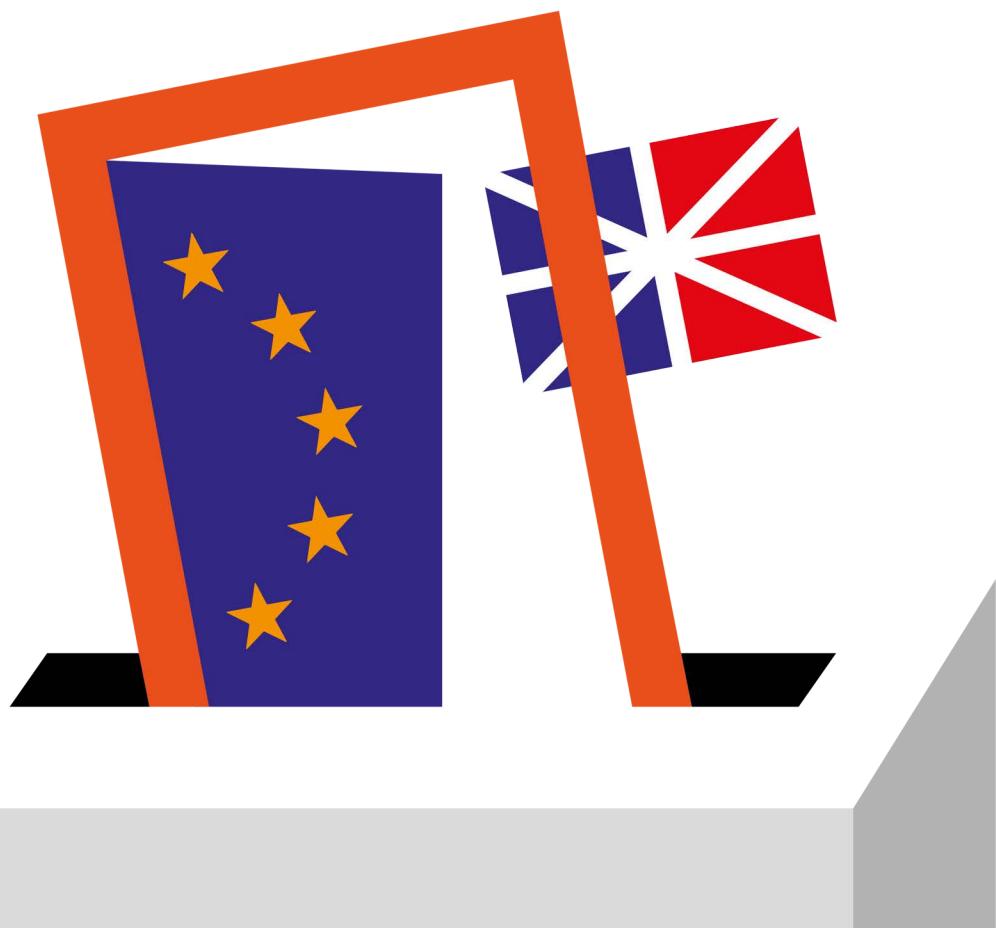


# Disunited Kingdom? Brexit, trade and Scottish independence

Hanwei Huang, Thomas Sampson and  
Patrick Schneider



## **CEP BREXIT ANALYSIS No. 17**

### **Disunited Kingdom? Brexit, Trade and Scottish Independence**

- Scotland is a small, open economy that mostly trades with the rest of the UK. In 2017, the rest of the UK accounted for 61% of Scottish exports and 67% of Scottish imports. Scotland's trade with the rest of the UK is around four times larger than its EU trade.
- We estimate there is around six times more trade between Scotland and the rest of the UK than predicted by a standard gravity trade model. Alternative methods imply there is from 2.6 to 7.8 times more Scotland-rest of UK trade than predicted. This excess trade is partly the consequence of Scotland's union with the rest of the UK.
- Independence would create a new international border between Scotland and the rest of the UK, leading to higher trade costs. We use the CEP trade model to study the impact of these new trade costs on Scotland's economy. We do not consider other effects of independence, such as changes in investment flows, fiscal arrangements or Scotland's currency.
- Drawing upon research on the magnitude of border costs, we analyse an optimistic scenario where trade costs between Scotland and the rest of the UK increase by 15% after independence and a pessimistic scenario with a 30% increase.
- We find that changes in trade costs due to independence would be two to three times more costly for the Scottish economy than the impact of Brexit.
- Together, Brexit and independence (without rejoining the EU) are estimated to reduce long-run Scottish income per capita by around 6.5% in the optimistic scenario and 8.7% in the pessimistic scenario. These numbers likely underestimate the losses caused by higher trade costs, as we do not account for any dynamic effects of trade on productivity.
- The trade-related costs of independence are similar regardless of whether Scotland rejoins the EU, since the benefits of lowering trade barriers with the EU by rejoining are roughly offset by the costs of putting the EU's external border between Scotland and the rest of the UK.
- Rejoining the EU would be preferable to maintaining a common economic market with the rest of the UK only if independence is sufficiently trade-destroying that the rest of the UK becomes a less important trade partner for Scotland than the EU.
- Changes in Scottish trade patterns following independence are likely to occur gradually, over a generation or more. Consequently, in the initial decades after independence, the rest of the UK will remain Scotland's biggest trade partner.

## Introduction

In 2014 Scotland voted against becoming an independent country. The referendum was intended to be a once in a generation event. However, the UK's 2016 vote in favour of Brexit reignited the Scottish independence debate after 62% of Scottish voters opposed leaving the EU (Sampson 2017). The Scottish National Party has pledged to use the 2021 Scottish Parliament elections to seek a mandate for a second referendum. Although there is no guarantee the UK government will agree to a new vote, recent opinion polls show a majority of Scots in favour of independence (The Herald 2020).

This briefing studies the economic consequences of Scottish independence and how Brexit affects the costs and benefits of independence. We seek to answer two main questions. First, how do the estimated effects of independence compare to the impact of Brexit on the Scottish economy? Second, would an independent Scotland be better off inside or outside the EU?

We address these questions using the Centre for Economic Performance (CEP) trade model, which was initially developed to study Brexit (Dhingra et al. 2016, 2017, Bevington et al. 2019). The model analyses how changes in trade costs due to independence and Brexit affect trade flows and aggregate income per capita in Scotland and the rest of the UK. In this briefing, we restrict our analysis to trade effects and do not consider other potentially important economic effects of Scottish independence, such as changes in investment flows into and out of Scotland, whether Scotland continues to use sterling as its currency and the fiscal implications of independence.<sup>1</sup>

Scotland is a highly open economy that mostly trades with the rest of the UK. In 2017, the rest of the UK accounted for 61% of Scottish exports and 67% of Scottish imports. Just under half of Scotland's foreign trade is with the EU, meaning that for Scotland the EU is a much less important trade partner than the rest of the UK.

Independence would introduce a new international border between Scotland and the rest of the UK. Borders create barriers to doing business that increase trade costs. An extensive academic literature documents that border costs are economically important and have large negative effects on international trade (Anderson and Van Wincoop 2004). Consistent with these findings, we show that trade between Scotland and the rest of the UK in 2017 is around six times greater than predicted by a gravity trade model that does not account for Scotland being part of the UK.

