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## Free Trade under Brexit- why its benefits have been widely underestimated

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# Free Trade under Brexit- why its benefits have been widely underestimated

It was astonishing during late 2015 to discover that most economists in the UK favoured staying in the EU on the basis of what appeared to be neo-protectionist arguments derived from recent 'gravity-related' trade thinking. In late additions to the second edition of my book 'Should the UK leave the EU?' (2015) I pointed out that the gravity modelling was of a partial equilibrium nature and that attempts hitherto made to turn it into general equilibrium were misconceived. It soon became apparent that my professional colleagues were not going to take any notice of these points; and indeed the Treasury economists promptly enlisted help from the LSE's gravity trade group in developing the gravity-based case for retaining existing trade links with the EU regardless of the costs of its well-known protectionism.
We begin in section I with comments on the various rival ' gravity' approaches, all of which have had a strong bias against eliminating EU protection to get to free trade, arguing that the gains are trivial while the losses from abandoning protected trade with the EU are large . We then go on in section II to set out the quantitative analysis we reached on Brexit, using our own models and realistic Brexit policy assumptions. As we will see, these models with realistic assumptions find that there are substantial gains from free trade with the rest of the world.

## I. Gravity Trade models and Brexit: a review

At the heart of the Brexit debate there is a fundamental disagreement about how trade works and affects the economy. In the last few years debate has raged over whether EU trade arrangements are beneficial, in particular to the UK. The EU is a customs union and so erects trade barriers around its Single Market where economic activity is regulated according to EU rules. The welfare effects of a customs union have always been controversial. According to classical trade theory global welfare is reduced compared with free trade as is the average welfare of citizens inside the customs union; however one country's citizens may gain from the union if it is a net exporter to others in the union, as then its terms of trade gain may offset the losses experienced by its consumers (Meade, 1955). However in recent times a new line of reasoning has become popular among trade economists: this 'gravity model' (eg Costinot and Rodriguez-Clare, 2013) regards trade as an outcrop of internal trade, the only difference being that it crosses borders. Otherwise it grows naturally due to the specialisation and division of labour within neighbouring markets. Viewed through the lens of the gravity model a customs union merely makes official what is already a fact of neighbourly inter-trade. Other sorts of trade, with more distant markets, grows analogously but more weakly, the greater the distance; size of distant markets may make up for their distance to some extent, because they are a 'neighbourhood' that naturally leads to inter-trade. As part of this view of trade as dominated by inter-trade, substitutability between heterogeneous goods and services of different origins is treated as fairly low. 'Gravity' in trade creation can be thought of as a function of distance and size. In this view of trade it makes no sense to put obstacles in the way of trade with close neighbours such as the EU in the hope of boosting trade with distant markets via new trade agreements that lower trade costs. The disruption from the former will reduce welfare while the gains from the latter will be small, simply because the reduced trade

costs will have little effect in switching demand from existing products in the presence of weak and imperfect competition. Furthermore, protection is seen in a fairly positive light in the gravity model, because low substitutability between countries' goods implies that there is scope for protection to improve the terms of trade- the 'optimal tariff' mechanism; He et al (2017) show that it pushes optimal tariff rates before and after retaliation above 100%- clearly a worrying policy implication, which in itself casts doubt on the model's realism.

