

Modelling the impact of Brexit using the E3ME macro-sectoral model¹

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Abstract: This paper estimates the economic impact of Brexit on the UK under a number of different types of exit. A series of scenarios is constructed to reflect alternative possible trading relationships with Europe, ranging from a ‘Norway’ scenario where the UK remains in the European Economic Area (EEA), to a ‘No Deal’ scenario, where the UK-EU trading relationship reverts to WTO rules. The modelling focuses on the impacts on trade, investment, migration/the labour market and prices, drawing implications for poor households. The analysis applies E3ME, a global macroeconomic model that captures bilateral trade relationships between the UK, each EU Member State and key global trading partners. Focussing on the largest impacts – in the ‘No Deal scenario’ – we find that the long run (by 2030) impacts are a 3% increase in the level of average consumer prices years, a £480 increase in the cost living for low-income households, a 1% reduction in the real wage of those employed in low-skilled occupations, a slight reduction in the employment rate, a 2% reduction in UK GDP, but a smaller (0.7%) reduction in GDP per capita because the population is lower due to assumed lower migration.

Keywords: Brexit; international trade; no deal.

1. Introduction

This paper estimates the economic impact of Brexit on the UK under a number of different types of exit. After a brief introduction to the macro-sectoral model used for the analysis, we review the issues involved in representing Brexit in economic modelling, the types of Brexit considered and how these are translated into modelling assumptions and then discuss the modelling results.

2. The suitability of the E3ME model for analysing Brexit impacts

E3ME includes a series of econometric equations to estimate the behaviour of households and businesses in response to an economic shock and applies an input-output framework to model industry interdependencies.

¹ This paper draws on modelling work carried out in projects for the Joseph Rowntree Foundation and the Greater London Authority. The authors alone are responsible for its contents.

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The key features that distinguish the E3ME³ model are:

- its global geographical coverage, capturing bilateral trade relationships, while still allowing analysis at a national level for the UK⁴
- its detailed sectoral disaggregation (GVA and employment are modelled for 70 separate sectors in the UK, consistent with SIC07)
- its econometric specification which provides a strong empirical grounding instead of relying on assumptions about the functioning of the economy, such as perfect competition and optimal behaviour (for example, no involuntary unemployment), which are common to other (CGE) modelling approaches

In E3ME, the determination of output comes from a post-Keynesian framework. The model is demand-driven and it is assumed that prices of each product are explained as a weighted average of the prices of domestically-produced products (which in turn are determined as a mark-up on costs) and import prices.

3. The issues involved in representing Brexit in economic modelling

Channels of impact

Depending on the exact post-Brexit agreement reached on the UK's trading relationship with the European Union and other countries and on a range of other dimensions including migration and regulation, the following represent the key potential channels of impact.

Tariff barriers to trade

In the case where the UK leaves the Customs Union and has no free trade agreement (FTA) with the EU, UK producers of goods will face tariffs on their exports to the EU. The UK may also impose tariffs on imports from the EU. Since the UK would then be free to negotiate its own trade deals with non-EU countries, there could be reductions in tariffs on both exports to and imports from these countries, depending on the view taken on the speed with which such deals are made and the extent of their scope. Tariffs raise the cost of trade and divert the sourcing of products. To the extent that imported goods become more expensive, domestic costs and prices increase. In the modelling, tariff barriers are introduced as explicit taxes on imports in each country and then the model's relationships determine the consequences for the prices of goods imports and exports, the volume of bilateral imports and exports, and the pass-through from import prices to domestic prices.

Non-tariff barriers to trade

Non-tariff barriers also raise the cost of trade, but the scale of this impact is less transparent than for tariff barriers. They cover trade in services as well as goods. In the modelling, assumptions are introduced for the 'tariff equivalent value' of the non-tariff barriers and then these affect import prices in the same way as for tariff barriers.

Departure from other EU policies

Leaving the Single Market gives the UK the opportunity to depart from other EU policies. A key policy with respect to domestic food prices is the Common Agricultural Policy. The Government has given assurances that the existing subsidy regime will remain in place till 2025; changes thereafter

³ See www.e3me.com for more information.

⁴ The geographical scope of E3ME allows us to capture bilateral trade relationships between the UK and 58 partner countries/regions (including every EU Member State).

could affect the structure of subsidies (with some winners and some losers) or the level of subsidies (with knock-on effects on food prices and UK agricultural production and imports).

Exchange rate

Between May 2016, on the eve of the Brexit referendum, and October 2016 sterling fell by 15% against the US dollar and 13% against the euro. A Brexit deal perceived as unfavourable for UK economic prospects could result in a further depreciation. The result would be some measure of compensation for the impact of trade barriers on UK exporters and a further increase in the price of imports.

Investment

Investment activity could be lower in the short-term due to uncertainty over the Brexit deal that will be reached. It could be lower in the long run if the general economic impact of Brexit is negative. In particular, foreign direct investment would be expected to be lower if the UK leaves the Single Market because the UK would be a less attractive place from which to export to the EU and cross-border supply chains with EU Member States would face greater trade friction.

International migration

In the case where the UK leaves the Single Market, the right of free movement of workers to and from EU Member States will end. Since the 2016 referendum, net long-term migration into the UK from the rest of the EU has fallen sharply, from about 189,000 in the year ending December 2015 to about 60,000 in the year ending September 2018. This has been led in particular by a reversal of net migration from Eastern European MS from a net inflow of 42,000 in the year ending December 2015 to a net outflow of 15,000 in the year ending September 2018. In contrast, net long-term migration into the UK from outside of the EU has continued on its rising trend, increasing from an annual rate of about 290,000 in December 2015 to 340,000 in September 2018. It is unclear what should be assumed for net migration as a result of Brexit: a reduction in the total or simply a change in the relative shares of EU and non-EU migrants. If we assume some reduction in the total, in principle lower net migration of workers into the UK could improve the labour market position of those remaining in the UK, in terms of their likelihood of being in work and the wage that they earn.

Housing market

Given the inelastic supply of housing in the UK, a reduction in net migration could be expected to affect the availability of social housing and the rents and prices of private housing.

Productivity

Lower investment, especially foreign direct investment, and any constraint on skills availability arising from lower net migration would be expected to lower overall labour productivity. In addition, a reduction in the UK's openness to trade could have 'dynamic' impacts on growth and productivity through reduced competition, R&D and diffusion of ideas: (Dhingra, et al. 2017) cite relevant examples from the literature and argue for a strong impact. In contrast (Coouts, Gudgin and Buchanan 2018) argue that the link between trade and productivity is less clear when the scope of analysis is restricted to OECD countries and limited to the post-1980 decades, which they argue is more relevant to the Brexit case.

4. Types of post-Brexit arrangements

Table 1 summarises the different types of post-Brexit arrangement that we have modelled.