It is uncertain how large the effect of independence on Scotland's trade costs with the rest of the UK would be. Based on existing estimates of border costs and the effects of economic disintegration, we study an optimistic, low border cost scenario in which trade costs increase by 15% and a pessimistic, high border cost scenario where costs increase by 30%. These cost increases apply in the event that an independent Scotland maintains a common economic market with the rest of the UK. If Scotland rejoins the EU, its border with the rest of the UK

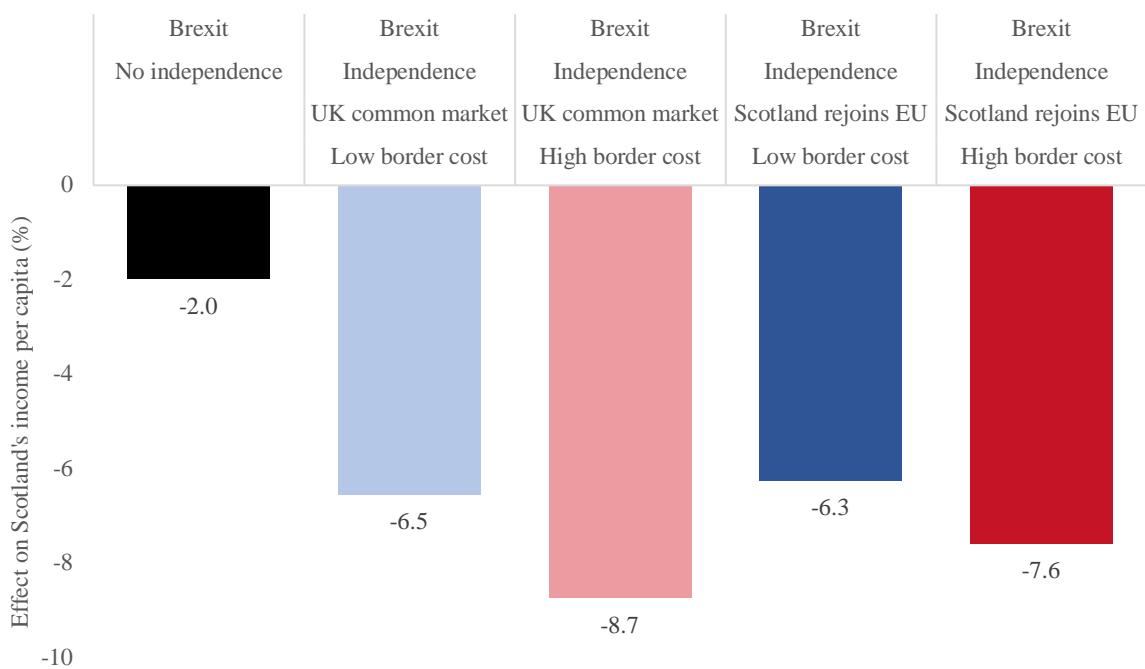
---

<sup>1</sup> HM Government's Scotland Analysis briefings, published in the run-up to the 2014 referendum, give an overview of the economic issues linked to Scottish independence. See also the articles collected in Armstrong and Ebell (2014) and Bell, Eiser and Beckmann (2014).

would become one of the EU's external borders leading to additional trade barriers. We model the effect of Brexit on trade costs using previous joint CEP-UK in a Changing Europe work that assumes a free trade agreement between the UK and the EU (Bevington et al. 2019).

The analysis leads to two main conclusions. First, the negative impact of independence on Scotland's economy is two to three times greater than the costs of Brexit. As shown in Figure 1, we estimate that Brexit reduces Scotland's long-run income per capita by 2.0%. By contrast, the combination of Brexit and independence reduces Scottish income per capita by between 6.3% and 8.7% depending upon whether border costs are low or high and whether Scotland rejoins the EU. Independence hits Scotland's economy harder than Brexit primarily because Scottish trade with the rest of the UK is four times larger than its trade with the EU.<sup>2</sup>

**Figure 1: Estimated effects of Brexit and independence on Scotland's long-run real income per capita**



Source: Authors' calculations using CEP trade model.

Notes: Brexit modelled assuming a UK-EU free trade agreement as in Bevington et al. (2019). Scottish independence is assumed to increase trade costs between Scotland and the rest of the UK by 15% in the low border cost case and 30% in the high border cost case.

Since the CEP trade model isolates the economic effects of variation in trade costs holding production technologies, foreign direct investment, immigration and fiscal arrangements constant, our estimates are likely to underestimate the overall costs of Brexit and Scottish independence. Dhingra et al. (2017) present evidence that allowing for dynamic productivity effects may triple the costs of Brexit compared to model-based estimates. The same is likely to

<sup>2</sup> Comerford and Rodriguez Mora (2019) also find that the likely impact of independence on the Scottish economy due to changes in trade costs is many times larger than the effect of Brexit.

be true for Scottish independence. Nevertheless, the estimates shown in Figure 1 provide a useful indication of the relative costs and benefits of alternative scenarios.

The second conclusion is that rejoining the EU would do little to mitigate the costs of Scottish independence. Figure 1 shows that the combined impact of Brexit and independence on Scottish income per capita is similar regardless of whether Scotland maintains a common market with the rest of the UK or rejoins the EU. While EU membership boosts trade with the EU, it also leads to additional increases in trade costs with the rest of the UK. These effects roughly offset, although Scotland is slightly better off as an EU member. The effects approximately offset because the model expects an independent Scotland to have similar levels of trade with the EU and the rest of the UK.

The analysis highlights a paradox in the economic argument that Scotland should become independent in order to rejoin the EU. For an independent Scotland to be better off inside the EU, independence must destroy a sufficiently large share of Scotland's trade with the rest of the UK that the EU becomes Scotland's most important trade partner. However, the more independence reduces trade, the greater its economic costs. In other words, for rejoining the EU to be economically desirable, independence itself must bring substantial economic costs.

Our estimates should be interpreted as the long-run effects of Brexit and independence after the economy has adjusted to changes in trade costs. Brexit studies typically argue that it will take 10-15 years for the full effects to materialise (Sampson 2017; HMG 2018). Adjustment to Scottish independence is likely to be even slower and may take a generation or more, as border costs gradually increase due to divergence between economic policy and regulations in the two countries and the erosion of existing cultural, social and business ties.

This slow adjustment means that in the initial decades after independence the rest of the UK will continue to be Scotland's most important trade partner. Consequently, even if in the long-run there is an economic case for an independent Scotland to rejoin the EU, we conclude that Scotland's medium-run priority following independence should be keeping border costs with the rest of the UK as low as possible.

## **Scotland's trade**

Unlike independent countries, Scotland does not collect detailed statistics on its external trade. Export Statistics Scotland provides useful data about onshore Scottish exports, but import data is relatively sparse. Measuring Scotland's trade is further complicated by the convention that economic statistics are produced separately for the onshore Scottish economy and its offshore counterpart (i.e. oil and gas production). However, by merging data sources and combining statistics for the onshore and offshore economies, we can obtain an overview of Scottish trade. Five facts stand out.

*Fact 1. Scotland is a highly open economy.* Table 1 shows 2017 export and import statistics for Scotland and the rest of the UK (i.e. the UK excluding Scotland, henceforth RUK). In Table 1, and throughout this briefing, trade includes not only trade with foreign countries, but also trade between Scotland and RUK. Exports account for 58% of Scottish GDP and imports for 60% of Scottish GDP. By contrast, in RUK exports account for 35% of GDP and imports for 36%

of GDP. This difference reflects the fact that trade as a share of GDP tends to be higher in smaller economies. In European terms, the UK is a large economy, whereas Scotland is medium-sized. In 2017 Scotland's GDP was £169 billion, similar to Czechia, Greece, Romania and Portugal.

