzenkowski et al., 2016), based on estimates contained in Fournier (2015). There are various available estimates as to the share of such FDI that could be relocated to Ireland.

Based on the range of long-term estimates, a 6% increase is taken as the estimated rise in the stock of Irish FDI over the long-term following the United Kingdom's departure from the EU.¹⁵ In this projection, a linear increase is assumed, and thus the FDI stock in Ireland

14. OECD (2017b) provides an in-depth analysis of services trade policies, and discusses barriers to services trade using the OECD Services Trade Restrictiveness Index. The NTMs faced by exporters under MFN rules, are the weighted average of the index, where EU countries or the UK, depending on the exporter, is at the same level as of the rest of world.

15. See Appendix B for a review of FDI estimated for Ireland.

increases by 3% over the medium-term. These estimates are incorporated into the NiGEM model at the same time as the trade shock in order to gauge the extent to which they offset the negative impact on the Irish economy.

An increase in FDI will also increase total factor productivity (TFP), R&D and managerial quality

As in Kierzenkowski et al. (2016), the increase in FDI is assumed to affect productivity through research and development (R&D) spending. In Ireland almost two-thirds of R&D expenditure is by foreign owned enterprises, with just over EUR 1.3bn on current expenditure (CSO 2017). Égert and Gal (2016) provide estimates for how an increase in R&D spending impacts TFP, with a rise in business sector R&D intensity of 0.1 percentage points boosting TFP by 0.17% after 10 years. These estimates are used to translate the increase in the FDI stock into a productivity increase in Ireland given that almost two thirds of total R&D spending is accounted for by foreign firms and there will be an increase in the number of foreign firms from increased FDI. The increase in TFP over the long-term is thus 0.1%.

As discussed in Ruane and Buckley (2006) and Kierzenkowski et al (2016), FDI can also increase managerial quality in a country. Figures on the difference in managerial quality between domestic and foreign firms as presented in Bloom et al., (2014), are combined with the estimated increase in the FDI stock to calculate the expected improvement from the FDI relocation channel. The estimates of how a change in managerial quality, of 0.9% in the long-term, affects productivity are again taken from Brexit estimates for the United Kingdom in Kierzenkowski et al. (2016), where a 1% reduction in managerial quality reduces productivity by 0.02 percentage points. This change is scaled for the Ireland estimate.

1.5. The empirical framework

The analysis proceeds in two stages; the OECD's METRO model is used to quantify how the tariff and non-tariff barriers impact both total trade and different sectors in the Irish economy. The overall macroeconomic impact on Ireland from the two main channels, trade and FDI is subsequently quantified using the NiGEM global economy model. The trade channel is calibrated by drawing on the information on the impact on exports and import prices from the METRO model. For the long-term macroeconomic analysis the medium-term trade results for Ireland from METRO are extended using Kierzenkowski et al. (2016).

1.5.1. The METRO model

The METRO model is a computable general equilibrium model (CGE) and is described in detail in OECD (2015). For this analysis the model is aggregated to 13 regions, 34 sectors of the economy, and eight types of factors, with the United Kingdom and Ireland disaggregated from the rest of the European Union (EU 26). The simulations represent medium-term shocks where production factors are mobile, but there is no capital accumulation.

CGE models rely on a comprehensive specification of all economic activity within and between countries (and therefore the different inter-linkages that tie these together) and are suitable for examining the impact of a wide range of different trade shocks. The METRO model builds on the GLOBE model developed by McDonald and Thierfelder (2013). The

novelty and strength of the METRO model lies in the detailed trade structure and the differentiation of commodities by end use. Specifically, commodities and thus trade flows, are distinguished by end use category, as those designed for intermediate use, for use by households, for government consumption, and as investment commodities.

The underlying framework of METRO consists of a series of individually specified economies interlinked through trade relationships. As is common in CGE models, the price system in the model is linearly homogeneous, with a focus on relative, not absolute, price changes. Each region has its own numéraire, typically the consumer price index, and a nominal exchange rate (an exchange rate index of reference regions serves as model numéraire). Prices between regions change relative to the reference region.

The database of the model relies on the GTAP v9 database (Aguiar et al 2016) in combination with the OECD Trade in Value Added data. Policy information combines tariff and tax information from GTAP with OECD estimates of non-tariff measures on goods, trade facilitation and export restricting measures. The dataset contains 61 countries and regional aggregates and 57 commodities.

The model is firmly rooted in microeconomic theory, with firms maximising profits and creating output from primary inputs (i.e. land, natural resources, labour and capital), which are combined using constant elasticity of substitution (CES) technology, and intermediate inputs in fixed shares (Leontief technology). Households are assumed to maximise utility subject to a Stone-Geary utility function, which allows for the inclusion of a subsistence level of consumption. All commodity and activity taxes are expressed as ad valorem tax rates, and taxes are the only income source to the government. In this study, the government is assumed to maintain an internal balance by adjusting its expenditure. At the same time, the trade balance is variable, and the nominal exchange rate is fixed in the simulations. Wages are assumed downwardly rigid, but remuneration rates of all other factors (land, capital, natural resources) are assumed to adjust. The model does not allow for possible change in macroeconomic policies or financial markets; these channels are considered in the analysis using NiGEM.

1.5.2. The NiGEM model

The NiGEM model is a global macro-econometric model.¹⁶ It includes separate models of most advanced economies and key emerging market economies using a common theoretical structure estimated separately for each country (NIESR, 2017). Other countries are aggregated and modelled using regional aggregates. The model is based around a ‘New-Keynesian’ framework with the long-run properties of the equations imposed so as to be consistent with theory. Responses to shocks are demand driven in the short-term, but determined by the supply side of the economy in the long-term, with spillovers between economies determined by trade volumes and prices, asset prices, commodity prices and competitiveness. Different dynamic adjustment patterns and parameter values for each country and region are based on estimates from historical data. Importantly for this analysis, NiGEM has separate country models of Ireland and the United Kingdom. The model contains forward looking financial markets and liquidity constraints, with myopic behaviour and nominal rigidities slowing the full adjustment to shocks (NIESR, 2017). Both fiscal and monetary policy are endogenous in all the major economies.