Table 1: Key features of each scenario

Scenario	Summary
S1 – Baseline	The UK remains in the EU.
S2 - Norway	The UK remains in the European Economic Area (EEA) and the ‘four freedoms’ ⁵ of the single market are preserved. There is no change in the level of migration compared to in the baseline. There are no tariffs to trade with the EU (with the exception of food and agriculture imports, where a low tariff rate is applied).
S3 - Turkey ⁶	The UK remains in the Customs Union, but not in the EEA. There are no tariffs on trade between the UK and other EU countries and the EU customs duty is applied to trade with non-EU countries. There is a reduction in migration and an increase in trade friction costs.
S4 - Ukraine	The UK joins the Deep and Comprehensive Free Trade Area (DCFTA). There are no tariffs for trade with the EU (except for food and agriculture). There is a reduction in migration and an increase in trade friction costs.
S5 - Canada	The UK negotiates a Free Trade Agreement (FTA) with the EU. There is a reduction in migration and high trade friction costs.
S6 - No Deal	Trade between the UK and the EU reverts to WTO rules with MFN tariffs. There is a reduction in migration and high trade friction costs.

In the central variants of each scenario it is assumed that there is no change to import or export tariffs for trade with countries outside of the EU. Any FTAs negotiated between the EU and partner countries in the rest of the world before Brexit are assumed to be automatically carried over to the UK post-Brexit. To gauge the potential benefit of abolishing all import tariffs⁷ for all the scenarios with independent trade policy we have carried out sensitivity tests in which the UK also implements unilateral trade liberalisation. In that case, we also assume FTAs are reached with the US and China, leading to a reduction in prices of exports to these countries.

In the No Deal scenario, we test a more pessimistic variant where we assume that EU-negotiated deals with third countries⁸ are not carried over and the trade relationship between the UK and these countries reverts to WTO rules.

Treatment of the channels of impact in the modelling

This section describes how these channels were treated in the E3ME model runs.

Tariff and non-tariff barriers to trade

The tariffs applied in the No Deal scenario and shown in Figure 1 are based on the assumption that trade between the UK and EU reverts to the WTO Most Favoured Nation (MFN) tariffs. (Dhingra, et al. 2017) have calculated average trade-weighted MFN tariffs at a broad sector level that is consistent with the sector classification used in E3ME. These tariffs are used as assumptions in the No Deal scenario, as shown in Figure 1. In all scenarios except for the ‘No Deal’ scenario, we assume that the UK and the EU reach a free trade agreement, with no tariffs applied to the trade in goods between the two regions. The only exception to this is in the food and agriculture sectors where, in line with current EU trade policy with the respective nations, there are some tariffs applied, despite FTAs in place for trade of all other goods. We assume tariffs on food and agricultural products are one third of

⁵ Freedom of movement in labour, capital, goods and services.

⁶ This illustrative scenario assumes that the UK remains in the complete customs union. The scenario does not fully reflect Turkey’s relationship with the EU, as Turkey is only in a partial customs union with the EU and does face some tariffs on agriculture, for example.

⁷ (Minford, Gupta, et al. 2015) and (Minford, From Project Fear to Project Prosperity, An Introduction 2017) argue that a Brexit scenario with unilateral trade liberalisation would lead to a net increase in GDP, compared to a baseline where the UK remains in the EU.

⁸ The EFTA includes Iceland, Norway and Switzerland. In addition, the EU has FTAs with Mexico, Colombia, Canada, South Korea, Singapore, Ukraine and Turkey. Trade with these countries accounts for around 10% of total UK trade.

the MFN tariff rate in the Norway scenario, and two thirds of MFN tariff rate in the Ukraine and Canada scenarios.

In all scenarios except for the no-Brexit baseline, there is an increase in non-tariff barriers to reflect factors such as rules of origin checks, border controls and regulatory divergence. These non-tariff barriers increase the cost of trade with the EU and are therefore an important assumption and key driver of the price effects in the modelled scenarios. Our assumptions for EU-UK non-tariff barriers are taken from (Dhingra, et al. 2017), and (Ries, et al. 2017) where it is assumed that, under a FTA with the EU, EU-UK non-tariff barriers would rise to one quarter of the EU-US non-tariff barriers. If

Trading relationships with the EU

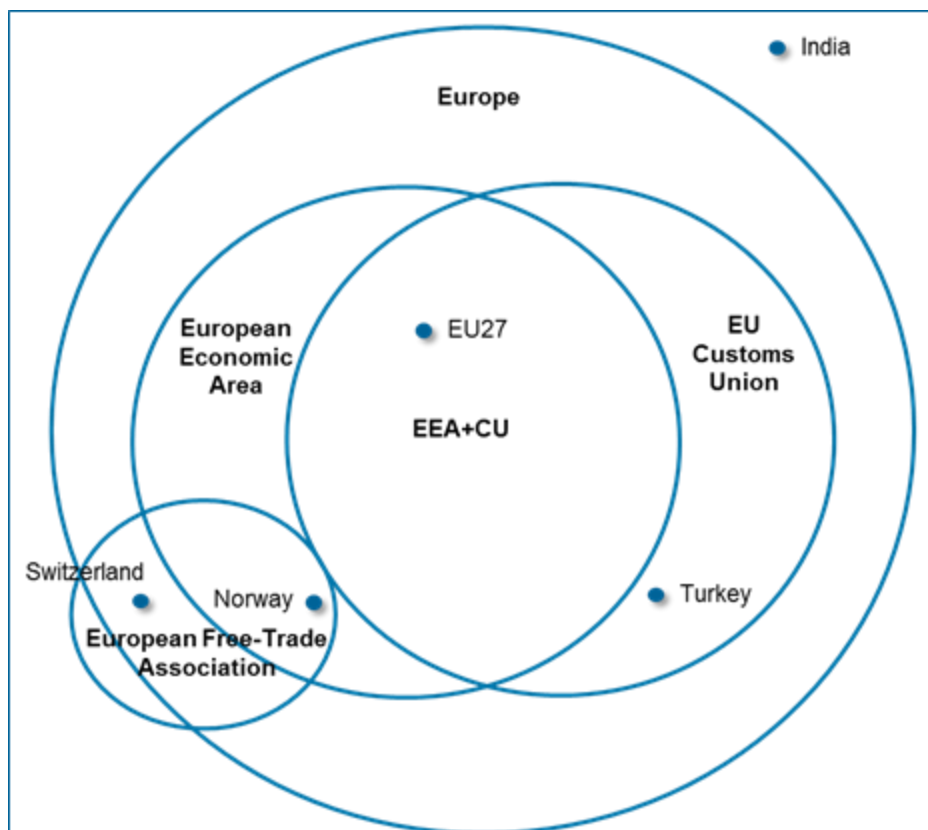
Single Market

Single Market membership is effectively ‘EEA membership’, which includes the current EU28 countries and Iceland, Liechtenstein and Norway (but not Switzerland, which is part of the European Free Trade Association (EFTA), but not the EEA). It refers to the countries as one territory without any internal borders or other regulatory obstacles to the free movement of goods and services (i.e. it eliminates tariffs, quotas or taxes on trade and attempts to remove non-tariff barriers such as rules on packaging, safety and standards). The EEA includes the four freedoms (free movement of goods, capital, services and labour) plus all the legislation supporting them, competition/state aid rules and all the accompanying measures (rules on social policy, consumer protection and environment). It also provides for participation in funding programmes, in particular the main “Framework” programmes on research and innovation. EEA does not cover the common agriculture or fisheries policies nor Justice & Home Affairs, nor foreign and security policy.