Before we go further into the technicalities of different models and calculations of trade policy effects, it is worth spending a little thought on what light the history and structure of UK trade throw on the matter. For centuries the UK has been regarded as the archetype of a 'trading nation', in that its great trading companies, such as the East India company, sought out trading opportunities around the world and in the process founded the British Empire, with trading links all over the world. European neighbouring countries had little to do with it, other than the Dutch with whose Indies trading fleets the UK fought several wars, settled by the Treaty of Westminster in 1674. In recent years UK trade has been dominated by services, whose weightlessness implies a total lack of 'gravity'; furthermore the containerisation of goods transport has brought shipping costs down to almost trivial levels. The role of gravity, viz distance x size, seems on the face of it to be small in UK trade. As for European trade, in spite of high EU tariffs against non-EU suppliers, the share of EU trade (imports plus exports) in UK trade has never gone over 25% of UK GDP. Currently it is running at 20% against around 30% with the non-EU world; so UK trade with the EU is about 40% of all its trade, in spite of massive trade barriers (around 20% in both food and manufactures) against non-EU countries. It does not look as if gravity has much to do with it all, certainly European gravity. It is perhaps not a surprise that classical trade theory, with its strong relevance to far-flung UK and other Northern European (Swedish/ Dutch) trade, was developed by British and northern European economists such as Ricardo, Heckscher and Ohlin, while the more recent gravity theory has mainly been developed by economists based in the US or continental Europe where distant trade plays a minor role in GDP. Compare the UK with a country like the Czech Republic with limited trading activity other than with the EU by which it is surrounded; 80% of its trade is with the EU, reflecting its quite different trade opportunities, which are indeed naturally describable by gravity. It would certainly be unsurprising if our test of UK trade rejected the gravity model; as we will see it does.

Before that we review the various attempts that have been made by different groups of economists, using different approaches, to evaluate the trade effects of Brexit.

## 'Gravity model' estimates of Brexit trade effects

Clearly these two models, the classical and the gravity models, are different and so may well have different welfare implications. However, while trade economists have recently tended to favour the gravity model over the classical, there has been no convincing empirical test of the two models as overall predictors of the data. Gravity modellers do point to the Tinbergen (1962) gravity regressions as evidence in favour of the gravity model: these are statistical correlations between the size of two counties' GDPs and their distance from each other on the one hand, and the size of their trade on the other. However these regressions have long been familiar to trade economists, and classical trade models too can generate trade data in line with these regressions. Thus we face here an 'identification' problem: two models can both generate the same data, at least that would be the claim of their proponents. We need an

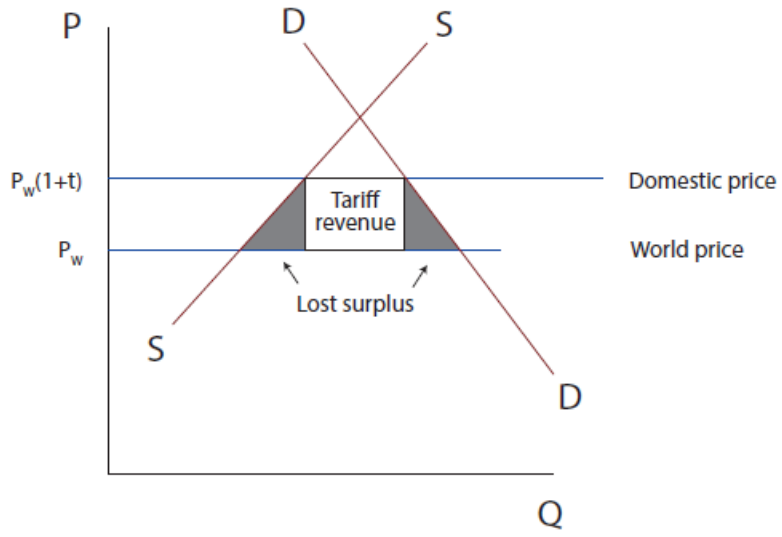
empirical test that can discriminate powerfully between the two models- we will develop this in the section below 'Why the gravity model should not be used…'.

Plainly one has to use the underlying model (i.e. one in which all the interactions within trade and the economy are allowed for) to calculate policy effects, since these work through all the channels of the model; one surely, so we would say, cannot use the Tinbergen and related regressions, since these are simply correlations and associations generated by the model, and are not causal. So we would argue that we must uncover the true model- and this requires a test, to be discussed below.