16. For an overview see NIESR (2017).

1.6. Results

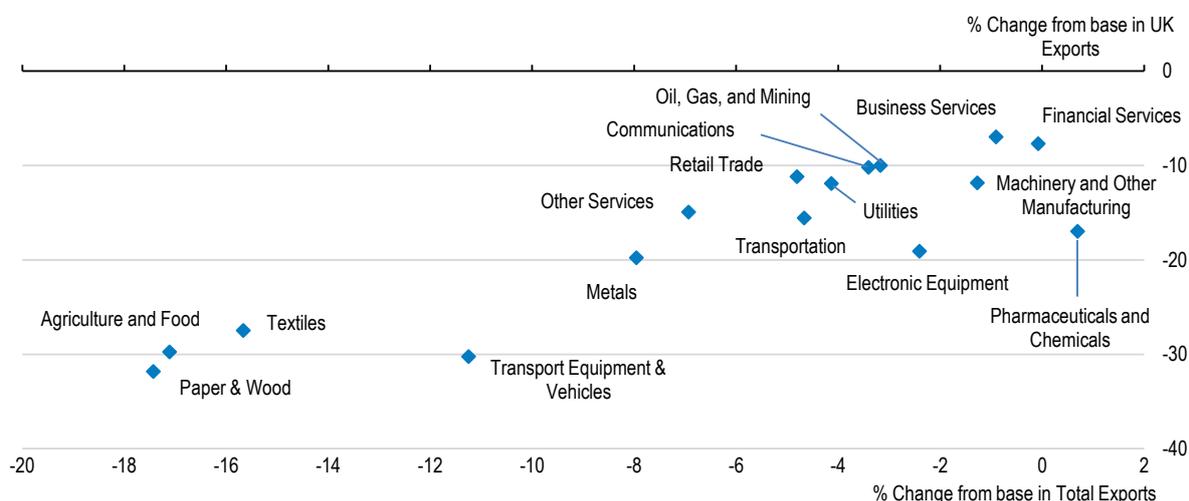
1.6.1. METRO trade and sectoral results

This section first presents the sectoral level and overall impact on Irish trade from the United Kingdom exit shock from the METRO model.

The Irish agriculture and food and smaller manufacturing sectors suffer the biggest export losses

The Brexit as modelled in METRO would decrease total Irish exports by 2.1%¹⁷. This is concentrated in the United Kingdom market, where Irish exports decrease by 18.7% as a result of the imposition of the WTO tariff schedule and a rise in NTM's. The increasing trade restrictions also apply to Irish imports and Irish import prices rise by 0.5%.

Figure 8. Per cent change from base of UK and total exports of the sectors of the Irish economy



Note: The vertical axis corresponds to the percentage change from the baseline in Irish exports to the UK. The sectoral aggregation corresponds to that used for the tariff schedule with the exception of Wood Products being grouped with paper instead of agriculture and food. This aggregation is shown in Appendix Table A1.7.

Source: OECD METRO Simulation.

There is considerable variation in the degree to which sector is affected, both in terms of total exports and bilateral exports to the United Kingdom. In line with the qualitative results in Department of Finance (2016a), goods sectors are more affected than services sectors, with the largest losses in the agriculture and food and smaller manufacturing sectors (Figure 8).¹⁸ Total agriculture and food exports fall by around 17% from the baseline, and exports decline by over 15% in the three smaller manufacturing sectors of textiles, paper & wood and transport equipment and vehicles. These sectors have a high proportion of

17. Relative to the base, under an assumption of fixed exchange rates.

18. For detailed results and the composition of the sectors used see Appendix A. Smaller manufacturing sectors refer to paper and wood, textiles, transport equipment and vehicles, electronic equipment and metals. These sectors share of turnover and employment in Ireland is small compared to the large pharmaceutical and chemical and agriculture and food sectors (Department of Finance 2016a).

their total exports going to the United Kingdom and, as outlined in Lawless and Morgenroth (2016), they face relatively high tariffs on their products under a WTO MFN-rate shock.

Another factor that influences the outcome for total exports is the extent of market diversion, which is captured in METRO. This can be seen in part in the difference between the respective reactions of the agriculture and food sector and the pharmaceuticals and chemicals sector. These two sectors account for the largest shares of Ireland's goods exports to the United Kingdom, at over 25% each (Department of Finance, 2016a).¹⁹ In METRO, both sectors experience a decline in exports to the United Kingdom, but the total exports of the pharmaceuticals and chemicals sector increase, driven by demand changes in the rest of the world. Total exports of agriculture and food on the other hand decline. This divergent result is in part due to demand changes in third markets that compensate for the decline in exports to the United Kingdom in the pharmaceuticals and chemicals sector. Thus the pharmaceuticals and chemicals sector is helped by a more globally diversified export portfolio with less dependence on the UK (Department of Finance, 2016a), this cushions against weakened demand from the United Kingdom. The presence to the third market channel is an advantage of using the detailed METRO CGE model in this paper and is an effect not widely captured in the literature.

In the analysis here, the financial services sector is composed of two sub-sectors: financial services and insurance. Although the sector's overall exports decline slightly, exports of the financial services sub-component increase by 1.6% under the WTO tariff and NTM shock, helped by an increase of 6% in exports to the EU 26. This comes from the market diversion effect where Irish financial services exports increase to meet demand.

Comparing these results to some of those in the literature, the 30% fall in exports to the United Kingdom of the Irish agriculture and food sector is substantially below the 71% estimated in Bellora et al., (2017) and the 87% in Copenhagen Economics (2018). The fall in overall exports for Ireland is also lower than that estimated in Bergin et al., (2017). The estimates in Bergin et al., (2017) rely on estimates from Ebell and Warren (2016) of the trade effects for the United Kingdom and relate them to trade impacts on Ireland. In that study, UK exports and imports fall by between 21% and 30% in the long-run optimistic and pessimistic scenarios respectively.

Some of the differences between the estimates in this report and other studies thus emerge from the trade channel and use of the METRO model, which allows a complex and singular event without historical precedent, such as the United Kingdom exit, to be analysed by the way of 'what-if' simulations. The calibration of the METRO model also accounts for some of the difference in the results from those of Bellora et al., (2017) and Bergin et al., (2017), who assume a substantially higher level of NTMs. One reason for the lower level in METRO is because it is unlikely that the full benefit of past reduction in trade costs related to NTMs over a long period of integration and regulatory convergence will be lost immediately following UK exit from the EU, even in the event of a WTO MFN-rate shock. In the short run, costs related to conformity assessment and demonstration of compliance are likely to play a role for UK-EU trade, while the two other categories identified in OECD (2017c) can be expected to become more important over time: costs related to gathering information on regulatory requirements and, perhaps most importantly, costs of adjusting the production of goods and services to comply with different regulatory requirements. The modelling of market diversion in METRO may also account for some differences; in