Customs Union

In the EU Customs Union all the Member States follow a set of common rules in exercising customs controls over goods entering the EU from outside the EU. This means that goods which come into the EU from outside are subject to a common external tariff, but once they have entered through an external port and paid any duty which is due on them, they can then circulate freely inside the customs union. Goods which are made inside the customs union can likewise circulate freely without being subject to tariffs at the internal borders within the customs union.

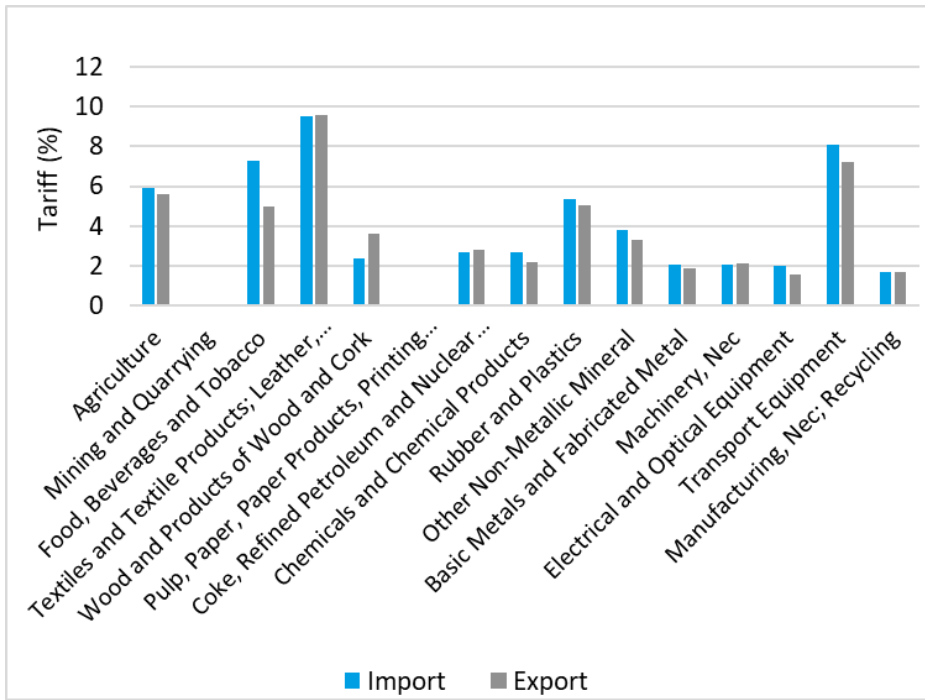
Individual members cannot negotiate trade deals with non-member countries and are not able to set its own tariffs. It is possible for a country to be part of a customs union with the EU but not in the single market (e.g. Turkey).



no deal is agreed and EU-UK trade takes place under WTO rules, the increase in non-tariff barriers is assumed to be three quarters of EU-US non-tariff barriers. The assumptions in these studies, in turn, rely on estimates of the scale of EU-US non-tariff barriers from (Berden, et al. 2009). (Ries, et al. 2017) use bilateral trade data to show that one-quarter vs three-quarter assumption proves to be a good approximation of the non-tariff barrier costs between the EU and trade partners.

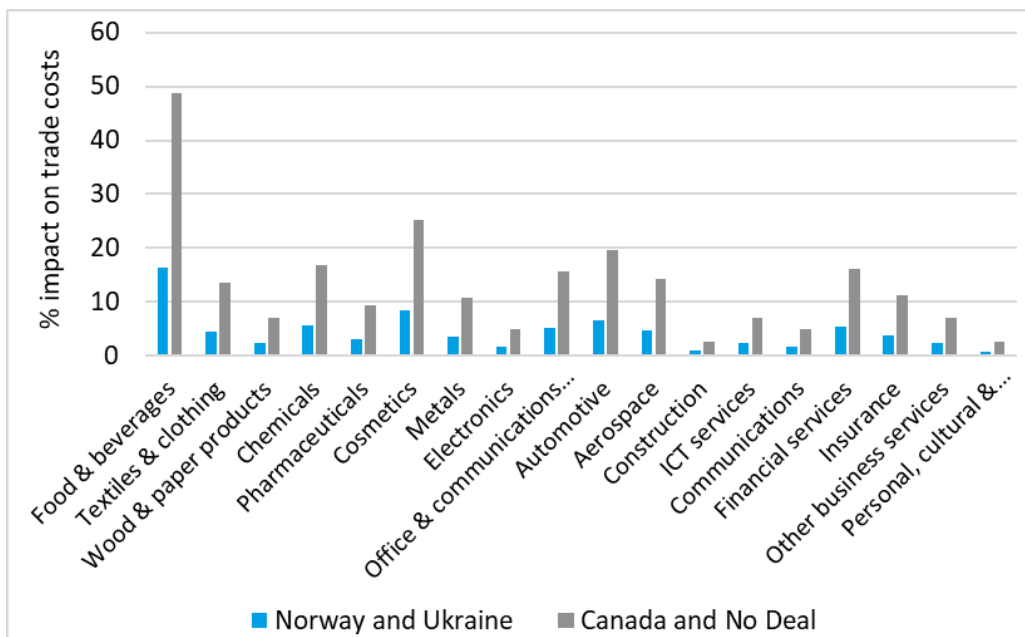
The immediate non-tariff barriers that are applied in each scenario are shown in Figure 2.

Figure 1: Tariffs applied to trade in goods between the UK and EU in the No Deal scenario (presented as a percentage change in prices of trade with the EU)



Source: (Dhingra, et al. 2017).

Figure 2: Immediate non-tariff barriers applied in each scenario (presented as a percentage change in prices of imports from the EU)



Source : CE calculations based on (Dhingra, et al. 2017) and (Berden, et al. 2009).

As well as an immediate increase in non-tariff barriers (reflecting increased trade friction and border controls), (Ries, et al. 2017) assume a gradual increase in non-tariff barriers over time to reflect growing regulatory divergence. We use a similar approach to take account of this effect:

- in the Norway, Turkey and Ukraine scenarios, we apply a 0.06% pa increase in non-tariff barriers for trade in goods and services over the period to 2030
- in the Canada and No Deal scenarios, we apply a 0.08% pa increase in non-tariff barriers for trade in goods and services over the period to 2030

Around 10% of UK trade is with countries that have an EU Free Trade Agreement⁹. In our central scenario, we assume that these FTAs are carried over to the UK.