**Table 1: Scotland and rest of UK trade in 2017**

|            | Exports   |                         |                        | Imports   |                         |                        | GDP<br>£ billion |
|------------|-----------|-------------------------|------------------------|-----------|-------------------------|------------------------|------------------|
|            | £ billion | Share of exports in GDP | Intra-UK exports share | £ billion | Share of imports in GDP | Intra-UK imports share |                  |
| Scotland   | 98        | 58%                     | 61%                    | 102       | 60%                     | 67%                    | 169              |
| Rest of UK | 659       | 35%                     | 10%                    | 681       | 36%                     | 9%                     | 1,903            |

Source: Authors' calculations using Whole of Scotland Economics Account Project Development of Supply & Use Satellite Accounts for Extra-Regio Economic Activities Summary Tables 1998-2017, ONS Pink Book 2019 and ONS Blue Book 2019.

Notes: The table covers trade in goods and services. Scottish data combine both the onshore and offshore economies and uses the Mid Specialisation Scenario for the offshore economy. RUK trade calculated by adjusting whole of UK trade using Scottish data. Intra-UK share reports share of Scottish exports/imports going to RUK and share of RUK exports/imports going to Scotland.

*Fact 2. The rest of the UK is by far Scotland's biggest trade partner.* In 2017 Scotland exported £98 billion of goods and services, of which £60 billion went to RUK. This means that sales to RUK accounted for 61% of Scotland's exports (see Table 1). At the same time, 67% of Scotland's imports were purchased from RUK. These shares have been broadly stable for the past twenty years, as shown in Figure 2. By contrast, Scotland accounts for only 10% of RUK's exports and 9% of its imports. This shows that trade within the UK is substantially more important to Scotland than to the rest of the UK. The asymmetry results from the RUK economy being eleven times larger than the Scottish economy.

*Fact 3. Scotland's exports to countries beyond the UK are evenly split between EU and non-EU destinations.* Table 2 shows the top destinations for exports from Scotland's onshore economy in 2017 (comparable data is not available for the offshore economy or imports). The second largest export destination after RUK is the USA, but Scotland exports nine times more to RUK than to the USA. After the USA, Scotland's other biggest export destinations are all European countries. In total, 46% of Scotland's overseas exports (i.e. exports to destinations other than RUK) go to EU countries. For the UK as a whole, 45% of exports go to the EU, showing that the share of overseas exports accounted for by the EU is similar for Scotland and RUK.

**Figure 2: Share of rest of UK in Scottish trade**



Source: Authors' calculations using Whole of Scotland Economics Account Project Development of Supply & Use Satellite Accounts for Extra-Regio Economic Activities Summary Tables 1998-2017.

Notes: Data covers trade in goods and services, combines both the onshore and offshore economies and uses the Mid Specialisation Scenario for the offshore economy.

*Fact 4. Scotland's comparative advantage is in Mining & Quarrying, Business services and Food products.* Table 3 shows export and import shares by sector for Scotland and RUK in 2014, which is the most recent year for which this sectoral decomposition can be calculated. Mining & Quarrying makes up 26% of Scotland's exports, which is mostly accounted for by offshore oil and gas production. Figure 3 shows that the share of offshore oil and gas production in Scottish exports is fairly volatile, with fluctuations driven by changes in production capacity and oil prices.

Business services contribute 20% of Scottish exports, almost evenly split between Financial & Insurance services and Professional, Scientific & Technical services. By comparison, Business services only account for 10% of RUK exports, even though RUK also has a comparative advantage in this sector compared to most of the world. Food products account for a further 12% of Scottish exports, reflecting the strength of Scotland's food and drink producers. However, outside of Food products, Scotland's manufacturing exports are relatively small. In total, manufacturing accounts for 30% of Scottish exports compared to 46% of RUK exports.

**Table 2: Onshore Scotland's top export destinations 2017**

| Rank                  | Destination | Exports (£ billion) | Share of exports |
|-----------------------|-------------|---------------------|------------------|
| 1                     | Rest of UK  | 48.9                | 60.1%            |
| 2                     | USA         | 5.5                 | 6.8%             |
| 3                     | Netherlands | 2.5                 | 3.0%             |
| 4                     | France      | 2.4                 | 3.0%             |
| 5                     | Germany     | 2.3                 | 2.9%             |
| 6                     | Ireland     | 1.5                 | 1.8%             |
| 7                     | Norway      | 1.0                 | 1.2%             |
| 8                     | Belgium     | 1.0                 | 1.2%             |
| 9                     | Denmark     | 0.9                 | 1.1%             |
| 10                    | Spain       | 0.9                 | 1.0%             |
| Total EU exports      |             | 14.9                | 18.3%            |
| Total non-EU exports  |             | 17.6                | 21.6%            |
| Total onshore exports |             | 81.4                |                  |

Source: Export Statistics Scotland 2017.

Notes: Exports of goods and services from the onshore economy only.  
Exports by destination country not available for the offshore economy.

*Fact 5. Services are more important to Scotland's trade with the rest of the UK, than in Scotland's trade with foreign countries.* Globally, services comprise around one-fifth of trade, but the share of services in Scottish trade, particularly trade with RUK, is much higher. In 2014 services made up 48% of Scotland's exports to RUK and 59% of its imports. By contrast, services account for 32% of Scottish exports outside of the UK and 29% of Scottish imports. These statistics suggest that, in the event of Scottish independence, maintaining low barriers to services trade between Scotland and RUK will be particularly important for the Scottish economy.

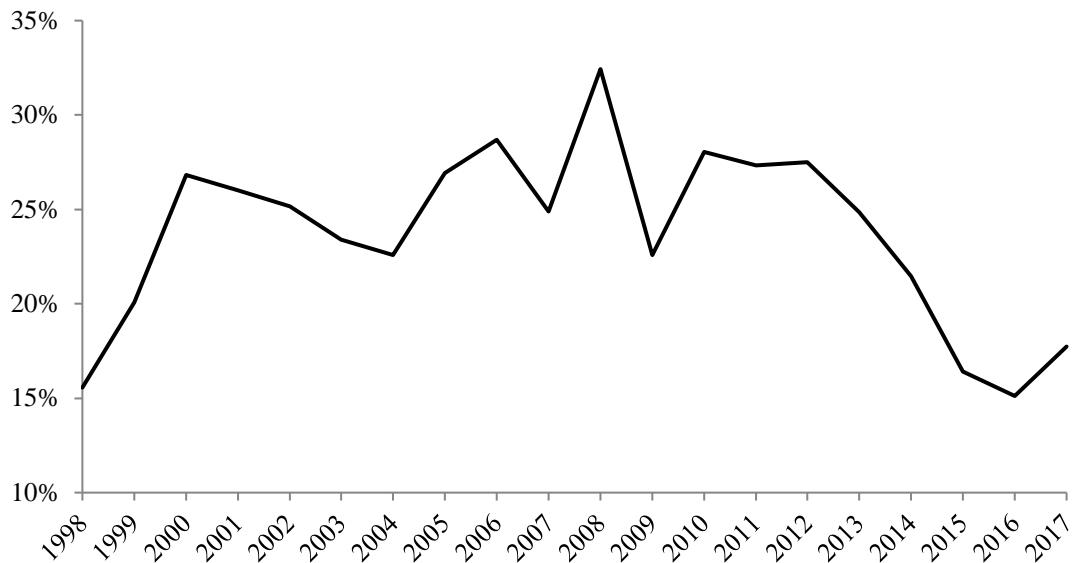
**Table 3: Sectoral breakdown of Scotland and rest of UK trade 2014**

|   | Sector export share |     | Sector import share |     |
|---|---------------------|-----|---------------------|-----|
|   | Scotland            | RUK | Scotland            | RUK |
| Agriculture, Forestry & Fishing               | 3%                  | 4%  | 2%                  | 8%  |
| Mining & Quarrying                            | 26%                 | 1%  | 2%                  | 8%  |
| Food Products, Beverages & Tobacco            | 12%                 | 1%  | 10%                 | 3%  |
| High-tech Manufacturing                       | 9%                  | 19% | 15%                 | 22% |
| Other Manufacturing                           | 9%                  | 26% | 23%                 | 31% |
| Financial & Insurance Services                | 11%                 | 9%  | 6%                  | 5%  |
| Professional, Scientific & Technical Services | 9%                  | 1%  | 7%                  | 1%  |
| Other Services                                | 22%                 | 40% | 35%                 | 23% |
| Total Manufacturing                           | 30%                 | 46% | 48%                 | 56% |
| Total Services                                | 41%                 | 49% | 49%                 | 29% |

Source: Authors' calculations using Scotland Supply, Use and Input-Output Tables 1998-2016, Whole of Scotland Economic Accounts Project Supply and Use Satellite Account Tables 1998-2014 and UK Supply and Use Tables 2014.