## The gains from trade- how they are (mis)calculated

The effects of trade policies such as tariffs can be understood with the help of a simple diagram, showing demand and supply of imports. A tariff raises the home price of imports over the world price. Assume for now the world price stays the same. Then the loss of welfare is shown by the shaded area of reduced consumer surplus. This shows the loss to consumers from higher prices, causing lower consumption, and also their loss as producer households from over-production- in which the extra output does not cover rising costs. In effect the tariff revenue, redistributed by the Treasury to households after paying more to producers for uneconomic output expansion, fails to compensate households for their higher costs of purchase.

**Figure 1. Loss of surplus due to tariff**



If the tariff causes world import prices to fall, there is acountervailing gain from better terms of trade, viz lower import/export prices. The size of this gain depends on substitutability between goods, as we will see.

In a classical model, there is only substitutability between different commodity types; every country sells identical goods of each type at the same price. So to get a reduction of import prices a tariff-raising country has to reduce demand forthe commodity worldwide. But as its share of world demandis low any reduction in demand the tariff creates will have onlya small effect on world prices.

However, in the gravity model it is assumed that the substitutability between goods of different origins is quite low. So our diagram above applies to many different imports from differing origins. We can now compute consumer surplus costs for each country-facing tariff; but also the terms of trade gain for each country-origin import. As each country now has a big import share in these markets, it can drive down the price in them by tariffs more strongly.

We see therefore that the temptation under gravity models to raise tariffs is high, owing to the low substitutability these models assume between goods of different origins. On the one hand, there are losses of consumer surplus, but on the other there are terms of trade gains from protection. While all models differ in their exact assumptions, we can discern a pattern in the welfare estimates: gravity models will find a greater gain from the protection given by the EU customs union against the non-EU world, while it will find a consumer surplus loss from this and also from any EU-UK barriers. Because these barriers are mutual, terms of trade effects favour the largest importer, namely the EU.

Hence we find that within a gravity model of the CGE type, there is a bias towards protectionism. The latest Treasury calculations after the referendum, in which the Treasury uses the GTAP model, a gravity model in respect of low assumed origin substitutability, discarding its earlier pre-referendum methodology in response to our and others' criticism, find that Brexit is damaging in its trade effects- for details see Appendix 3. However, in addition to using this gravity model, it uses policy assumptions about Brexit that we cannot accept as realistic. First and foremost, it assumes that there will be little adoption of free trade with the rest of the world. Whereas on this GTAP model the full elimination of the 20% EU trade barriers (tariff and non-tariff) on food and manufactures would boost UK GDP by 4%, the Treasury assumes that only a twentieth of this would be eliminated in practice, so that the gain falls to 0.2%.

Second, it assumes that the EU will erect non-tariff barriers both via standards and border difficulties even with a UK-EU Canada+ trade agreement. This causes a loss to the UK of no less than 4.9-6.8% of GDP. Yet this assumption is in fact illegal under WTO rules against discrimination and border inefficiency- so in effect it would not be allowed under the laws recognised by both the UK and the EU. Thus under the Treasury's GTAP model, if realistic Brexit assumptions are inputted, then according to that model, there would be a welfare gain

to the UK from Brexit due to the trade effects of 2.6% of GDP under an exit on WTO-rules, or 4% under an exit with a Canada-plus EU FTA. The Treasury assumptions yield losses under WTO rules of 6.6% of GDP and under Canada+ of 4.7% of GDP. So it can be seen that the Treasury's assumptions add an unwarranted 9% of GDP to the cost of Brexit, even if one accepts the gravity model. We now go on in the next section to show that using the classical model, as estimated in Cardiff research, in place of the gravity one adds a further 9 or 10% of GDP to the calculated gains of Brexit.