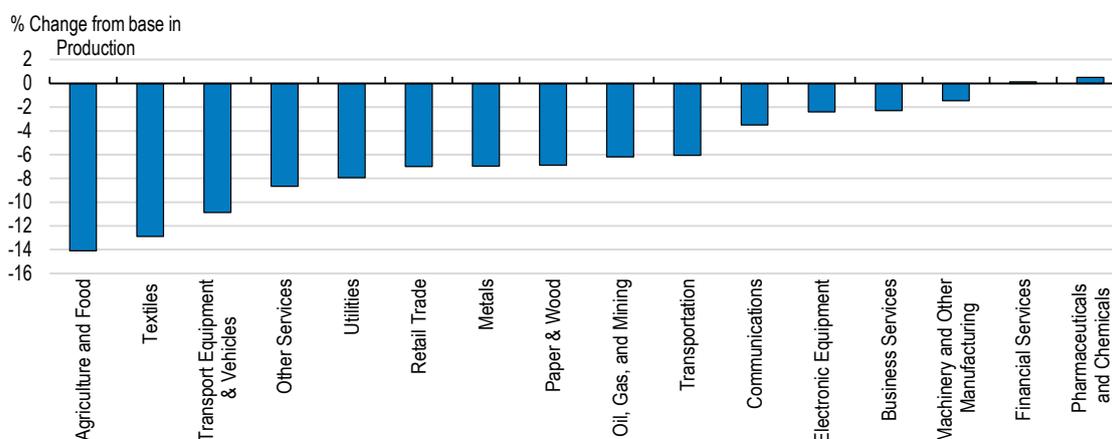
19. While these sectors are not defined identically between this paper and Department of Finance, (2016a) they are broadly similar.

Copenhagen Economics (2018) there is a substantial fall in output in the pharmaceutical sector, in METRO there is no such contraction.

Barriers to trade imposed by Brexit have significant implications for production in Ireland

In terms of production, the agriculture and food sector experiences the largest decline, with output falling by 14% (Figure 9). The smaller manufacturing sectors of textiles and transport equipment and vehicles experience a decline of more than 10%.²⁰ These output reductions suggest there could be sizeable effects on employment in these sectors.

Figure 9. Per cent change from base in production of sectors of the Irish economy



Note: The sectoral aggregation corresponds to that used for the tariff schedule with the exception of Wood Products being grouped with paper instead of agriculture and food.

Source: OECD METRO simulation.

The modelled decline in production by the agriculture and food and smaller manufacturing sectors would impact regional and rural economies in Ireland

The effects on production are consistent with the qualitative and numerical findings of Department of Finance, (2016a), Lawless and Morgenroth (2016) and Barrett et al., (2015). In these papers, the agriculture and food and smaller manufacturing sectors tend to have their employment concentrated in more regional and rural labour markets such as the Midlands and Border region of Ireland (Department of Finance, 2016a). Unsurprisingly, the agriculture and food sector, for example, has almost 80 per cent of its employment located outside of Dublin. Other sectors strongly exposed to the United Kingdom market via exports, such as traditional manufacturing, materials manufacturing and electrical equipment, have 69-91% of their employment outside of Dublin. On a comparative basis, the Border region, the region of Ireland that has experienced the slowest post-financial crisis labour market recovery, has the highest share of employment in UK exposed goods sectors (Department of Finance, 2016a). As well as being important for regional and rural employment in Ireland, these sectors have characteristics that make them vulnerable to economic shocks; they tend to have a higher concentration of small and medium sized

20. This is a pure trade policy shock within the model, full macroeconomic impacts are modelled in NiGEM.

enterprises, a higher proportion of domestic ownership and operate with comparatively low profit margins (Barrett et al., 2015, Department of Finance, 2016a).

Ireland's participation in global value chains would be reduced as a result of Brexit

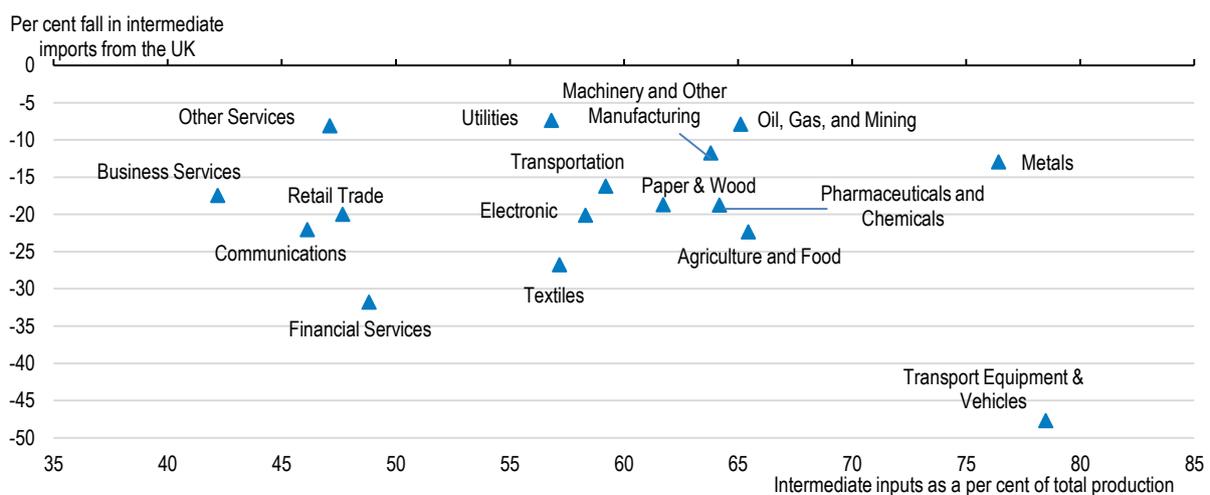
Production in the global economy is increasingly fragmented across borders, with more firm's being part of complex production networks that involve goods and services inputs from domestic and foreign firms (Dicken, 2014). Individual countries integration in the global economy is closely linked to their participation in global value chains (GVC's). Importantly, participation in GVC's allows higher levels of specialisation, productivity growth and thus job creation (OECD 2017).

An important feature of the globalised Irish economy is that many sectors source a substantial amount of their inputs from abroad (Barrett et al., 2015, Department of Finance, 2016a). This input sourcing backward linkage can be used as an indication of how the WTO scenario affects the production networks of the sectors of the Irish economy.

There is considerable variation in the degree to which different sectors use intermediate inputs in their production (Figure 10). Of the total value of production in the Irish transport equipment and vehicles sector 78% is accounted for by intermediate inputs with the remainder being domestic value added. This is the highest percentage of any sector the lowest is in the business services sector at 42%.

In the WTO scenario with restricted access to the UK market the sourcing of intermediate inputs from the UK falls. The largest fall in intermediate imports from the UK is estimated to be in the Irish transport equipment and vehicles sector with a 48% reduction. The second largest fall in imports is in financial and insurance sector at 47%. Overall all sectors would see a reduction in their intermediate imports from the UK, with the average reduction being 19%. This is an indication that in the scenario the connection of the sectors of the Irish economy to supply chains is disrupted. The overall effect is an increase in intermediate input costs in Ireland.