Departure from other EU policies

Under the new Agricultural Bill, the Government has committed to maintaining direct payments until the end of this Parliament (which we have assumed to be 2022) and has indicated that it is unlikely to move to a new system of farm support before 2025. It has indicated that, after a transition period, direct payments will be replaced with a system of public money for public goods. We therefore keep the level of support available to farmers fixed in nominal terms over the period to 2025 to represent the Government's current position. Our assumptions about agricultural policy post-2025 are based on scenarios drawn from (Van Berkum, et al. 2016) and (Agriculture and Horticulture Development Board 2017). We assume no change to the Pillar II (rural development) payments, but a gradual reduction in Pillar I payments, reaching a 5% reduction by 2030 (roughly equivalent to a €600m reduction annually compared to the baseline).

Exchange rate

When the 2016 referendum took place, the outcome in favour of Brexit came as a surprise and sterling experienced a sharp depreciation. Given the difficulty of getting a Parliamentary majority for any of the options that the Government and some MPs have proposed, markets are presumably assuming already pricing in the risk of some degree of disruption and a possible No Deal. Hence, it is unclear whether and by how much the exchange rate might shift when Britain eventually leaves the EU. Consequently, to distinguish any exchange rate effect from other Brexit impacts, we have not assumed any further change in the exchange rate in the modelling.

Investment

There has not been a collapse in either business confidence or investment since the 2016 referendum. Eurostat's economic sentiment and business confidence indicators show a pick-up in confidence during 2017 but a fallback in 2018 and into 2019, both for the UK and the whole EU. UK business investment peaked in 2017Q4 and declined modestly through 2018 to stand 2.5% lower in 2018Q4 than a year earlier. While there may yet be an adverse reaction to a perceived disorderly Brexit, the data so far do not indicate a large short-term Brexit effect and we do not include one in our scenarios.

Honda's decision, announced in February, that it would close its Swindon plant has highlighted concerns about foreign direct investment (FDI), although the weight of Brexit in its decision is unclear (it is production back to Japan rather than to elsewhere in the EU). There has been limited discussion in the literature directly addressing the potential impact of Brexit on investment. Most of the discussion has centred on the impacts on inward foreign direct investment and finds that it would

⁹ According to the 2017 edition of the ONS Pink Book, around 5% of UK trade was with the EFTA countries (Iceland, Norway and Switzerland) and another 5% of trade was with other countries with which the EU has a FTA (Mexico, Colombia, Canada, South Korea, Singapore, Ukraine and Turkey).

be lower in any scenario compared to the baseline of the UK remaining in the EU. (Ebell and Warren 2016) is the only study that explored quantitatively different scenarios with respect to all business investment (but their result is still derived from an FDI impact). Based on the results of that study, we assume that investment in 2030 is lower than the baseline by 1.5% in the Norway scenario, by 2.6% in the Turkey and Ukraine scenarios, and by 3.5% in the Canada and No Deal scenarios.

International migration

Our migration assumptions are based on ONS population projections.

In the baseline and Norway scenarios, there is free movement of labour and we assume annual net international migration of 245,000 per year. This figure is similar to recent migration figures (net migration to the UK was 246,000 in 2016-2017).

In the other Brexit scenarios, where it is assumed that there are tighter immigration controls, net migration is assumed to fall to 165,000 per year from 2021 (in line with the ‘principal’ ONS scenario) As a result, the UK population is around 900,000 lower by 2030 in the Brexit scenarios compared to the baseline and Norway scenarios. We use recent data on the shares of migrants by age group to infer the impact on the working-age population.

The literature, summarised by (Nickell and Saleheen 2015), generally suggests a minimal impact of immigration on average wages, but (Nickell and Saleheen 2015) find a somewhat larger impact in occupations in semi/unskilled services. (Nickell and Saleheen 2015) also note that the acceleration in immigration into the UK from Eastern Europe MS following their accession in 2004 has been reflected particularly in an increase in the share of EU immigrants in low-skilled occupations. Hence, to capture the effect of lower immigration on wages for low-skilled workers in our Ukraine, Turkey, Canada and No Deal scenarios (where freedom of movement is restricted), we combine estimates of the impacts of migration on wages from (Nickell and Saleheen 2015) with our assumptions about the level of immigration in each scenario.

Housing market

(Ministry of Housing, Communities & Local Government 2018) suggested that over 1991-2016 immigration accounted for 20 pp of the 320% real increase in UK house price. However, since EU immigration has been weighted towards low-skill occupations, the impact of private rents (and, potentially, social housing vacancies) is probably of greater interest, but we were unable to identify suitable literature to support estimates of this effect and so none have been included in our modelling.

Productivity

E3ME captures some of the potential impacts on investment, for example as a result of lower investment. Given the weighting of EU immigration towards low-skill occupations, we do not make any assumption that reduced immigration will reduce labour productivity due to skill shortages. The earlier discussion suggests that it is unclear whether or not EU membership has stimulated productivity through greater competition and so again not additional assumption for that kind of impact has been introduced in the modelling.

5. Outcomes of the scenarios using E3ME

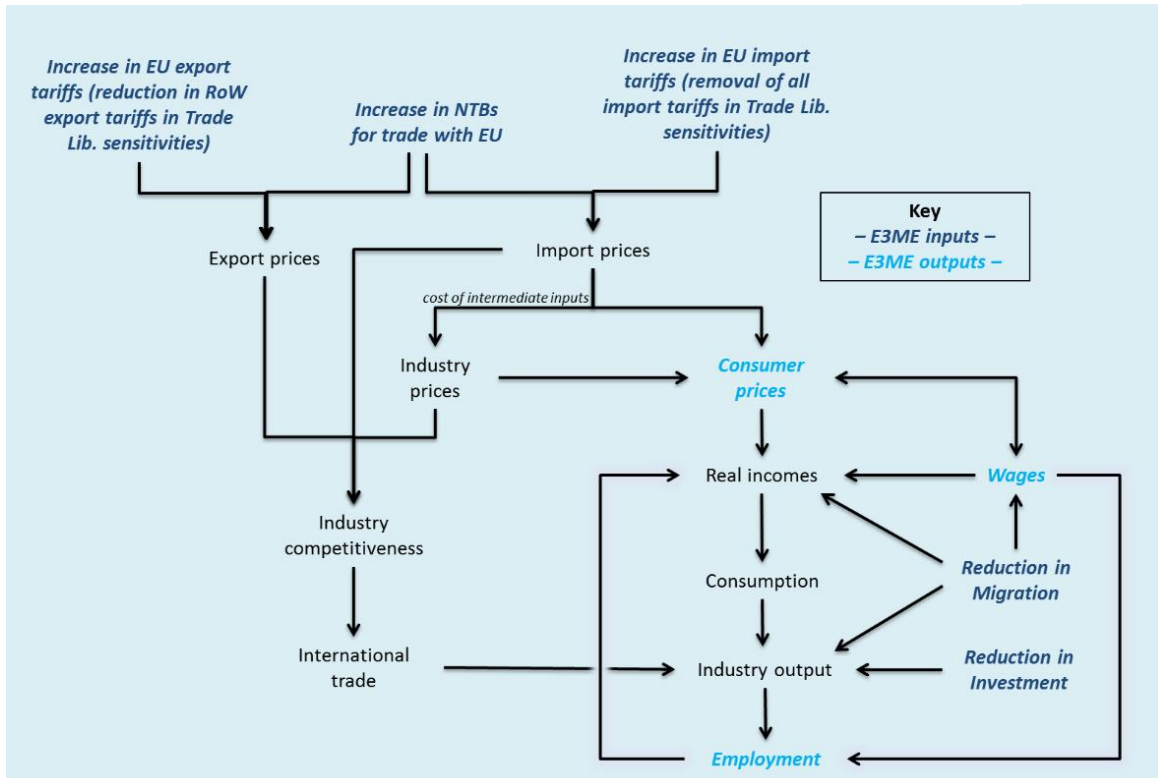
The net socio-economic impact of each Brexit scenario, as modelled in E3ME, is therefore determined by four key drivers:

- changes to export prices (reflecting the change to tariff and non-tariff barriers on exports)
- changes to import prices (reflecting the change to tariff and non-tariff barriers on imports)

- changes to investment (reflecting reduced foreign direct investment, as firms based in the UK have reduced access to EU markets)
- changes to migration (reflecting restrictions to the freedom of movement of people)

Figure 3 show key interactions and feedbacks in E3ME and how these drivers interact with other variables in the model to ultimately affect prices, wages and employment.

Figure 3: Key interactions and feedbacks in the modelling of Brexit impacts with E3ME



An increase in export tariffs (in the No Deal scenario) and an increase in non-tariff barriers (in all of the Brexit scenarios) reduces the competitiveness of UK industry, leading to a reduction in exports and a reduction in industry output, particularly in the most price-competitive sectors. In the trade liberalisation sensitivities, a reduction in export tariffs for trade with the US and China leads to an increase in trade with these countries.

An increase in import tariffs (in the No Deal scenario) and non-tariffs barriers (in all of the Brexit scenarios) drives an increase in import prices, which has a direct impact on industry competitiveness, with some manufacturing sectors benefitting from the more protectionist measures. However, the longer-term effect includes the impact of higher prices of imports on the costs of intermediate inputs in industry supply chains, ultimately leading to increases in industry prices. The extent of this increase is dependent on the estimated cost pass-through rates in each sector and the import-intensity of each sector’s supply chain. The higher industry prices drive an increase in prices for consumers, although the impact on consumer prices is dampened by the role that (non ad valorem) taxes and retail and distribution margins play.

Higher consumer prices lead to a reduction in real incomes and consumption, with this reduction in demand eventually driving a reduction in industry output and employment.

Reduced investment in the Brexit scenarios reflects a relocation of manufacturing activities to outside of the UK, where there is more unrestricted access to EU markets. The reduced investment leads to a reduction in industry output and employment, as the productive capacity of the economy is reduced.

The impacts of migration on output in the economy depends on the extent to which non-economically active people are willing, capable and suitably qualified to fill the jobs that the migrant workforce would otherwise fill. This potential substitution effect (where economically inactive British workers take jobs that would otherwise be filled by migrants) is not included in our central scenario assumptions. One of the reasons for assuming no substitution effect is that the unemployment rate in the UK is already low (3.9% in December 2018 - February 2019), so many of those left in unemployment are likely to be those that are hardest to place in jobs.

Therefore, by design, we assume that the productive capacity of the workforce falls in line with the reduction in the size of the working age population due to reduced immigration. We do not assume that the reduction in immigration creates job vacancies that are then filled by the otherwise unemployed or inactive workforce. This assumption is consistent with the finding that high net immigration in the past two decades did not lead to any significant increase in unemployment¹⁰

The impacts of migration on nominal wages are taken from (Nickell and Saleheen 2015), which shows that the reduced migration is likely to have a small positive impact on wages in most occupations. The increase in prices also leads to a positive impact on nominal wages, due to wage bargaining effects.

The net impact on *real* wages depends on the scale of the increase in nominal wages relative to the scale of the increase in prices. Real incomes are also affected by changes in the employment rate.

Impacts on consumer prices

The impacts on consumer prices (by category) are determined by:

- the scale of the increase in the level of tariff and non-tariff barriers (which are equivalised to price effects)
- the share of imports relative to domestic production in domestic consumption
- the import intensity in each sector's supply chain
- cost pass-through rates in each sector
- the influence of import prices on domestic prices in each sector
- the level of tax and retail and distribution margins for each consumer good

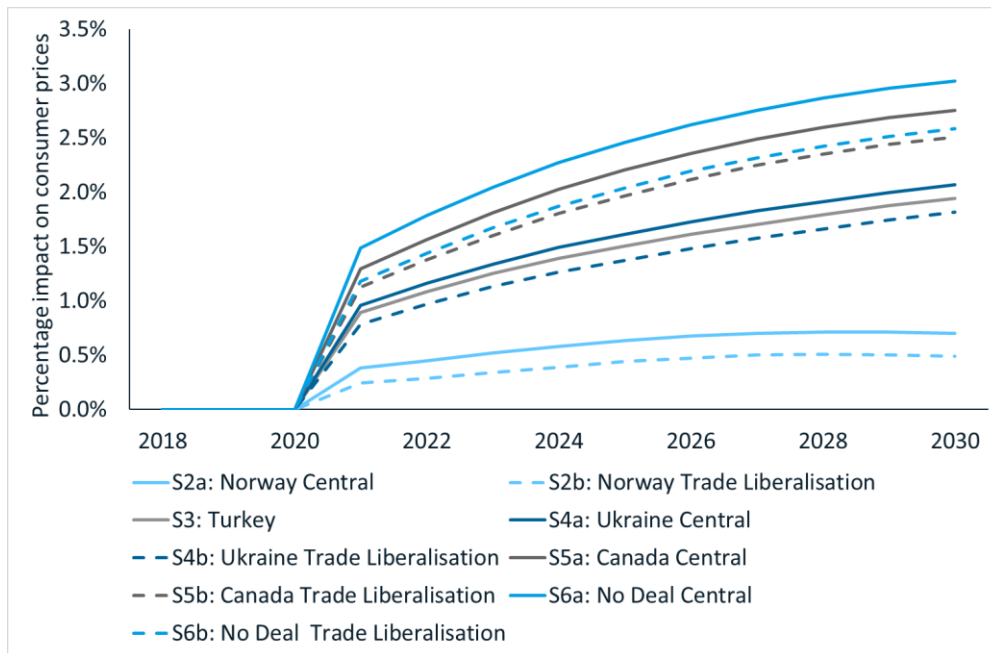
Our results show that consumer prices increase by up to 3% in the No Deal scenario as a result of the increase in tariff and non-tariff barriers.