## Cardiff World Trade Model calculations of Brexit effects on UK welfare

If we apply the same assumptions to the Cardiff World Trade Model that we will show below passes our empirical tests against UK trade data, as well as for all other countries or blocs we have looked at, the gains are considerable. If we assume that only 10% of the existing EU 20% protection of food and manufactures is abolished, then the gain* to UK GDP is 7%, mainly via higher productivity, while consumer prices fall 6%; if we assume that the full 20% protection is abolished, these numbers of course double. This is true both under the WTO-rules exit and the Canada-plus case; the reason these are the same is that once the UK has driven UK prices to world prices via FTAs with the non-EU world, it makes no difference what EU FTA we strike. EU producers, like our own home consumers and producers, can only sell and buy in our markets at world prices; EU trade barriers will simply be passed on to EU consumers, while UK trade barriers must be absorbed by EU suppliers. Paradoxically, this implies that the UK Treasury can levy tariffs on the EU and gain at EU expense, while the EU can only raise any tariff revenue it gets from UK imports from its own consumers. This accounts for the UK gaining 0.6% of GDP more from a 'WTO No Deal' with the EU than from a Canada+ FTA.

*we calculate this taking the resources used in production as given. This is the most realistic and standard assumption; the welfare measure then mainly calculates the loss of GDP and so consumption from the productive resources households have in use in the baseline. If one assumes, less realistically, that the resources of labour, land and capital unused in production would be used respectively in leisure and leisure use, or in the case of capital sold off to foreigners, then a deduction should be made for these savings of 'opportunity cost'- using suitable prices. For UK welfare, adjustment for resource savings reduces the gain from FTAs- by how much depending on the opportunity cost of unused capital and land. Here we assume a low cost on the grounds that alternatives uses such as selling them off to foreign buyers, are unrealistic.

It is worth explaining how it is that these results come about. A key effect of agricultural protection is a large rise in the price of agricultural land. This acts as the base price in alternative use for all land that gets planning permission to be used in other sectors. Hence it raises costs of production across the whole economy, strongly reducing services output. The non-traded sector also contracts, as costs and prices rise. By moving to free trade through a comprehensive set of FTAs, these higher costs of land are swept away and land is supplied as needed to the different sectors as they expand. Consumer prices fall generally as do costs of production; and at the same time the greater competition from falling import prices puts pressure on home producers to raise productivity. Notice in all this that the gains from free trade come from abolishing our protection on imports, not- as widely suggested in popular writing- from the greater access to foreign markets granted reciprocally in these FTAs. This greater access does give short run gains to our exporters, which helps to get political support

for FTAs; however, in the long run these gains largely get eroded by the downward pressure on our export prices in other markets from other countries' exports displaced from the markets where we get better access.

We summarise these results in a Table showing the gains/losses in % of GDP under the different model/assumption combinations; we label the assumptions we have argued reasonably represent the policy reality as 'Cardiff', which of course contrast with those used by the Treasury as detailed in appendix 3. As can be seen, the failure to compute sufficient gains in trade from Brexit come about half from poor policy assumptions, half from the gravity modelling mistake. The poverty of the policy assumptions we have already explained. We now go on to set out the testing results that reveal the failure of the gravity model.

**Table 1. Assumptions/models: differing estimates of gains/losses (% of GDP)**

| Model | Cardiff Classical | | Cardiff Gravity | | GTAP | | | |
|---|---|---|---|---|---|---|---|---|
| Policy assumption | Real(istic) | | Real | | Real | | Treasury | |
| Trade deal | WTO | Canada+ | WTO | Canada+ | WTO | Canada+ | WTO | Canada+ |
| Total gains | 15.6 | 15.0 | 1.5 | 3.0 | 2.6 | 4.0 | -6.6 | -4.7 |
| Of which due to: | | | | | | | | |
| Rest of World FTAs | 15.0 | 15.0 | 3.0 | 3.0 | 4.0 | 4.0 | 0.2 | 0.2 |
| EU barriers | 0.6 | | -1.5 | | -1.4 | | -6.8 | -4.9 |

Note on EU-UK barrier estimate in Cardiff Gravity model: barrier set at 10% in both directions. Effect of UK barrier on EU prices negligible as barrier mainly food and EU food prices largely fixed by CAP mechanisms; effect of EU barrier on UK= 10%x (EU share of UK imports=0.5) x (UK import share in GDP=0.3=1.5% of GDP.