Figure 10. Intermediate inputs: Per cent of production and per cent change in UK imports



Note: The sectoral aggregation corresponds to that used for the tariff schedule with the exception of wood products being grouped with paper instead of agriculture and food.

Source: OECD METRO Simulation.

Brexit may also impact labour demand and the distribution of income within Ireland

Consistent with the pattern of sectoral export impacts, the largest declines in factor incomes are observed for land and natural resources. The fall in the value of agricultural land comes from the decline in the agriculture and food sector. Incomes of all types of labour also decline. Given the assumption of downwardly rigid wages in the model, changes in factor income for workers are reflective of changes in employment.

Changes in labour demand across sectors are driven by production changes which respond both directly to the trade barriers imposed under the shock as well as indirectly due to subsequent declines in consumer demand. In percentage point terms, the declines in labour demand in the agricultural and manufacturing sectors are particularly significant.²¹ However, services sectors experience greater absolute changes in the number of workers as these tend to be more labour-intensive. Of the manufacturing sectors, the largest declines in absolute labour demand are for the food processing sector, the chemical, rubber and plastics sector and the machinery and equipment sector.

Examining the impacts on labour demand by skill level, the results may suggest some narrowing in income inequality: demand for some categories of high skill workers (e.g. technical and assistant professionals, office managers and professionals) contracts more sharply than for low skilled workers (e.g. service and shop assistances, agricultural and other low skilled workers; Table 2). Nevertheless, the shock also results in firms substituting away from labour towards capital, as they respond to shifts in relative prices. This causes the fall in capital income to be relatively muted. To the extent that such income ultimately derives to relatively high wealth individuals, this would have a countervailing effect on any decline in income inequality.

Table 2. Percentage change in factor income as a result of the illustrative Brexit shock

	Land	Technical and Assistant Professionals	Office managers and Professionals	Clerks	Service and shop assistants	Agricultural and other low skilled workers	Capital
Ireland	-47.0	-7.8	-8.2	-4.7	-6.4	-6.2	-2.7
EU (exc. Ireland)	-3.4	-1.1	-1.2	-0.7	-0.9	-0.8	-0.4

Source: OECD METRO model.

1.6.2. NiGEM Results for the two key channels: trade and FDI.

The trade reduction, sterling depreciation and rise in uncertainty from Brexit have a strong negative impact on the Irish Economy

The NiGEM analysis is built up by combining a number of separate findings, drawing on both the METRO results, as previously detailed, and the separate medium and longer-term analysis in Kierzenkowski et al (2016).

- For the medium-term, the changes in export volumes and import prices from the METRO model (using the fixed exchange rate shocks on METRO outlined above) are combined with additional effects from changes in UK export volumes and Irish

21. See tables A1.7 - A1.8 in the Appendix.

import prices from the 4% depreciation of sterling vis-à-vis the euro on NiGEM (to be consistent with the medium-term assumption in Kierzenkowski et al., 2016). As a result of the additional exchange rate shock, Irish export volumes of goods plus services now fall by 2.5% (instead of 2.1% in the fixed exchange rate simulation on METRO) and import prices now only rise by 0.2%.

- For the longer-term, a larger decline in Irish exports is imposed in NiGEM. The increased shock to exports reflects the differences between the medium-term scenario in Kierzenkowski et al. (2016), where UK trade declines by 8-9%, and the longer-run analysis in which UK trade openness declines by between 10-20% (based on separate gravity model estimates). Overall, a decline of 4% in Irish exports and trade openness is imposed. As discussed above, this change is assumed to be reflected in a longer-term decline in TFP (via lower labour-augmenting technical progress), which falls by 1.2% after a decade.

NiGEM is run in forward mode given that the supply shocks are ones that can eventually be anticipated by firms and households.²² The default fiscal rule of an unchanged budget target is assumed in all countries, so that the government reacts to any negative shock by adjusting tax rates on households to return to its baseline budget balance to GDP ratio. Monetary policy is endogenous in all economies with an independent monetary authority. The shocks considered have a small adverse effect on the wider euro area, resulting in a slight easing of the area-wide policy interest rate relative to baseline. The model is run with exports exogenous. Financial asset prices are endogenous, including the exchange rate. As noted above, all simulations include a 4% depreciation of sterling relative to the euro, consistent with the medium-term response assumed in Kierzenkowski et al (2016).

Higher uncertainty, including about the longer-term fiscal outlook in Ireland, is assumed to be reflected in a higher sovereign risk premium. The risk premium is calibrated as a 50 basis point increase in the medium-term and a 25 basis point increase in the longer-term, both relative to baseline. The implicit assumption behind the downward shift in the risk premium is that policy uncertainty declines as negotiations between the EU and the United Kingdom progress. However, the risk premium does not decline completely, owing to the long-term decline in Irish GDP. Such an assumption is consistent with the approach taken in Kierzenkowski et al (2016). In the simulation, the increase in the sovereign risk premium is reflected directly in long-term interest rates in Ireland and the user cost of capital. The government debt-to-GDP ratio increases even with the assumption of an unchanged budget deficit to GDP objective, consistent with the persistent elevation of the sovereign risk premium.

The reduction in export demand has a direct negative impact on activity, and in the longer-term the reduction in TFP associated with lower openness has adverse supply-side effects. Both these changes are deflationary, pushing down the consumer price level and raising the real interest rate, as Ireland does not have an independent monetary policy.²³ Combined, they have a significant adverse effect on business investment, with the capital stock declining by 3.9% in the longer-term (Table 3). Nominal wages also decline, hitting household consumption, reflecting the lower price level and the need for an adjustment in

22. NiGEM model allows forward-looking expectations in wages, consumption, exchange rates, bond and equity prices and in monetary policy making (NIESR 2017).

23. Some of the export fall may be offset by an increase in competitiveness not captured in NiGEM as exports are exogenous. However, some of this price change/competitiveness impact is captured in METRO and thus through the trade calibration in NiGEM.

real wages in order for displaced workers to regain employment. Some offset to the decline in domestic demand and export volumes is provided by a sharp fall in import volumes, reflecting weaker demand as well as an increase in the relative price of imported goods and services.²⁴ The overall effect on the economy from these channels is a 1.5% and 2.4% reduction in GDP over the two time horizons.²⁵

Nevertheless, it should be highlighted that the GDP effects are sensitive to the choice of model and assumptions employed in the scenarios. The macroeconomic specifications of METRO that were selected for aligning the two models, METRO and NiGEM, such as the assumption of fixed exchange rates and a flexible trade balance, as well as other specifications such as the level of trade elasticities, and finally the specification the shock itself (which differ between the two modelling approaches) influence the model reaction. While the financial macroeconomic channels are not as well specified in the METRO model, it estimates a larger decline in output for the observed trade shock than estimated with NiGEM – around a 4½ per cent decline in real GDP.²⁶ Furthermore, using the Core Structural Model of the Irish economy (COSMO), previous work by Ireland’s Economic and Social Research Institute and Department of Finance find that the imposition of a UK WTO MFN trade restrictions scenario on Ireland with different assumptions taken in relation to NTMs (than those assumed in METRO) would result in a 3.8% decline in real GDP (Bergin, et al., 2017).