Some studies¹¹ have argued that the effect of Brexit on prices could be reduced by the implementation of unilateral trade liberalisation. Our analysis shows that this policy would have a limited impact on prices, as a large part of the price impacts are driven by non-tariff barriers and trade frictions (such as border controls and regulatory divergence). In the trade liberalisation sensitivity that was tested on the No Deal scenario, there is still an increase of around 2.5% in the consumer price level due to non-tariff barriers.

In the other scenarios we assume that FTAs are agreed with the EU and so, in the central scenarios, the increase in prices in these cases primarily reflects the impact of non-tariff barriers.

¹⁰ See: (Lemos and Portes 2008), (Jean and Jiménez 2011) (Lucchino, Rosazza-Bondibene and Portes 2012).

¹¹ (Economists for Brexit 2016).

Figure 4: Impacts of selected Brexit scenarios on consumer prices (% difference from baseline)

Source: E3ME.

The price impacts are largest for food, where prices in the No Deal scenario increase by over 8%, due to high tariffs for trade with the EU (due to the Common Agricultural Policy) and high non-tariff barriers for trade with the EU (reflecting the cost of divergence in food standards).

Prices of clothing and footwear increase by around 2% in the No Deal scenario. Even though a high share of clothing and textiles are imported, the overall impact on prices of clothing and footwear are dampened by high retail margins (which are assumed not to rise).

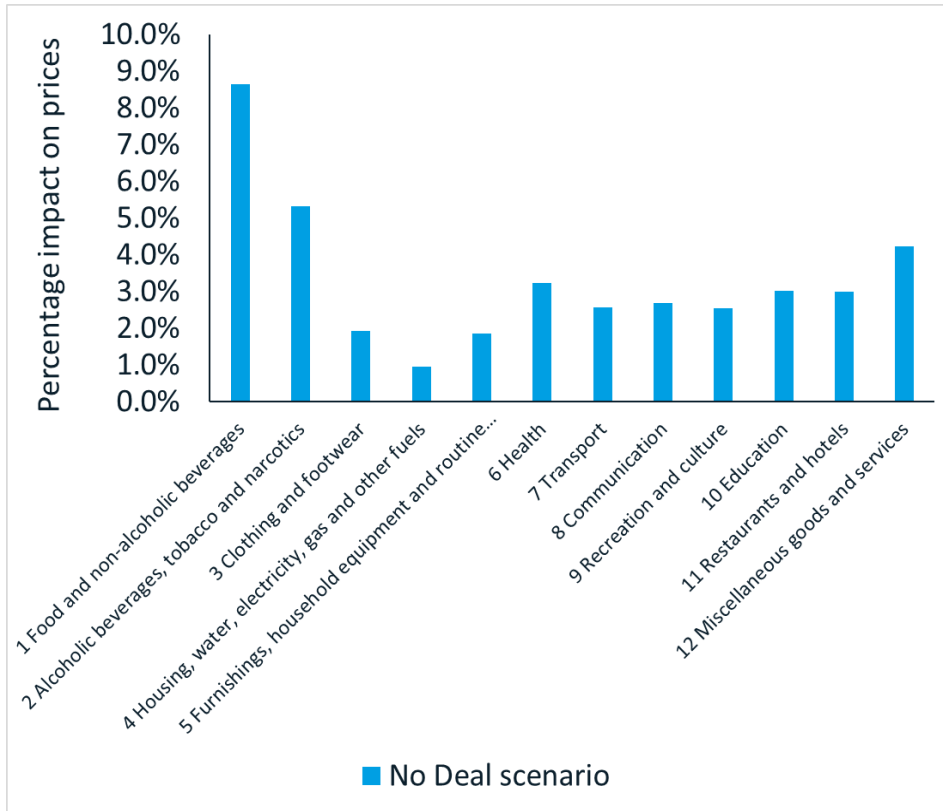
Housing and fuel costs are an important component of expenditure for low income groups (accounting for a quarter of total spending for the bottom income decile). These items are less affected by the changes in trade costs: prices of these commodities increase only by around 1% in the No Deal scenario.

In the No Deal scenario, there is a 6.8% increase in the price of vehicles, due to the high share of vehicle imports and the relatively high MFN tariff rate applied. The overall impact on transport prices faced by consumers is much lower, however, as transport services are not a traded sector and so are less affected by the increase in trade costs.

Modest increases in the prices of services are driven by increased costs of intermediate inputs in their supply chains.

Taking account of the weight of different consumer items in the shopping basket of the poorest quintile of households, the consumer price impacts of a No Deal Brexit translate into a £480 increase (2018 prices) in the cost of living in the long term (2030)

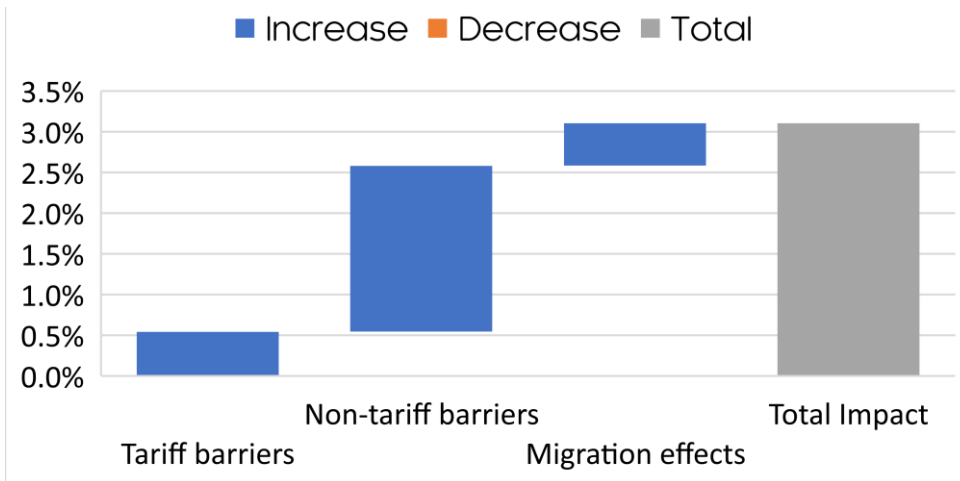
Figure 5: Impacts on consumer prices by category in the No Deal scenario in 2030 (% difference from baseline)



Source: E3ME.

The largest contributor to higher prices is the assumption for non-tariff barriers, as shown in the decomposition analysis¹² presented in Figure 6.

Figure 6: Decomposition of No Deal scenario impact in 2030 on consumer prices



Source: E3ME.