**Why the gravity model should not be used and instead the classical model should be- latest results from testing models on UK and other countries' trade behaviour**

While as we saw above one key element in understating free trade gains has been the use of false policy assumptions biasing calculations towards the negative even on mistaken gravity models, nevertheless it has mainly been the 'gravity' modelling by Remainer trade economists that have damned free trade gains relative to supposed losses from reduced trade with the EU. Yet our work on these models compared with the 'classical' one we have used based on comparative advantage shows that the facts of world trade lie far closer to our classical than to the gravity model for the UK; and that this extends also to other major countries and groups including China and the EU- for the US gravity makes little difference. These tests compare the simulated behaviour of our models with the actual behaviour of the data. The latter's probability under the model can be assessed from this comparison. Basically, one can see how well the two models do by comparing the trends in the data with the average simulated trends from the model. The charts below- Figure 2- show this for the UK. If you examine the trade shares, you can see that the average gravity simulations depart sharply from the data, while the classical broadly mirror the data. It is not surprising therefore

that for the UK, the Gravity model is strongly rejected. Similar charts occur for China where the Gravity model is also rejected- see next section.

The classical model when simulated over past histories comfortably fits the data of actual history for all the major countries we have examined. This implies that the classical model is likely to be close to the true model; and a reliable guide to the policy effects of the government's programme of free trade deals around the world. According to this model the total gains to the UK from this programme in the long run- from fully eliminating the EU's protection of 20% on food and manufactures are around 15% of GDP, with consumer prices lowered by around 12%. The main effect on UK trade with the EU will be to lower the prices at which it happens by 20% on food and manufactured trade; the volumes of trade are not likely to change much, since there will continue to be no tariffs and each exporting side will meet required import standards.

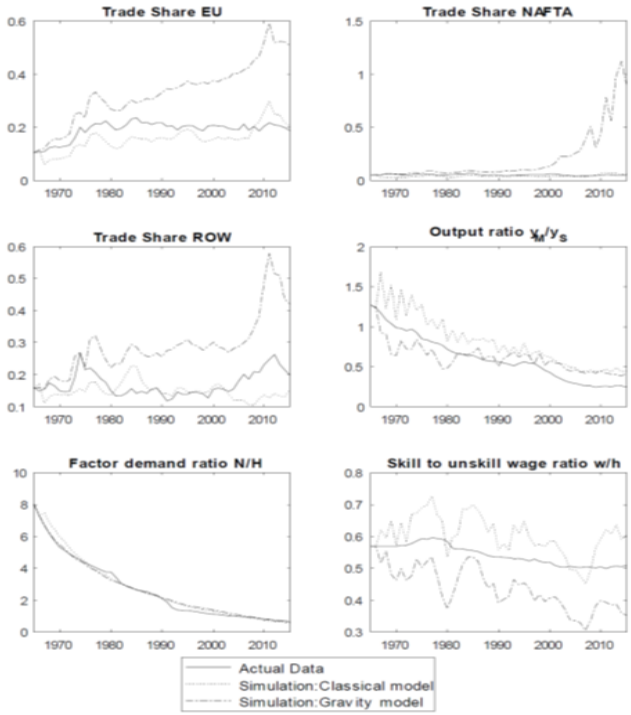
We have, as noted, recently been extending our tests to other major countries or groups, namely the US, China and the EU (Chen et al, 2021). We do this through simulating each country model on its own, with world variables simulated by a separate statistical model of world behaviour (for the UK this is not needed, as the UK is too small to affect world activity and prices); this 'Part of Model' test can tell us how likely the trade behaviour of each country is to come from either the Classical or Gravity model. The Table below summarises our findings in the form of the probability of each model being correct- 'p-values'. When this falls below 0.05 (5%) the model is considered rejected.