Notes: Scottish data combines both the onshore and offshore economies and uses the Mid Specialisation Scenario for the offshore economy. RUK trade calculated by adjusting whole of UK trade using Scottish data. Sectoral classification based on SIC 2007 sectors used in Export Statistics Scotland. High-tech Manufacturing includes: Computer, Electronic and Optical Products; Electrical Equipment; Machinery and Equipment N.E.C.; and Transport Equipment.

**Figure 3: Share of offshore oil and gas production in Scottish exports**



Source: Authors' calculations using Whole of Scotland Economics Account Project Development of Supply & Use Satellite Accounts for Extra-Regio Economic Activities Summary Tables 1998-2017.

Notes: Data covers exports of goods and services and uses the Mid Specialisation Scenario for the offshore economy.

## Border costs

International borders create barriers to doing business. Consequently, trade costs between countries are higher than trade costs between regions of the same country (Anderson and Van Wincoop 2004). Border costs result not only from economic policies, such as tariffs, customs checks and regulations, but also from cultural and social differences between nations that reduce the effectiveness of international communication or lead consumers to prefer domestically produced goods and services.

International agreements such as free trade agreements, customs unions or the EU's single market reduce the trade costs caused by international borders, but do not eliminate them. Even within the EU many economic policies are country-specific (e.g. taxes, labour market laws, regulation of many services industries), which creates border costs (Santamaria et al. 2020). If Scotland becomes independent, similar barriers would arise between Scotland and RUK, even if Scotland and RUK maintain a common economic market.

However, Scotland remaining in a common market with RUK following independence would result in lower Scotland-RUK border costs than joining the EU. If Scotland joins the EU, the Scotland-RUK border would become one of the EU's external borders. This means cross-border trade would be subject to customs checks and other border barriers. As an EU member, Scotland would also have to abide by EU regulations and economic policies, likely further increasing trade barriers due to regulatory divergence between Scotland and RUK. Border costs would also depend upon whether Scotland continued to use sterling as its currency (Armstrong and Ebell 2013), although we do not explicitly model currency choice in our analysis.

An extensive literature uses data on trade across countries and sub-national regions to estimate the size of border effects. The main conclusions of this literature are that border costs are economically important and have large negative effects on international trade (McCallum 1995; Anderson and Van Wincoop 2004). For example, Anderson and Van Wincoop (2003) estimate that the US-Canada border effect is equivalent to a 48% increase in trade costs,<sup>3</sup> while HMG (2013) estimates that Scottish independence would reduce Scotland's trade with RUK by roughly 80% after 30 years.

Comerford and Rodriguez Mora (2019) estimate that the border effect increases trade costs for goods between EU member states by 23% compared to trade costs between US states, 58% compared to costs between Canadian provinces and 91% compared to costs between Spanish regions. They also estimate that border costs for goods trade between EU countries are 13% lower than border costs between country pairs in which at least one country is not an EU member.<sup>4</sup>

However, Comerford and Rodriguez Mora argue that these average border effect estimates are likely to overstate the border costs that would arise following Scottish independence due to selection bias. Their argument is that regions which choose to form a political union, as England and Scotland did in 1707, probably share social and cultural affinities that result in lower trade costs whether or not they are separate countries. Instead, they assume that Ireland provides a valid counterfactual for Scotland's relationship with RUK after independence. Comparing Scotland-RUK trade with Ireland-UK trade, they estimate that independence would increase trade costs between Scotland and RUK by 31%.

Santamaria et al. (2020) use a novel dataset on goods trade by road between European regions to estimate the impact of national borders within the EU. Using an identification strategy designed to address endogeneity in the placement of borders, they find that borders cause large reductions in trade between EU countries. The estimated average border effect implies that a region's market share in a foreign region is only 17.5% of its market share in an otherwise similar domestic region. Their comparable estimate for regions separated by a border created after 1910 is 28.8%, showing that even the creation of 'new' borders has substantial effects on trade.

Additional evidence that disintegration leads to large increases in trade costs is provided by Head et al. (2010), who find that, when former colonies become independent, trade with their colonizer falls by an average of 65%.<sup>5</sup> HMG (2013) also reports that in the decade following the 1993 break-up of Czechoslovakia, the share of Czech exports going to Slovakia declined from 22% to 8%, while the share of Slovakian exports sold to the Czech Republic fell from 42% to 13%.

---

<sup>3</sup> Empirical studies estimate how borders affect trade flows. Converting these estimates to implied border costs requires imposing a value for the trade elasticity, which determines the sensitivity of trade flows to trade costs. Anderson and Van Wincoop's (2003) estimate assumes the trade elasticity equals 4, which is close to the value estimated by Simonovska and Waugh (2014). Increasing the trade elasticity from 4 to 9, reduces Anderson and Van Wincoop's estimated border effect from 48% to 19%.

<sup>4</sup> Comerford and Rodriguez-Mora (2019) assume the trade elasticity equals 3.5.

<sup>5</sup> Assuming the trade elasticity equals 4, a 30% increase in trade costs is required to generate a 65% decline in trade, all else constant.

The high level of trade currently observed between Scotland and RUK (recall Fact 2 above) is consistent with the border costs literature. On average, trade flows between country-pairs are well explained by the gravity equation, which posits that trade is increasing in economic size and decreasing in trade costs (Head and Mayer 2014). Consequently, the difference between observed trade and the level of trade predicted by gravity gives a measure of unexplained or ‘residual’ trade, which we can use to identify country-pairs with unusually high trade levels. Country-pairs that trade more than expected have high residuals.

Figure 4 plots Scotland and RUK’s residual trade with a sample of their major trading partners.<sup>6</sup> The point labelled SCO-RUK in the upper right-hand corner shows residual trade between Scotland and RUK. For Scotland, the unexplained trade with RUK is higher than with any country except Norway. For RUK, unexplained trade with Scotland is higher than with any other country.

The size of the SCO-RUK residual in Figure 4 implies there is six times more trade between Scotland and RUK than predicted by the gravity equation.<sup>7</sup> Assuming the trade elasticity equals four, Figure 4 implies that residual trade costs between Scotland and RUK are 12% lower than between Scotland and Latvia (which has the third highest residual with Scotland), 31% lower than between Scotland and USA and 36% lower than between Scotland and the average country, which has a zero residual.

Since the gravity equation used to construct Figure 4 does not account for the fact that Scotland and RUK share a political and economic union, a likely explanation for part of the high SCO-RUK residual is that there is no international border between Scotland and RUK. Scottish independence would introduce new border costs leading to a decline in Scotland’s trade with RUK. But, unfortunately, we do not know exactly how large the border costs would be.