¹² The decomposition analysis is carried out by carrying out separate runs of the model introducing each of the relevant assumptions separately.

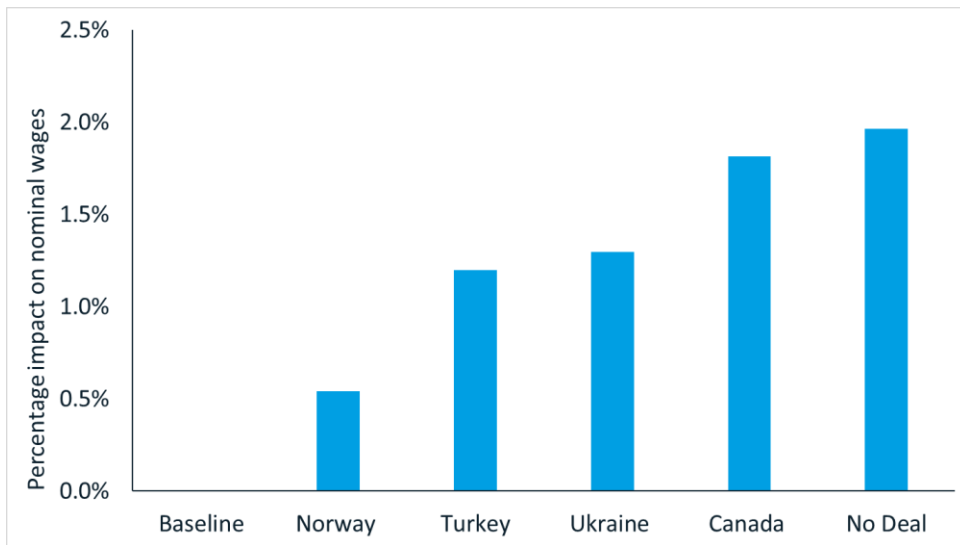
Impacts on wages

The key drivers of the impacts of Brexit on real wages are: (i) migration effects and (ii) price effects.

As a result of our assumptions for migration impacts on wages, the reduction in migration, when taken in isolation, has a small positive impact on nominal wages (of around 0.2%).

In addition to the migration impacts, the wage equations in E3ME also capture the effect of wage bargaining effects (as prices rise, workers demand higher pay) and this further pushes up nominal wages in the Brexit scenarios (as shown in Figure 7 below).

Figure 7: Impact on nominal wages in each Brexit scenario by 2030 (% difference from no-Brexit baseline)



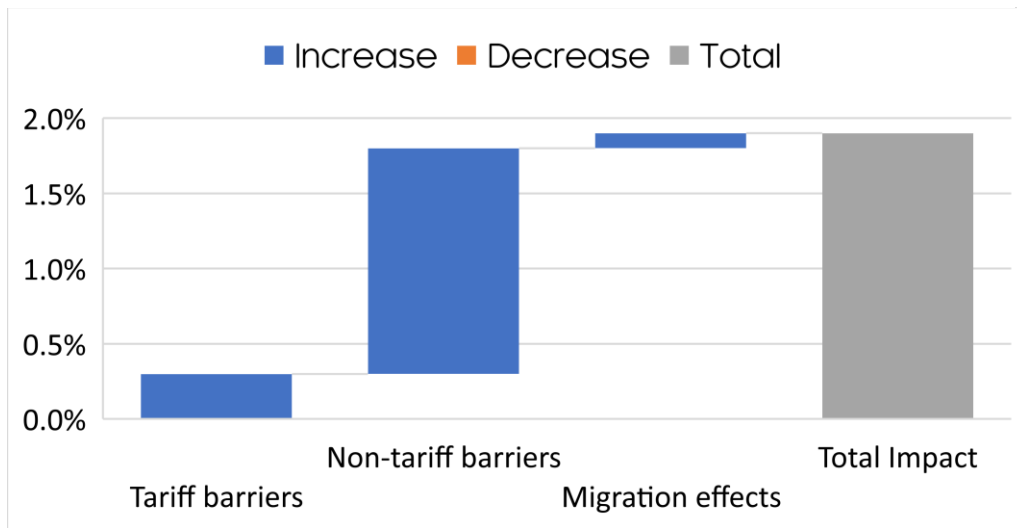
Source: E3ME.

Over the period we are considering, however, the migration and wage bargaining effects are not large enough to counter the overall increase in the price level and so there is a reduction in real wages in the Brexit scenarios, as shown in

Figure 9 below. By 2030, real wages are estimated to be 0.2% lower than baseline in the Norway scenario and 1.0% lower than baseline in the No Deal scenario. Real wages in the (low-paid) caring and elementary occupations fall by slightly less, in percentage terms, than the UK average. Real wages in these occupations are around 0.6% lower by 2030 in the No Deal scenario (as shown in Figure 10).

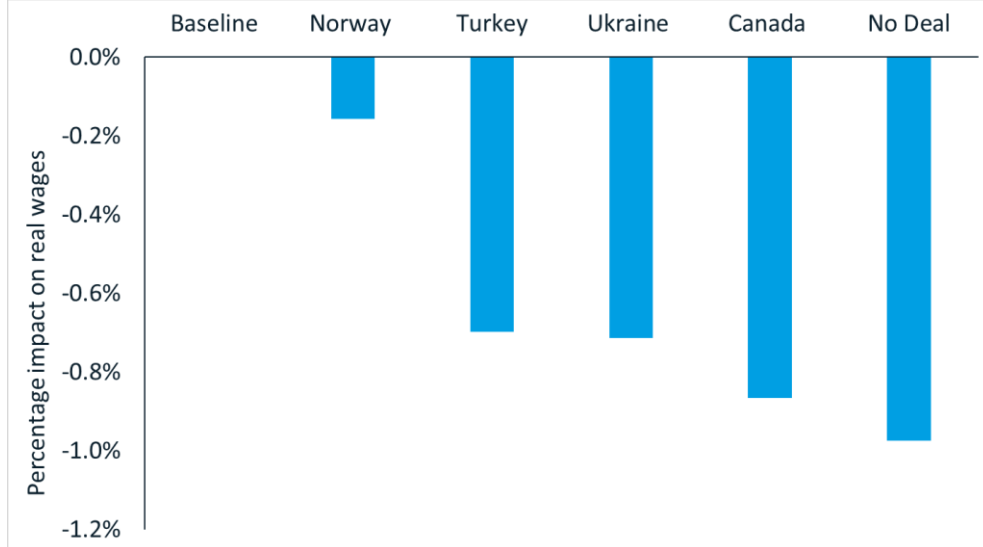
Again, the largest contributor to higher nominal wages is the assumption for non-tariff barriers (and consequent increase on the price level and wage bargaining behaviour), as shown in Figure 6.