**PART-OF-Model tests for major countries**

| | Classical | Gravity |
|---|---|---|
| **UK** | **0.09** | **0.000** |
| **US** | **0.07** | **0.07** |
| **EU** | **0.115** | **0.075** |
| **CHINA** | **0.11** | **0.034** |

One can see that for all these countries the Classical Model is accepted; and also that the Gravity Model is in all cases either as or less probable than the Classical. In two cases, the UK and China, the gravity model is strongly rejected. For the UK the rejection is extremely strong; the test we have used implies that the Classical Model cannot be more than 5% inaccurate for the UK- in other words a model very close to the assumed Classical one is virtually certain to be the true one. For all the other countries the test used implies the Classical Model cannot be more than 20% inaccurate- so a model close to the Classical is very likely to be the true one.

Figure 2: Actual and average of simulated data




The policy implications of this general result in favour of the Classical Model are, as we have argued above, of great importance for the UK and Brexit, as well as more widely for trade policies. Policies of free trade deliver best welfare results for all countries; protection implies self-harm. According to the model a 10% tariff equivalent on food and manufacturing (the EU's is 20%) causes welfare to fall by between 6.4% (EU) and 9.4% (US); the cost to China is 8.1% and to the UK 7.2%. Clearly the model condemns protection severely. Customs union also damages the totality of members signing up, as illustrated for the EU, where the customs union choices made (i.e. trade protection of food and manufactures double the 10% illustrative tariff above) are assessed to reduce welfare by 12.8%; it can of course benefit particular members whose exports are the most protected but then others are better off refusing to join. Brexit greatly benefits the UK via withdrawing from the generally damaging EU customs union. It gains in two ways: first it gets rid of 20% protection on food and manufactures, a gain of 14.4% of GDP. Second it removes the terms of trade loss on paying 20% too much on its net imports of food and manufactures from the EU (worth 5% of GDP), this loss is 1% of GDP. So overall the UK gain from Brexit is about 15% of GDP. This is to be compared with the estimates made by Gravity modellers, such as found in the Treasury's official anti-Brexit 2018 report, of quite large losses- as reviewed above in detail: for example the Treasury there set the cost of a No Deal Brexit at a loss of 9.3% of GDP.

# Latest developments in trade policy and analysis

### The better outlook and the reassessment of the Brexit trade opening process

It has been fashionable among forecasters to take a negative view of the UK. This attitude comes from the widespread hostility of both the business and the official forecasting community to Brexit; as we know, this hostility was consistent with the strong business and

civil service interests in remaining inside the EU, so continuing protection and easily-lobbied regulation, as well as civil service opportunities for promotion.

However, the post-Covid situation will be one of strong rebound, in which the UK, thanks to a highly successful vaccination strategy, will grow considerably faster than most other major countries. The negative Remainer commentary will continue, nevertheless, shifting its focus to trade and productivity; this is exemplified in the FT columns of Martin Wolf and others.

The trade negotiations with Australia will be a pivotal moment. Boris Johnson's government has signed an agreement in spite of strong complaints from the farming lobby. So much comment on FTAs misguidedly focuses on the size of new market access for UK producers; but the key gain for the UK is hiding in plain sight, as we have seen- namely, lower prices for consumers and increased competition on producers, forcing higher productivity. As we stated frequently in the Brexit campaign, only some 10% of UK residents work in protected industries, the other 90% have an overwhelming interest in lower prices, particularly poorer people for whom food prices contribute more to their budget. So the government's determination to free trade with Australia is not just good economics but also excellent politics- notably in 'red wall' areas of the country.

The FTA with Australia is just the first. Others will continue with other countries on the Pacific Rim, primarily, leading it is hoped to full membership of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). This should eventually include the US, NZ, Japan and the other SE Asian growth tigers like S Korea and Vietnam. These countries can supply food and manufactures at the most competitive world prices, bringing yet further benefits to our consumers. As for our producers, they will gain from higher productivity and from long term links to and competition with the fastest-growing markets in the world.