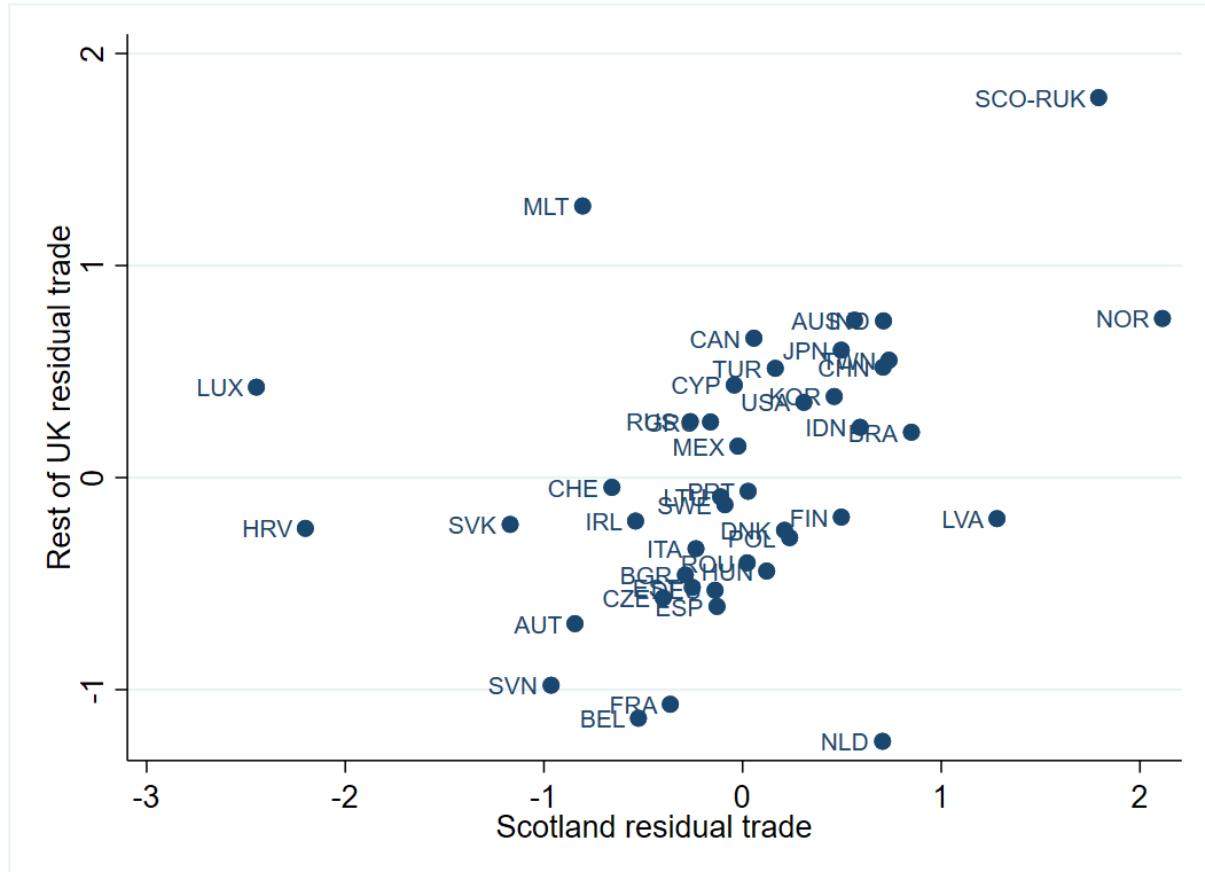
However, to model the consequences of Scottish independence, we need to take a stance on the effect of independence on trade costs. Given the fairly wide range of border cost estimates in the literature and the lack of historical precedents that can be used to obtain a ‘best estimate’ of border costs following Scottish independence, we choose to model two cases. In the *low border cost* case, trade costs between Scotland and RUK increase by 15%. In the *high border cost* case, trade costs increase by 30%.

---

<sup>6</sup> See the Appendix for an explanation of how the residuals are calculated.

<sup>7</sup> Figure 4 uses log scales, the value of the residual is 1.79 and  $\exp(1.79) \approx 6$ . The magnitude of this estimate is somewhat sensitive to how the gravity equation is estimated and the definition used to determine the distance between countries (see the Appendix for details). Plausible alternative estimates imply that there is between 2.6 and 7.8 times more Scotland-RUK trade than predicted by the gravity equation.

**Figure 4: Scotland and rest of UK's residual trade unexplained by gravity equation**



Source: Authors' calculations.

Notes: The figure plots the residuals from OLS estimation of a log-linear gravity equation controlling for distance, importer and exporter fixed effects and dummy variables for EU membership, having a free trade agreement and sharing a currency, language, land border or colonial relationship. For each country pair, the figure shows the average of the import and export residuals for log trade in 2014.

Both of these cases are designed to capture the increase in trade costs if Scotland and the rest of the UK maintain a common economic market following independence. Our judgment is that the low border cost case is optimistic about the effect of Scottish independence on intra-UK trade costs (assuming a UK common market), while the high border cost case is pessimistic. As discussed above, Scotland joining the EU would introduce additional border costs with RUK, while reducing border costs with EU countries. The approach we take to modelling changes in border costs due to EU membership is described in the next section.

## Modelling Scottish independence & Brexit

To analyse the effects of Scottish independence and Brexit on trade flows and living standards, we consider four scenarios.

1. Brexit, but Scotland remains part of the UK.
2. Scotland becomes independent, but there is no Brexit.
3. Brexit and Scotland becomes independent, but remains in a common economic market with the rest of the UK.

#### 4. Brexit and Scotland becomes independent, but rejoins the EU.

In each of the scenarios where Scotland becomes independent, we analyse both the low border cost and the high border cost case.

Our analysis uses the CEP trade model developed by Dhingra et al. (2017) to study Brexit. The CEP trade model is a general equilibrium, quantitative, international trade model with many countries, many sectors, intermediate input trade and input-output linkages between sectors. It is based on a multi-sector version of the Eaton and Kortum (2002) trade model developed by Caliendo and Parro (2015).

We calibrate the model using 2014 data for 27 sectors. We use 2014 data because it is the most recent year for which all the datasets needed to calibrate the model are available. The sectoral aggregation is based on that used by Export Statistics Scotland. To match the level of detail available in Scottish trade data, we aggregate countries into four regions: Scotland, the rest of the UK (RUK), EU countries and the rest of the world (NonEU). A detailed description of the calibration data is given in the Appendix. In addition, the calibration dataset, together with the bilateral trade data used to obtain the gravity estimates above and a complete data appendix, can be downloaded from the CEP website.

The model allows us to estimate the impact of changes in trade costs on trade flows, sectoral output and income per capita in each of our four regions. Both Brexit and Scottish independence affect trade costs and we model the changes in trade costs cumulatively.

As discussed above, we model Scottish independence by assuming that trade costs between Scotland and RUK increase by 15% in all sectors in the low border cost case and by 30% in all sectors in the high border cost case.

Brexit affects trade costs by creating new trade barriers between EU countries and regions that leave the EU (Dhingra and Sampson 2016; Sampson 2017). We model these barriers following Bevington et al. (2019) who assume that UK-EU trade is based on a free trade agreement similar to the deal reached by the UK and EU in December 2020. Trade is tariff-free and quota-free. However, because Brexit involves leaving the EU's customs union and single market, there is an increase in non-tariff barriers arising from customs checks, product standards, regulations and other costs of cross-border trade, particularly for services sectors.<sup>8</sup>

We assume that Brexit increases non-tariff barriers between the EU and exiting regions by half of the reducible non-tariff barriers on US-EU trade for goods sectors and two-thirds for services sectors. Using the estimates of reducible US-EU non-tariff barriers from Berden et al. (2009), this assumption implies a 5.5% increase in trade costs for goods and a 7.3% increase for services.