Table 3. Impact on Ireland after 5 and 10 years from the imposition of barriers to trade and a new external environment

	Medium-Term	Long-Term
	5 Years	10 Years
GDP level (%)	-1.5	-2.4
Import volumes level (%)	-3.5	-4.7
Export volumes level (%)	-2.5	-4.0
Import price level (%)	-0.2	-0.3
Export price level (%)	-0.4	-0.5
Nominal wage level (%)	-1.5	-3.3
Consumer price index level (%)	-0.5	-0.4
Business capital stock level (%)	-2.6	-3.9
Domestic demand level (%)	-2.4	-3.0

Source: NiGEM.

24. Over the medium and long-term import prices adjust down towards the lower domestic price level.

25. Nevertheless, it should be highlighted that the GDP effects are sensitive to the choice of model and the quantification of NTM’s. While the macroeconomic channels are not as well specified in the METRO model, it estimates a larger decline in output for the observed trade shock – around a 4½ per cent decline in real GDP. Furthermore, using the Core Structural Model of the Irish economy (COSMO), previous work by Ireland’s Economic and Social Research Institute and Department of Finance find that the imposition of a UK WTO MFN trade restrictions scenario on Ireland with different assumptions taken in relation to NTMs (than those assumed in METRO) would result in a 3.8% decline in real GDP (Bergin, et al., 2017).

26. This GDP outcome can vary by 0.05% to 0.3% depending on the closure specified.

The benefits from an increase in FDI are modest

An increase in the stock of FDI in Ireland is assumed to increase productivity through an increase in research and development and managerial quality, as discussed previously. By itself, such an increase in TFP induces an increase above baseline in business investment and consequently the business capital stock. Potential output rises above baseline by 0.1% over the 5 and 10 year horizons as a result of these changes (Table 4). The impact on GDP from the FDI channel is relatively modest, a rise of 0.1% above baseline after 10 years. This is as a result of the relatively modest increase in FDI expected in the scenario.

Table 4. Impact after 5 and 10 years from FDI relocation to Ireland

	Medium-Term	Long-Term
	5 Years	10 Years
GDP level (%)	0.0	0.1
Labour augmenting technical progress (%)	0.1	0.1
Potential output level (%)	0.1	0.1
Business investment level (%)	0.1	0.2
Business capital stock level (%)	0.0	0.1

Source: NIGEM.

The overall reduction in GDP from trade is not offset by the increase in FDI

When combining both shocks, the magnitude of the effects from the FDI channel is small relative to the negative impact from trade and uncertainty and does not mitigate the decline in GDP. In this combined shock with both the trade and FDI channel combined Irish GDP falls by 2.3% in the long term (Table 5).

Table 5. Impact after 5 and 10 years from the two channels combined

	Medium-Term	Long-Term
	5 Years	10 Years
GDP level (%)	-1.5	-2.3
Import volumes level (%)	-3.5	-4.7
Export volumes level (%)	-2.5	-4.0
Nominal wage level (%)	-1.6	-3.3
Govt. debt in % GDP (% pts)	1.5	1.8
Consumer price index level (%)	-0.6	-0.5

Source: NIGEM.

1.7. Conclusion

As a small open economy with strong links to the United Kingdom, Ireland is very exposed to any increase in barriers to trade between the United Kingdom and EU. This paper considers an illustrative shock in which trade relations between the EU and the United Kingdom default to operating along WTO MFN rules. There are a number of channels

through which this change could be transmitted to the Irish economy. The focus of this paper is on trade (along with associated impacts on uncertainty) and FDI, combining the strengths of an extensive and detailed trade model and a global macro-econometric model.

In the first stage of the analysis simulations from METRO, the trade model, show a sharp reduction of 19% in Irish exports to the United Kingdom from the pure trade policy changes. Considerable variation is seen in the impact across the different sectors of the Irish economy. The agriculture and food and smaller manufacturing sectors are the most severely affected. Exports from the agriculture and food sector fall by 30%, and those of the smaller manufacturing sectors fall by over 27%. These sectors are particularly negatively affected due to the concentration of their exports into the United Kingdom market and the comparatively high tariffs their products would face under a WTO schedule. Not all sectors are negatively impacted, with financial services experiencing a slight increase in total exports of 1.6% due to an increase in exports to the rest of the EU.

As a small and very open economy, Ireland is connected to globalised production networks. It is estimated that the imposition of WTO tariffs and the rise in trade costs from NTM's disrupt the sourcing of intermediate inputs from the UK across all sectors of the Irish economy. The increases the overall cost of intermediate inputs used in Ireland.

The trade model used also shows how the fall in export demand could affect production in different sectors. The highly UK-exposed agriculture and food sector sees a 14% fall in output, and smaller manufacturing sectors see declines of more than 10%. Employment in these sectors is concentrated in rural and regional labour markets, making them likely to be more vulnerable to an economic shock. The size of the export and production fall estimated for these sectors suggests that a UK exit might have strong regional consequences in Ireland if trade was subsequently undertaken on a MFN basis.

In the second stage of the analysis from the macroeconomic model, NiGEM, the effect of the trade reduction from METRO, along with the additional impacts from a sterling depreciation and a rise in uncertainty, is estimated to result in a reduction in the level of GDP, exports and nominal wages per employee by 2.4%, 4% and 3.3% respectively after 10 years.

The boost to the Irish economy from additional FDI is estimated to be only modest with a 0.1% increase in GDP after 10 years. Thus, in the overall shock combining the trade and FDI impact Irish GDP falls by 2.3% in the long term.

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APPENDIX A

Simulation details

Table A1.1 Ad valorem tariff rates applied to goods trade between UK and EU (including Ireland) post BREXIT

Sector Coverage	tariff rates
Agriculture and Processed Food	5.13
Oil, Gas, and Mining	2.09
Textiles and Wearing Apparel	8.00
Paper Products	0.05
Chemical Rubbers and Plastics	3.18
Metals	1.42
Motor Vehicles and Transportation	4.44
Electronics	0.94
Machinery, Equipment, and Other Manufacturing	1.55

Source: Author's calculation based on the WITS-IDB database.