## Broader issues of international trade policy

This paper has focused on the technical implications of different UK bilateral trade policies. But behind these lies the important international issue of the world trading system and its WTO-based rules. Both the system and the rules are under attack from their two biggest members, the US and China. The US under President Trump but with some general US consensus, attacked the WTO as putting the US at a disadvantage, with others exploiting its free trade approach; it is particularly incensed by China's protectionism and pirating of US technology by state-led 'deals' for US firms entering China, which mandate technology handover. The US originally welcomed Chinese membership of the WTO on the assumption that it would lead to Chinese policies of free market openness. This was originally forthcoming under Deng Xiao Ping's leadership but since Xi Jingping became leader, China has embraced a nationalistic policy of protectionism and national champions in 'key parts' of the economy; this has gone hand in hand with an aggressive expansionism in foreign policy.

Into this cauldron of confrontation has now arrived the corona virus crisis, with huge recrimination between the US and China over the origins of the infection and policies towards it. A major consequence of the crisis is likely to be a largescale shift away from outsourcing to distant supply chain providers because of both risks of future lockdowns and possible trade friction disputes.

The UK's interests in strong trade links dictate that our policies should aim to buttress WTO authority and rules; and we should oppose attempts by both China and the US to disrupt the system and disobey the rules. In these efforts we will need to build a wide coalition of countries with similar interests to ours in an open world trading system. These countries can be found in the CPTPP group in Asia, including Australia, New Zealand and Japan. As advocated by Singham and Tylecote (2019), the UK should join this group, along with other FTAs with non-EU countries, including the US and China; it has now applied to do so. As they argue, the UK should become the voice pushing for wide agreement on new liberal regulative standards for goods and services. Increasingly, international standards bodies are taking over the process of building international cooperation on standards, that in turn become the building blocks against trade discrimination, as outlawed in general under WTO rules.

Hence the UK has an important role in international diplomacy in pursuing a stronger world trading order.

# Conclusions

In this paper we have reviewed the wide range of work analysing the trade effects of Brexit under a variety of trade policies. We have shown that the trade models closest to the UK data do not have 'gravity' mechanisms in them and that these models predict substantial gains from striking free trade agreements with non-EU countries, regardless of what agreement is struck with the EU. We have also shown that when reasonable assumptions about policy are fed into models of the gravity variety, there are still fairly large gains to be made by general free trade together with a basic FTA with the EU. The UK trade policies should therefore be the pursuit of not simply an agreement with the EU to keep zero barriers but also simultaneously a wide range of free trade agreements around the world, most of all with the US, free trade with whom would bring most of the gains from general free trade with the non-EU world. Finally, the UK has a strong interest in an open world trading system under WTO rules and widely agreed international standards; and it should use its best efforts to promote this via a coalition of countries with similar interests.

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# Appendix 1: HM Treasury 2016 pre-referendum calculations

We have explained in the main text how one must use a full CGE model to calculate the effects of Brexit on all aspects of the economy vis general equilibrium where they all interact. Thus one cannot directly use the associations found in the data between trade, GDP and prices, or between trade and productivity; The reason is that one cannot work out from these what effects Brexit will have on the 'right hand side' variables in these relationships. However, gravity theorists of trade have argued that one can use these associations directly to assess the effects of Brexit; they make assumptions about the effect of Brexit on these RHS variables and go from there. But of course these assumptions are arbitrary, in the absence of a CGE model derivation.

The most notable example of this methodology was the Treasury's report in 2016 (HMT, 2016). For its calculations, it directly used associations (correlations) between a) trade and Agreements like EU; b) trade and FDI; and c) FDI and productivity. It applied regression estimates of Agreement effects on trade in gravity trade equations (a), obtain the effects on UK-EU trade by commodity. It then used the trade/FDI regressions to get the effects of this reduced trade on FDI. Finally, it input these FDI reductions into equations at c) to obtain the productivity effects. Finally, it fed the productivity into exogenous potential output into a macro model of the UK, NIGEM. Rather similar methods were used by non-official groups to calculate Brexit effects- I review them in Appendix 1.