In addition, regions that leave the EU do not share in future reductions in intra-EU trade costs. Based on Méjean and Schwellnus (2009), we assume that intra-EU trade costs fall 40% faster

---

<sup>8</sup> Our analysis treats Northern Ireland as part of RUK and does not attempt to model its special customs status under the terms of UK's withdrawal from the EU. Northern Ireland only accounts for around 2% of the UK economy.

than trade costs in the rest of the world for ten years after Brexit and we assume that for goods sectors this decline applies to half of the reducible non-tariff barriers, while for services sectors it applies to two-thirds. This implies an 8.4% decline in goods trade costs and an 11.2% decline in services trade costs that regions which leave the EU do not benefit from.

Scotland and RUK have been in a political and economic union for over three centuries. Consequently, we assume falling intra-EU trade costs do not affect trade costs between Scotland and RUK, except in scenario 4 where Scotland joins the EU following independence. In this case, we assume that changes to Scottish policy required to achieve deeper integration with other EU countries lead to increased regulatory divergence from RUK, causing an additional increase in Scotland-RUK trade costs equal in magnitude to the decline in Scotland-EU trade costs.

In the event that Scotland remains part of the UK (scenario 1) or Scotland becomes independent, but remains in the UK's common economic market (scenario 3), changes in trade costs due to Brexit would apply to RUK-EU trade and Scotland-EU trade. However, if an independent Scotland leaves the UK's single market to join the EU (scenario 4), the effect of Brexit on trade costs would apply to RUK-EU trade and Scotland-RUK trade (in addition to the border cost effect due to independence), but not to Scotland-EU trade. Thus, when deciding whether to join the EU following independence, Scotland would face a trade-off between reducing its trade costs with the EU and further increasing its trade costs with RUK.

## Modelling results

We estimate the impact of each scenario on real income per capita in Scotland and RUK. The estimates should be interpreted as long-run effects after all economic adjustment is complete, relative to a baseline where the UK remains in the EU and Scotland remains part of the UK.

As with all economic forecasts, our estimates are subject to uncertainty and should be treated with caution. We do not know exactly how large an effect Scottish independence and Brexit will have on trade costs and, although we use the best available data and modelling techniques, our model is an imperfect representation of the global economy.

In particular, it is important to stress that our analysis is designed to isolate the economic effects of variation in trade costs holding production technologies constant. Both Brexit and Scottish independence are also likely to impact the economy through changes in technology, foreign direct investment, immigration and fiscal arrangements. Moreover, Scottish independence may affect which currency Scotland uses. We do not study these channels.

There is some evidence that trade integration has positive effects on productivity that are not included in our model (Sampson 2017). For example, Dhingra et al. (2017) find that reduced-form estimates of the costs of Brexit are two to three times larger than model-based estimates. These reduced-form estimates seek to capture the impact of Brexit on technological possibilities and foreign direct investment in addition to the channels included in our trade model.

This implies that our analysis is likely to underestimate the costs of Brexit and Scottish independence. Nevertheless, the results give a useful indication of the magnitude of potential changes in income levels and, most importantly, the relative costs and benefits of alternative scenarios.

The estimates are shown in Table 4. In scenario 1, we find that Brexit leads to a 2.0% fall in Scotland's income per capita and a 3.0% fall in RUK's income per capita. These results are comparable in magnitude to the estimates of Bevington et al. (2019) for the UK as a whole, who estimate that a free trade agreement Brexit based on Prime Minister Johnson's proposals for future UK-EU relations would reduce UK income per capita by 2.5% (not accounting for productivity effects).

Brexit is less costly for Scotland than for RUK primarily because trade with the EU accounts for a lower proportion of Scottish output than RUK output. In our dataset, trade with the EU accounts for 10.9% of Scottish output, but 13.5% of RUK output. However, given the limitations of existing Scottish trade data, we would caution against interpreting our results as providing conclusive evidence that Scotland has less to lose from Brexit than RUK.

The Scottish government estimates that with future UK-EU relations based on a free trade agreement, Brexit will reduce Scottish GDP in 2030 by 6.1% (Scottish Government 2019). These estimates are not directly comparable to our results because they incorporate the effects of Brexit on FDI, productivity, immigration and fiscal transfers between the UK and EU, while we focus solely on trade effects. However, the relative size of the estimates is consistent with the hypothesis put forward by Dhingra et al. (2017) that the total economic costs of Brexit may be up to three times larger than the estimates produced by our trade model.

In the absence of Brexit, we estimate independence reduces Scotland's income per capita by 4.2% in the low border cost case and 6.3% in the high border cost case (scenario 2). Therefore, we conclude that changes in trade costs due to independence are likely to be around two to three times more costly for Scotland than changes in trade costs due to Brexit. Independence is worse economically for Scotland than Brexit primarily because Scotland trades around four times more with RUK than with the EU. In addition, the assumed impact of independence on trade costs is similar to the Brexit effect in the low border cost case and larger than the Brexit effect in the high border cost case.

**Table 4: Effects of Brexit and Scottish independence on long-run real income per capita**

| Scenario                                     | Percent change in income per capita |            |
|--|-------------------------------------|------------|
|  | Scotland                            | Rest of UK |
| 1. Brexit                                    | -2.0                                | -3.0       |
| <b>Low border cost case</b>                  |                                     |            |
| 2. Scottish independence                     | -4.2                                | -0.2       |
| 3. Independence & Brexit & UK common market  | -6.5                                | -3.2       |
| 4. Independence & Brexit & Scotland joins EU | -6.3                                | -3.4       |
| <b>High border cost case</b>                 |                                     |            |
| 2. Scottish independence                     | -6.3                                | -0.4       |
| 3. Independence & Brexit & UK common market  | -8.7                                | -3.4       |
| 4. Independence & Brexit & Scotland joins EU | -7.6                                | -3.5       |

Source: Authors' calculations using CEP trade model.

Notes: Changes in trade costs between EU and regions that leave the EU following Brexit are modelled assuming a UK-EU free trade agreement as in Bevington et al. (2019). Scottish independence is assumed to increase trade costs between Scotland and rest of the UK by 15% in the low border cost case and 30% in the high border cost case.

The estimated effect of independence on RUK living standards is small. Income per capita declines by 0.2% in the low border cost case and 0.4% in the high border cost case. Trade between RUK and Scotland accounts for 3.9% of RUK output compared to 44% of Scottish output, making Scotland much more exposed than RUK to the creation of a border within the UK.

Our estimates of the costs of independence are slightly smaller than the estimate of Comerford and Rodriguez Mora (2019), whose model predicts independence would reduce Scottish income per capita by 8.5%. As discussed above, Comerford and Rodriguez Mora argue that independence would increase trade costs between Scotland and RUK by 31%, which is comparable to our high border cost case. However, Comerford and Rodriguez Mora assume a trade elasticity of 3.5, whereas we use sector-specific trade elasticities estimated by Caliendo and Parro (2015). In our calibration the Scottish trade weighted average trade elasticity is 7.5. Trade models usually find that the impact of changes in trade costs on living standards is larger when the trade elasticity is smaller.

Scenarios 1 and 2 analyse Brexit and Scottish independence in isolation. However, the UK's departure from the EU means that an independent Scotland would have to choose between maintaining a common economic market with RUK (scenario 3) and rejoining the EU (scenario 4). As discussed above, rejoining the EU would reduce Scotland-EU trade costs, while further increasing Scotland-RUK trade costs.