Table A1.2 The mark-up applied to the EU tariff rate in order to calculate the United Kingdom's tariff rate on imports post-UK exit.*

Sector Coverage	can	che	chn	ind	jpn	kor	latam	nor	usa	row
Agriculture and Processed Food	1.02	31.61	1.08	2.06	1.06	13.75	2.37	3.53	1.07	3.40
Oil, Gas, and Mining	2.02		1.01	2.11	1.08	396	2.25		1.87	2.60
Textiles and Wearing Apparel	1.00		1.00	1.32	1.00	161	2.11		1.04	5.71
Paper Products	1.00		1.00	2.00	1.00		1.00		1.00	1.00
Chemical Rubbers and Plastics	1.00		1.00	1.33	1.01	13.21	1.71		1.14	1.82
Metals	1.31		1.00	11.73	1.00	110	2.00		1.00	3.00
Motor Vehicles and Transportation	1.00		1.01	1.06	1.00	4.24	5.36		1.00	5.28
Electronics	1.00		1.09	6.00	1.10	9.17			1.09	3.53
Machinery, Equipment, and Other Manufacturing	1.00		1.00	39.00	1.00	51.67	1.98		1.00	2.62

*Used to calculate the United Kingdom's post-BREXIT tariff rate.

Source: Author's calculation based on the WITS-IDB database. Based on tariff rates for the EU28. The EU applies tariffs only on agriculture and food imports from Switzerland and Norway.

Table A1.3 The mark-up multiplied by each countries ad valorem tariff rate, giving the new tariff rate UK exporters could face post-UK exit.*

Sector Coverage	can	chn	ind	jpn	kor	latam	nor	usa	row
Agriculture and Processed Food	1.15	1.18	1.14	1.22	1.42	3.57	1.00	1.00	4.95
Oil, Gas, and Mining	17.91	1.12	7.56	1.08	4.36	6.16		3.36	4.72
Textiles and Wearing Apparel	1.67	1.67	3.38	1.02	2.07	3.33		1.00	5.42
Paper Products	1.00	1.32	6.45	1.00		6.38		1.00	4.89
Chemical Rubbers and Plastics	2.81	1.26	4.62	1.00	1.00	4.61		1.09	5.01
Metals	7.78	4.19	5.53	1.07	1.70	5.72		1.00	1.00
Motor Vehicles and Transportation	1.03	1.23	1.25	1.00	1.10	2.07		1.00	3.76
Electronics	2.93	1.07	1.44	1.00	1.05	9.36		1.00	4.96
Machinery, Equipment, and Other Manufacturing	6.34	1.37	4.05	1.19	1.36	5.40		1.00	4.84

*Used to calculate the tariff rate applied to imports from the United Kingdom post-BREXIT.

Source: Author's calculation based on the WITS-IDB database.

Notes: Switzerland (CHE) is not included in the table because Switzerland applies only specific tariffs. Norway (NOR) applies ad valorem tariffs on the agriculture and processed food sector.

Table A1.4 Per cent increase in non-tariff measures on services, by product

Service sector	IRL to GBR	EU to GBR
Construction	1.87	6.09
Trade	1.63	2.77
Transport nec	9.09	6.29
Sea transport	21.32	11.42
Air transport	9.09	6.29
Communication	7.83	17.93
Financial services nec	4.05	8.27
Insurance	0.52	0.58
Business services nec	1.16	8.04
PubAdmin Defence Health Educat	8.57	21.00

Source: author's calculation based on Fontagné, L., C. Mitaritonna and J. Signoret (2016), "Estimated Tariff Equivalents of Services NTMs", CEPII Working Paper, No. 2016-20, August; and Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G. J. (2015), "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production", *Review of International Economics*, 23: 575–605.

Table A1.5 Per cent Increase in Non-Tariff Measures on Goods between UK and EU (including Ireland)

Sector Coverage	UK and EU/IRL
Agriculture and Processed Food	15.05
Oil, Gas, and Mining	0.00
Textiles and Wearing Apparel	0.80
Paper Products	8.54
Chemical Rubbers and Plastics	4.28
Metals	1.86
Motor Vehicles and Transportation	8.54
Electronics	4.35
Machinery, Equipment, and Other Manufacturing	0.80

Source: OECD (2011)

Table A1.6 Changes in Ireland gross exports by product and destination with a WTO MFN-rate schedule

	% change from base				value at base			
	Total	Destination			Total	Destination		
		UK	EU26	USA		UK	EU26	USA
Agriculture	-19.7	-32.5	-6.4	-4.2	1,675	891	478	53
Food	-16.8	-29.3	-10.3	-5.9	14,193	5,063	4,841	865
Natural resources	0.0	-6.6	-0.7	0.3	650	65	399	1
Textiles	-13.4	-27.0	-8.9	-2.4	553	167	301	36
Wearing apparel	-17.8	-27.3	-14.1	0.0	336	111	209	5
Leather products	-18.6	-28.9	-12.2	0.1	182	77	91	5
Wood products	-31.1	-40.4	-8.7	0.1	533	388	99	9
Paper products publishing	-7.2	-19.5	0.6	0.5	713	269	186	51
Petroleum, coal products	-5.3	-9.6	-0.6	0.0	365	193	88	15
Chemical rubber plastic prods	0.7	-17.0	2.5	2.0	88,727	7,385	35,492	30,845
Mineral products nec	-7.1	-11.8	-2.6	0.0	326	172	91	15
Ferrous metals	-6.3	-16.7	-1.3	0.1	445	154	204	3
Metals nec	-5.5	-21.7	2.0	0.0	731	225	287	7
Metal products	-10.5	-19.9	-5.6	-4.8	990	363	432	72
Motor vehicles and parts	-8.7	-18.5	-0.8	0.1	389	176	137	10
Transport equipment nec	-12.5	-42.2	-5.6	-9.6	790	173	308	57
Electronic equipment	-2.4	-19.1	-0.3	0.0	12,677	1,363	6,914	152
Machinery and equipment nec	-1.1	-11.9	-0.1	0.1	19,370	1,889	6,844	5,849
Manufactures nec	-4.7	-11.7	-1.8	-1.2	927	288	396	117
Electricity	-2.9	-11.1	-0.6	-3.0	37	5	10	4
Gas manufacture distribution	-0.4	0.0	-0.8	0.0	0	0	0	0
Water	-5.7	-12.6	-4.8	-3.8	29	6	7	7
Construction	-5.1	-12.8	-1.4	-7.2	134	10	23	12
Trade	-4.8	-11.2	-5.2	-5.0	12,259	412	3,728	396
Transport nec	-5.5	-17.8	-3.3	-2.8	2,222	397	532	499
Sea transport	-0.7	-27.1	0.3	0.0	1,211	38	70	16
Air transport	-5.2	-14.8	-1.0	-0.2	5,466	1,684	1,553	585
Communication	-3.4	-10.2	-0.1	-2.1	1,110	280	361	179
Financial services nec	1.6	-8.2	6.5	-1.0	8,615	1,171	3,979	1,394
Insurance	-0.8	-6.4	-0.7	-0.6	19,890	452	4,846	9,037
Business services nec	-0.9	-7.0	-0.2	-0.8	46,939	1,643	21,105	879
Recreation and other services	-5.9	-10.4	-5.1	-5.0	789	151	209	185
PubAdmin Defence Health Educat	-7.8	-17.4	-4.9	-5.1	1,218	292	276	276
Dwellings	-	-	-	-	-	-	-	-
Total	-2.1	-18.7	0.1	0.8	244,491	25,951	94,494	51,637

Source: OECD Metro Model.