Figure 8: Decomposition of No Deal scenario impact in 2030 on nominal wages



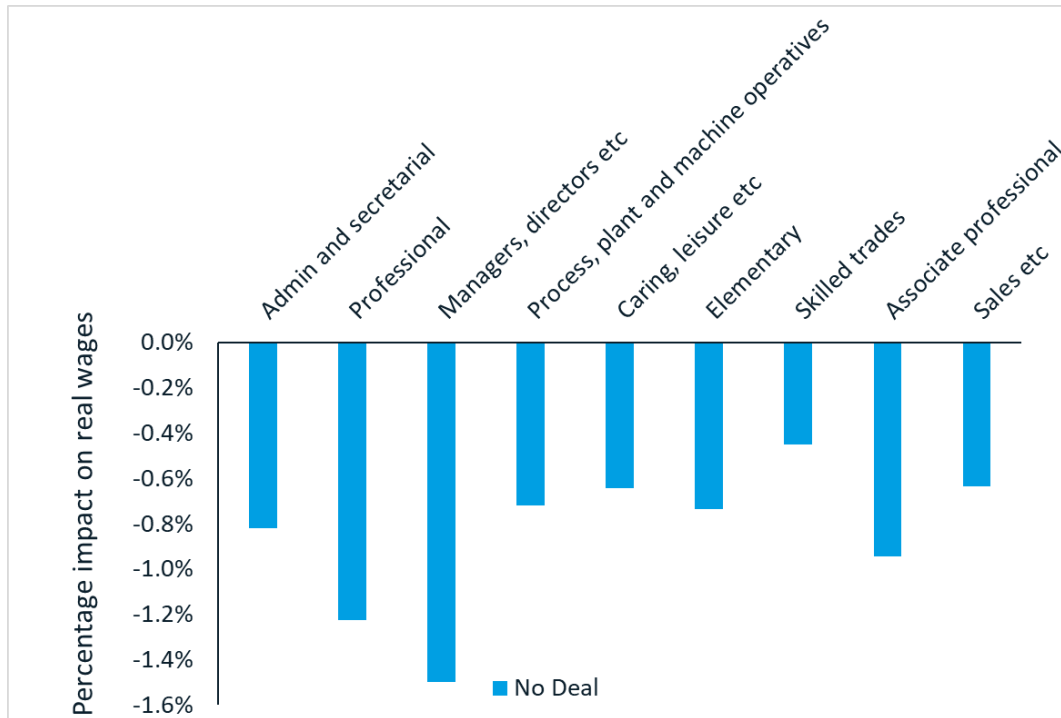
Source: E3ME.

Figure 9: Impact of Brexit scenarios on real wages in 2030 (% difference from no-Brexit baseline)



Source: E3ME.

Figure 10: Impact of No Deal scenario on real wages by occupation in the No Deal scenario in 2030 (% difference from baseline)



Source: E3ME.

Impacts on employment

The E3ME results show an overall reduction in employment in the Brexit scenarios. This is predominantly due to a reduction in labour supply because of reduced immigration but reductions in gross output, driven by lower investment and exports, are also contributing factors. The percentage reduction in employment is spread fairly evenly across occupational groups, which each see a 2.5-3% reduction in employment by 2030 in the No Deal scenario (equivalent to around 850,000 jobs in total).

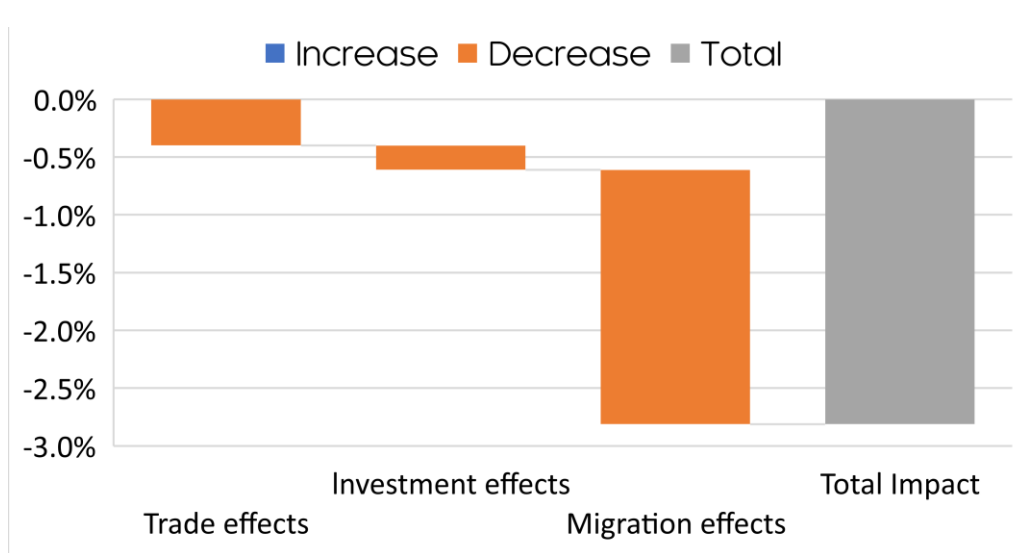
When considering impacts on those living in the UK, the employment rate is a more useful measure. Our modelling is consistent with the studies referenced earlier that high net migration into the UK did not significantly increase the rate of unemployment and so, in our central scenarios, we assume that lower net migration will not reduce it. It is plausible that a sudden tightening in migration policy would lead to certain skill shortages if the UK working-age population are not readily substitutable for working-age migrants in the UK. However, the impact of migration policy due to particular skill attributes of migrants is out of scope for this analysis.

In addition to the scaling-back of UK production in response to shortages of migrant labour and reduced exports in the Brexit scenarios, reduced levels of investment adversely affect labour productivity which raises unit labour costs. These effects, in combination, lead to an employment rate that is 0.5 pp lower than the baseline by 2030.

As shown in Figure 11, the impact of the No Deal scenario on employment is predominantly driven by the reduction in *migration*, which reduces the size of the workforce and the productive capacity of the UK economy. By assumption, the change in migration does not affect the employment rate for

workers in the UK. However, there are small reductions in the employment rate in the No Deal scenario due to *trade* effects (as UK competitiveness and industry output is harmed by the export tariffs imposed in this scenario) and *investment* effects (which reduce the productive efficiency of the economy and reduce output in the long-run).

Figure 11: Decomposition of No Deal scenario impact in 2030 on employment



Source: E3ME.

Impacts on low-paid workers

To assess the impact of Brexit on in-work poverty, we calculate the proportion of workers that earn below a certain pay threshold. The low-pay threshold is defined as the proportion of the workforce earning less than 60% of median (baseline) income, which is equivalent to £14,790 in 2030 (in 2017 prices).

Our results show a small increase in the proportion of the workforce on low pay following Brexit. Using the definition above, in the No Deal scenario the share of low-pay workers increases by 0.6 pp, 0.4 pp and 0.5 pp, respectively in the ‘Caring’, ‘Administrative’ and ‘Elementary’ occupations.

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