The results in Table 4 show that the costs of independence are similar regardless of whether or not Scotland rejoins the EU. In the low border cost case, Brexit and independence together reduce Scottish income per capita by 6.5% if Scotland and RUK form a common economic market (scenario 3) and 6.3% if Scotland rejoins the EU (scenario 4). The small difference between these estimates leads us to conclude that while rejoining the EU would not exacerbate the costs of independence, neither would it mitigate them.

This finding is a consequence of the model's prediction that, in the low border cost case, Scotland would trade roughly the same amount with RUK following independence as with the EU. In these circumstances, Scotland is indifferent over whether the EU's external border should apply to Scotland-EU trade or Scotland-RUK trade.

Comparing scenarios 3 and 4 highlights a paradox inherent in the argument that Scotland should seek independence in order to rejoin the EU. In order for rejoining the EU to make Scotland better off than maintaining a common economic market with RUK, independence must have a sufficiently large negative effect on Scotland-RUK trade that the EU becomes Scotland's biggest trade partner. However, the more independence reduces Scotland-RUK trade, the larger its economic costs. In other words, the economic case for rejoining the EU implicitly relies on the assumption that independence has a sufficiently large economic cost. In fact, in the (implausible) scenario where independence does not affect border costs with the rest of the UK, the model implies that rejoining the EU following Brexit would be twice as costly to the Scottish economy as maintaining a common market with the rest of the UK.

This reasoning also implies that rejoining the EU is more attractive in the high border cost case than in the low border cost, which Table 4 confirms. In the high border cost case, Scotland's income per capita falls by 8.7% in scenario 3 and 7.6% in scenario 4, meaning that an independent Scotland is slightly better off inside the EU. However, regardless of whether Scotland rejoins the EU, the costs of independence are greater in the high border cost case than the low border cost case.

The results for scenarios 3 and 4 imply that the combination of Brexit and independence would reduce Scotland's income per capita by between 6.3% and 8.7%. In pound terms, this corresponds to an income decline ranging from £2,000 to £2,800 per person.<sup>9</sup>

How long economic adjustment to Brexit and Scottish independence would take is highly uncertain. Brexit studies typically argue that it will take 10-15 years for the full effects to materialise (Sampson 2017; HMG 2018). Adjustment to Scottish independence is likely to be even slower and may take a generation or more, as border costs gradually increase due to divergence between economic policy and regulations in the two countries and the erosion of existing cultural, social and business ties. Head et al. (2010) find that the decline in trade following the end of colonial relationships occurs gradually over four decades.

Slow adjustment implies that RUK would continue to be Scotland's most important trade partner for many years after independence. Consequently, even if there may be a long-run

---

<sup>9</sup> This calculation uses Scotland's GDP per capita from the Quarterly National Accounts. Reported GDP per capita in 2019 including a geographical share of Extra-Regio activity is £32,338.

economic case for rejoining the EU (as Table 4 suggests), in the immediate aftermath of independence Scotland should prioritise keeping border costs with RUK as low as possible by seeking to maintain an economic union with RUK rather than rejoining the EU. Given the uncertainty that exists over the size of border costs, this policy would also allow a future Scottish government to learn more about the effect of independence on Scottish trade (and other economic outcomes not considered in this briefing) before deciding whether to rejoin the EU.

## Conclusions

Many considerations beyond economics will play a role in shaping the outcome of a second referendum on Scottish independence. But to make an informed decision on the costs and benefits of independence, voters need to know what the likely economic consequences of independence would be. This briefing contributes to that goal by analysing how changes in trade costs due to independence and Brexit are expected to affect aggregate Scottish income per capita.

We find that the costs of independence to the Scottish economy are likely to be two to three times larger than the costs of Brexit. Moreover, rejoining the EU following independence would do little to mitigate these costs and in the short run would probably lead to greater economic losses than maintaining a common economic market with the rest of the UK.

Our work focuses on the aggregate effects of changes in trade costs holding production technologies constant. A complete account of the economics of independence should also consider changes in technology, foreign investment, immigration, currency arrangements and fiscal transfers as well as studying the distributional consequences of independence. But our analysis shows that, at least from a trade perspective, independence would leave Scotland considerably poorer than staying in the United Kingdom.

## February 2021

We are grateful to Angus Armstrong, Jim Gallagher and Mairi Spowage for useful discussions about the Scottish economy and Scottish data. This research was funded by the Economic and Social Research Council under grant ES/M010341/1.

### *For further information, contact:*

Hanwei Huang: [hhuang54@cityu.edu.hk](mailto:hhuang54@cityu.edu.hk)

Thomas Sampson: [t.a.sampson@lse.ac.uk](mailto:t.a.sampson@lse.ac.uk)

Patrick Schneider: [p.schneider4@lse.ac.uk](mailto:p.schneider4@lse.ac.uk)

or Helen Ward: 07970 254872, [h.ward1@lse.ac.uk](mailto:h.ward1@lse.ac.uk)

or Romesh Vaitilingam: [romesh@vaitilingam.com](mailto:romesh@vaitilingam.com)

## Further reading

Anderson, J. E. and E. Van Wincoop (2003) 'Gravity with Gravitas: A Solution to the Border Puzzle', *American Economic Review*, 93(1): 170-192.

Anderson, J. E. and E. Van Wincoop (2004) 'Trade Costs', *Journal of Economic Literature*, 42(3): 691-751.

Armstrong, A. and M. Ebell (2013) 'Scotland's Currency Options', National Institute of Economics and Social Research Discussion Paper No. 415.

Armstrong, A. and M. Ebell (2014) 'The Economics of Scottish Independence: Introduction', *National Institute Economic Review*, 227(1): R1-R2.

Bell, D., D. Eiser and K. Beckmann (2014) 'The Economic Consequences of Scottish Independence', Hamburg.

Berden, K., J. Francois, S. Tamminen, M. Thelle and P. Wymenga (2009) 'Non-Tariff Measures in EU-US Trade and Investment – An Economic Analysis', Ecorys report prepared for the European Commission, Reference OJ 2007/S180219493.

Bevington, M., H. Huang, A. Menon, J. Portes, J. Rutter and T. Sampson (2019) 'The Economic Impact of Boris Johnson's Brexit Proposals', CEP Brexit Analysis No. 16.

Caliendo, L. and F. Parro (2015) 'Estimates of the Trade and Welfare Effects of NAFTA', *Review of Economic Studies* 82(1): 1-44.

Comerford, D. and J.V. Rodríguez Mora (2019) 'The Gains from Economic Integration'. *Economic Policy*, 34(98): 201-266.

Costinot, A. and A. Rodríguez-Clare (2014) 'Trade Theory with Numbers: Quantifying the Consequences of Globalization'. In *Handbook of International Economics*, Vol. 4, 197-261, Elsevier.

Dhingra, S., H. Huang, G. Ottaviano, J. Pessoa, T. Sampson and J. Van Reenen (2017), 'The Costs and Benefits of Leaving the EU: Trade Effects', *Economic Policy*, 32(92): 651-705.

Dhingra, S., G. Ottaviano, T. Sampson and J. Van Reenen (2016), 'The Consequences of Brexit for UK Trade and Living Standards', CEP Brexit Analysis No. 2.

Dhingra, S. and T. Sampson (2016) 'Life after Brexit: What are the UK's Options Outside the European Union?', CEP Brexit Analysis No. 1.

Eaton, J. and S. Kortum (2002) 'Technology, Geography, and Trade', *Econometrica*, 70(5): 1741-1779.

Head, K., and T. Mayer (2014) 'Gravity Equations: Workhorse, Toolkit, and Cookbook', In *Handbook of International Economics*, Vol. 4, 131-195, Elsevier.