Table A1.7 Per cent change in factor demand in Ireland by sector

	Technical and Assistant Professional s	Clerks	Service and shop assistant s	Office managers and Professional s	Agricultura l and other low skilled workers	Capital	Natural Resource s
Agriculture	-15.7	-14.1	-14.1	-15.7	-14.1	-10.3	-5.2
Food	-17.2	-14.6	-14.6	-17.2	-14.6	-11.8	0.0
Natural resources	-4.6	-1.3	-1.3	-4.6	-1.3	1.6	6.8
Textiles	-12.0	-10.3	-10.3	-12.0	-10.3	-6.4	0.0
Wearing apparel	-15.8	-15.2	-15.2	-15.8	-15.2	-10.4	0.0
Leather products	-19.1	-16.9	-16.9	-19.1	-16.9	-13.9	0.0
Wood products	-19.3	-18.6	-18.6	-19.3	-18.6	-14.0	0.0
Paper products publishing	-9.0	-5.9	-5.9	-9.0	-5.9	-3.1	0.0
Petroleum, coal products	-12.2	-10.0	-10.0	-12.2	-10.0	-6.6	0.0
Chemical rubber plastic prods	-4.2	-0.9	-0.9	-4.2	-0.9	2.0	0.0
Mineral products nec	-9.4	-8.5	-8.5	-9.4	-8.5	-3.6	0.0
Ferrous metals	-5.8	-5.6	-5.6	-5.8	-5.6	0.3	0.0
Metals nec	-6.4	-5.6	-5.6	-6.4	-5.6	-0.3	0.0
Metal products	-9.0	-8.3	-8.3	-9.0	-8.3	-3.1	0.0
Motor vehicles and parts	-9.2	-8.6	-8.6	-9.2	-8.6	-3.3	0.0
Transport equipment nec	-13.3	-12.8	-12.8	-13.3	-12.8	-7.7	0.0
Electronic equipment	-6.1	-3.3	-3.3	-6.1	-3.3	-0.1	0.0
Machinery and equipment nec	-4.5	-2.1	-2.1	-4.5	-2.1	1.6	0.0
Manufactures nec	-8.1	-5.5	-5.5	-8.1	-5.5	-2.1	0.0
Electricity	-12.1	-9.4	-9.4	-12.1	-9.4	-6.4	0.0
Gas manufacture distribution	-13.4	-10.8	-10.8	-13.4	-10.8	-7.8	0.0
Water	-10.4	-8.8	-8.8	-10.4	-8.8	-4.6	0.0
Construction	-11.2	-9.5	-9.5	-11.2	-9.5	-5.4	0.0
Trade	-9.2	-7.6	-7.6	-9.2	-7.6	-3.4	0.0
Transport nec	-9.2	-8.1	-8.1	-9.2	-8.1	-3.4	0.0
Sea transport	-2.3	-1.9	-1.9	-2.3	-1.9	4.0	0.0
Air transport	-9.0	-7.1	-7.1	-9.0	-7.1	-3.1	0.0
Communication	-6.2	-4.3	-4.3	-6.2	-4.3	-0.2	0.0
Financial services nec	-2.3	0.4	0.4	-2.3	0.4	4.0	0.0
Insurance	-4.1	-1.8	-1.8	-4.1	-1.8	2.1	0.0
Business services nec	-6.0	-3.4	-3.4	-6.0	-3.4	0.1	0.0
Recreation and other services	-11.9	-9.1	-9.1	-11.9	-9.1	-6.2	0.0
PubAdmin Defence Health Educat	-9.8	-9.0	-9.0	-9.8	-9.0	-4.0	0.0
Dwellings	-13.8	-11.7	-11.7	-13.8	-11.7	-8.2	0.0

Source: OECD METRO Model.

Table A1.8 Factor demand quantities in Ireland by sector (millions)

	Land	Technical and Assistant Professionals	Clerks	Service and shop assistants	Office managers and Professionals	Agricultural and other low skilled workers	Capital	Natural Resources
Agriculture	881.2	0.5	1.2	0.7	110.9	10.1	995.2	151.4
Food		4.9	6.2	1.8	15.5	16.3	2484.3	
Natural resources		2.4	1.1	0.3	1.2	3.8	191.4	114.6
Textiles		0.3	0.3	0.1	0.9	0.9	94.7	
Wearing apparel		0.2	0.3	0.1	0.7	0.7	12.7	
Leather products		0.1	0.1	0.0	0.2	0.2	44.0	
Wood products		0.3	0.4	0.1	1.1	1.2	29.5	
Paper products publishing		0.4	0.5	0.2	1.4	1.4	2086.9	
Petroleum, coal products		0.0	0.1	0.0	0.1	0.1	70.0	
Chemical rubber plastic prods		7.0	9.0	2.6	22.4	23.5	39739.5	
Mineral products nec		0.4	0.5	0.2	1.4	1.4	60.9	
Ferrous metals		0.3	0.4	0.1	0.9	0.9	2.9	
Metals nec		0.1	0.2	0.0	0.4	0.4	7.5	
Metal products		1.1	1.4	0.4	3.5	3.7	75.0	
Motor vehicles and parts		0.2	0.3	0.1	0.7	0.8	12.4	
Transport equipment nec		0.3	0.3	0.1	0.8	0.8	18.5	
Electronic equipment		1.3	1.7	0.5	4.2	4.4	2536.2	
Machinery and equipment nec		5.5	7.0	2.0	17.6	18.5	5116.8	
Manufactures nec		0.8	1.0	0.3	2.4	2.5	490.6	
Electricity		1.1	1.8	1.8	3.0	3.4	1719.3	
Gas manufacture distribution		0.0	0.0	0.0	0.0	0.1	21.8	
Water		0.2	0.3	0.3	0.6	0.6	85.3	
Construction		5.0	10.1	2.2	30.9	201.3	744.9	
Trade		24.0	52.7	230.8	98.6	35.5	8819.5	
Transport nec		2.0	8.7	2.4	7.8	3.0	928.6	
Sea transport		0.2	1.1	0.3	1.0	0.4	21.5	
Air transport		1.4	6.1	1.7	5.4	2.1	1103.3	
Communication		3.7	16.1	4.4	14.4	5.5	1463.3	
Financial services nec		6.1	23.1	1.9	17.6	0.8	8906.1	
Insurance		6.7	25.3	2.0	19.3	0.9	3569.1	
Business services nec		21.5	38.9	17.9	109.7	8.2	28868.1	
Recreation and other services		1.0	0.9	7.2	2.8	34.0	1698.1	
Pub Admin								
Defence								
Health Educat		51.7	98.7	136.1	288.0	12.4	5367.7	
Dwellings		0.1	0.1	0.1	0.3	0.0	49.7	

Source: OECD Metro Model.

Table A1.9 Aggregation of sectors for the imposition of tariffs and NTM's

Agriculture and Processed Food	Agriculture
	Food
	Wood products
Oil, Gas, and Mining	Mineral products nec
	Natural resources
	Petroleum, coal products
Textiles and Wearing Apparel	Leather products
	Textiles
	Wearing apparel
Paper products	Paper products publishing
Chemical Rubbers and Plastics	Chemical rubber plastic prods
Metals	Ferrous metals
	Metal products
	Metals nec
Transportation equipment	Motor vehicles and parts
	Transport equipment nec
Electronic Equipment	Electronic equipment
Machinery, Equipment, and Other Manufacturing	Machinery and equipment nec
	Manufactures nec
Utilities	Electricity
	Gas manufacture distribution
	Water
Retail Trade	Trade
Motor vehicles and Transportation	Air transport
	Sea transport
	Transport nec
Communications	Communication
Financial Services	Financial services nec
	Insurance
Business Services	Business services nec
Other Services	Construction
	Dwellings
	PubAdmin Defence Health Educat
	Recreation and other services

APPENDIX B FDI Relocation

In assessing the potential degree of FDI relocation, the recent volatility of Irish FDI data must be considered. From the OECD's Foreign Direct Investment statistics, Ireland's share of the EU's net inward FDI stock increased from 5% in 2012 to 11% in 2015, with a 126% rise in the FDI stock over the period. By contrast, the net inward FDI stock of the United Kingdom, Germany and France all changed by less than 3% over the same period.²⁷ Due to this volatility, the three-year (2013-15) average and the single year 2015 data will be used in benchmarking FDI shares.

Several approaches are used to calibrate the potential FDI relocation to Ireland, drawing on Barrett et al. (2015), Lawless and Morgenroth (2016b) and Davies et al. (2016). In Lawless and Morgenroth (2016b), the fall in the stock of UK FDI is reallocated across the remaining 27 EU Member States. The shares for each EU country are given by their current share of the non-UK EU FDI stock, as this is taken as reflecting the country-specific factors determining the attractiveness for FDI. In Lawless and Morgenroth (2016b), the decline in the United Kingdom FDI stock over the long-term is given as 27%, which is approximately the middle of the range estimated in Fournier (2015).²⁸ Using these figures, Lawless and Morgenroth (2016b), estimate that the stock of Irish FDI will increase by 7.3% in the long-term.

Using the approach of Lawless and Morgenroth (2016b), that of reallocating the stock shares, and employing both the three-year average and the 2015 figures for the FDI stock data, Ireland's share of the non-UK EU FDI stock is 8.9% and 13.7% respectively. Reallocating the United Kingdom share with these figures yields an increase in the FDI stock in Ireland of 6.5% and 6.0% respectively in the long-term.

In calculating these figures, it is assumed that all of the 27% fall in the United Kingdom FDI stock transfers to elsewhere in the EU, and that all of the fall in the FDI stock is in sectors that are traded, and so could move to Ireland. As discussed in Barrett et al. (2015), UK FDI is diverse, and although financial services dominate, some flows are in sectors where it may not be viable to relocate, such as infrastructure or natural resource investment. Assuming that only 80% of FDI could relocate reduces the increase in Ireland's FDI stock from 6.0% to 4.8%. The assumption that all of the loss in the United Kingdom FDI stock will remain in the EU may also be a strong assumption. In a scenario with a 27% fall in UK FDI, with 80% traded, that only 90% remaining in the EU, using 2015 data, the rise in Ireland's FDI stock would be 4.3%.

An alternative approach incorporates the estimates of Davies et al. (2016), who employ a nested logit model to analyse the determinants of the location choice of 18,100 foreign affiliates established in EU countries over the period 2002-2013. The results suggest that Ireland and the United Kingdom are perceived as more similar locations for FDI than other groupings of European countries and that this perceived similarity is particularly high for

27. For a discussion on issues involved in international FDI statistics see Borga and Mehigan (2016)

28. This is taken from estimates in Hufbauer and Schott (2009) and Dhingra et al. (2016).

non-EU investors.²⁹ In addition, EU market potential is estimated to be highly significant and influential on the location decisions of non-EU FDI.³⁰ These results suggest the share reallocated to Ireland could be relatively high.

Assuming that for all FDI projects that there is a 40% fall in the United Kingdom EU market potential this reduces the location probability by 3.5%, assuming all this goes to Ireland yields an increase in the FDI stock of 7.5%, using 2015 data.³¹ Using the same calculation, but assuming that only 80% of UK FDI could move reduces this figure from 7.5% to 6.0%, further assuming that only 90% of the United Kingdom FDI drop remains in the EU reduces this again from 6.0% to 5.4%.

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29. This is indicated by the dissimilarity parameter from the nested logit model of utility maximizing location choice. This is a measure of the degree of independence in unobserved utility among the alternatives in a choice nest a nesting structure for the choices (i.e. Choices can be bundled into subsets) is used because in a utility maximizing location choice model an assumption must be made on the joint probability distribution of the unknown stochastic component of utility. Taking a standard assumption of independently and identically distributed error terms implies the strong assumption of the independence of irrelevant alternatives (iia), the relative probability of alternatives being chosen is independent of the composition of the choice set. This assumption is considered problematic in location choice analysis due to the range of possible location specific factors that are unobservable. The nesting structure provides a solution to this issue by allowing (iia) to hold within but not between nests. The dissimilarity parameter is constructed from a measure of the mutual correlation of the error terms for all alternatives within a nest. A low value of the dissimilarity parameter indicates a strong correlation among the unobserved components of alternatives in a nest and so a low degree of substitution between them.
30. EU market potential is measured as the sum of GDP in the host country and the inverse distance-weighted GDP of all location options in the EU other than the host country.
31. The fall in EU market potential in Barrett et al., (2015) is estimated to be 50%.