Head, K., T. Mayer and J. Ries (2010) 'The Erosion of Colonial Trade Linkages after Independence', *Journal of International Economics*, 81(1): 1-14.

The Herald (2020) 'IndyRef2: New Poll shows 53% would back Independence as SNP set for Record Holyrood Majority', 12<sup>th</sup> August,

<https://www.heraldscotland.com/news/18644907.indyref2-new-poll-shows-53-back-independence-snp-set-record-holyrood-majority/>.

HM Government (2013) 'Scotland Analysis: Macroeconomic and Fiscal Performance'.

HM Government (2018) 'EU Exit: Long term Economic Analysis'.

McCallum, J. (1995) 'National Borders Matter: Canada-US Regional Trade Patterns', *American Economic Review*, 85(3): 615-623.

Méjean, I. and S. Schwellnus (2009) 'Price Convergence in the European Union: Within Firms or Composition of Firms?', *Journal of International Economics*, 78(1): 1-10.

Sampson, T (2017) 'Brexit: The Economics of International Disintegration', *Journal of Economic Perspectives*, 31(4): 163-84.

Santamaria, M., J. Ventura and U. Yesilbayraktar (2020) 'Borders with Europe', NBER Working Paper No. 28301.

Scottish Government (2019) 'Scotland's Place in Europe: Our Assessment of the Revised Withdrawal Agreement and Political Declaration'.

Simonovska, I. and M. Waugh (2014) 'The Elasticity of Trade: Estimates and Evidence', *Journal of International Economics*, 92(1): 34-50.

## Appendix

### Model calibration

We describe below the main steps and assumptions used to calibrate the trade model. The calibration uses data for 2014 for 4 regions (Scotland, RUK, EU, NonEU) and 27 sectors. The calibration data together with a complete description of how we constructed the dataset can be downloaded from: <https://cep.lse.ac.uk/pubs/download/dataBR17.zip>.

To calibrate the model, we use the following data.

- Trade flows. Expenditure by each region on output from each source region, by sector.
- Value-added shares. The share of value-added in output, by region and sector.
- Intermediate input shares. Each source sector's share in intermediate input expenditure, by region and using sector.
- Trade elasticities. The elasticity of trade flows to trade costs, by sector.

Given this data we infer each sector's share of final demand expenditure by region from the trade model's equilibrium conditions.

For the EU and NonEU regions, and for the UK as a whole, the data needed for calibration is calculated from the World Input-Output Database (WIOD). For Scotland we combine data from: Export Statistics Scotland; the Supply, Use and Input-Output Tables for Scotland's onshore economy, and; the Supply and Use Satellite Accounts Tables for Scotland's offshore economy from the Whole of Scotland Economic Accounts Project. We also use the UK Supply and Use Table and the UK Input-Output Analytical Tables. For consistency with WIOD, the calibration uses basic price data for Scotland and RUK.

To construct the calibration data for Scotland and RUK, we follow a three-step procedure. First, we combine data on the onshore and offshore Scottish economies to calculate trade flows and an input-output table at basic prices for the whole Scottish economy. Second, we subtract Scotland's trade and input-output usage from UK values (taken from the UK Input-Output Analytical Table) to obtain trade flows and an input-output table at basic prices for RUK. Third, for consistency with WIOD, we constrain the sum of Scotland and RUK's trade and input-output usage to equal the corresponding values for the whole of the UK taken from WIOD.

Not all of the data required for calibration is available for Scotland. We make the following assumptions to impute missing Scottish data.

- Scotland does not publish import use by using sector at basic prices. We assume that there are no re-exports of non-processed imports and that total basic price imports of each sector are allocated across using sectors and final demand in the same proportions as domestic production. We also convert Scotland's offshore input-output table from purchasers' prices to basic prices using the ratio of basic to purchasers' price values in Mining and Quarrying from the UK Supply and Use Table.
- Scotland's onshore and offshore input-output tables do not distinguish between trade with EU and NonEU countries. For onshore exports, we split exports across the EU and

NonEU regions using proportions for each sector taken from Export Statistics Scotland. For imports and offshore exports, we do not have comprehensive data on how Scotland's trade is split across partner countries. Consequently, we assume that for each sector the proportion of Scotland's trade with the EU and NonEU regions is the same as for the whole of the UK, which we take from the UK Input-Output Analytical Tables.

Trade elasticities are taken from Costinot and Rodríguez-Clare (2014) who use Caliendo and Parro's (2015) estimates for goods sectors and set the trade elasticity equal to five for services sectors. We aggregate trade elasticities from Costinot and Rodríguez-Clare's 31 sector classification to our 27 sector classification using a weighted average, where each sector's weight equals its share of total Scottish trade from Scotland's supply and use tables.

Our counterfactual analysis uses a solution algorithm from Costinot and Rodríguez-Clare (2014). We start from an initial equilibrium with zero tariffs and eliminate trade deficits before simulating the scenarios.

### Gravity estimation

The gravity estimation uses a dataset of bilateral imports and exports in 2014 at the aggregate level for 42 countries plus RUK and Scotland. Bilateral trade between the UK and the 42 foreign countries in the sample is taken from WIOD. However, comprehensive bilateral trade data for Scotland does not exist.<sup>10</sup> Consequently, we infer Scotland's bilateral trade by splitting its EU and NonEU trade in our calibration dataset across the 42 sample countries.

We allocate Scottish imports and exports across countries using the proportion of Scotland's trade with each country in HMRC's Regional Trade Statistics.<sup>11</sup> We also take Scotland-RUK trade directly from the calibration dataset. Finally, RUK's bilateral trade with foreign countries is calculated as the difference between UK's bilateral trade in the WIOD dataset and Scotland's inferred bilateral trade. The bilateral trade dataset is included in the data download that accompanies this briefing.

To construct Figure 4, we regress log bilateral trade on log distance, importer and exporter fixed effects and dummy variables for: EU membership, having a free trade agreement, and sharing a currency, language, land border or colonial relationship. We then calculate residual trade as the difference between log trade and predicted log trade. Figure 4 shows the estimated residuals for each country's trade with Scotland and with RUK, where each observation is the average of the export residual and the import residual.

Figure 4 is constructed using the distance between capital cities to measure the distance between country pairs. We have also calculated the distance variable as the population-weighted average distance between all cities with population above 300,000 in 2015. Using

---

<sup>10</sup> Export Statistics Scotland reports onshore exports by destination for all sectors, but does not cover imports or the offshore economy. HMRC Regional Trade Statistics reports goods exports and imports by partner country, but does not cover services.

<sup>11</sup> For example, France accounts for 10.9% of Scottish imports from EU countries in the Regional Trade Statistics. Therefore, we assume Scotland's imports from France equal 10.9% of its total EU imports in the calibration dataset. Using Export Statistics Scotland data, instead of the Regional Trade Statistics, to apportion Scottish exports makes no substantive difference to the gravity estimates and residuals.

this alternative distance measure to estimate the gravity equation, we still find that Scotland's unexplained trade with RUK is higher than with any country except Norway, while, for RUK, unexplained trade with Scotland is higher than with any other country. The estimates imply that there is 4.8 times more trade between Scotland and RUK than predicted by the gravity equation.

Our baseline analysis uses a log-linear gravity equation, but estimating a Poisson regression model delivers similar results. For Scotland, residual trade with RUK is again higher than with any country except Norway, while, for RUK, unexplained trade with Scotland is now lower than with Malta, but higher than with all other countries. RUK's residual trade with Scotland is 2.6 times higher than predicted, while Scotland's residual trade with RUK is 7.8 times higher than predicted.<sup>12</sup>

---

<sup>12</sup> These calculations impose that the average log trade residual for each country with all its trading partners equals zero.