Ref
HMT(2016)https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/517415/treasury_analysis_economic_impact_of_eu_membership_web.pdf

There are many detailed criticisms that have been made of these calculations. These include the fact that in the trade regressions the effects of EU membership on many diverse economies are averaged to get the UK effects.
Critiques include: Michael Burrage (http://www.civitas.org.uk/content/files/mythandparadox.pdf), Graham Gudgin (https://policyexchange.org.uk/publication/defying-gravity-a-critique-of-estimates-of-the-economic-impact-of-brexit), and https://www.economistsforfreetrade.com/publication/the-critique-of-project-fear contains pieces by Blake, Dowd, Congdon and me.
But there is a more fundamental and quite devastating criticism of this method, which is that it is based on 'partial equilibrium' relationships, that take the aggregate environment, such as UK GDP, prices, wages, and supplies of factor inputs as given. This assumption cannot be made when a major policy change like Brexit trade arrangements is involved. This change will simultaneously affect all parts of the economy: sector production, investment/FDI, goods/services prices, factor supplies and prices such as wages, land rents and returns on capital. Calculating these 'general equilibrium' effects can only be done by a model that includes them all interactively, as is done in general 'macro-models' or in trade models that contain the same relationships but usually without dynamics (i.e. lags in adjustment and expectations), 'Computable General Equilibrium', CGE, models.

After exposure to this last criticism, the Treasury and Civil Service finally switched in 2018 to a full general equilibrium approach, using a well-known model developed at Purdue University, Indiana, the GTAP model. This moved the discussion towards the issue of what sort of CGE model should be used. To decide this issue one must set CGE models of differing specifications against each other and test them against the data, preferably with a powerfully discriminating test. We have attempted to advance this discussion by constructing a moderately-sized CGE model of the basic 'classical' type alongside one of a 'gravity' type, in which the key gravity mechanisms are added to the classical model- the GTAP model is of this gravity type. So far we have completed tests of both against UK, US, EU and Chinese data. We discussed this quite complicated procedure in the main text above.

However, not all those groups estimating Brexit effects have conceded that the partial equilibrium method is wrong. Several notable UK centres- LSE-CEP, NIESR, and the Sussex Trade Observatory- have continued to promulgate their estimates based on this method. We review their methods and estimates in Appendix 2.

## Appendix 2: Non-official UK groups' modelling strategies and calculations of Brexit effects

Three modelling groups have published full accounts of their calculations: LSE-CEP, NIESR and Sussex 'Trade Observatory'. We consider their methods in turn.

LSE-CEP: This group show details of their various exercises in Dhingra et al (2016a). In their main calculations, they follow a

'reduced form approach' similar to the Treasury's (2016) original one, and find results that are similar or larger; in fact in an appendix reviewing the Treasury work they argue it is 'too cautious' because of leaving out larger 'dynamic effects' on FDI and productivity. Our comments on this are the same as for the Treasury's, set out above: such a partial equilibrium analysis does not capture the causal mechanisms at work.

Dhingra et al (2016a) use, as an alternative approach, a static CGE model which they provide detail about in Dhingra et al (2016b), in technical appendix 3. There they explain that their method is to solve the Armington demand equations (a set of consumer-based demand relationships), using an elasticity of trade to tariff-induced price changes. With this assumed elasticity they can solve these equations for implied trade, expenditures, outputs and welfare.

They get much smaller estimates from this model than from the reduced form approach above, which they make it clear they prefer- wrongly we would say for reasons given.

However, the main problem with their 'state of the art' model is the key assumption of a general elasticity of trade response, whatever the shocks to the model. We know from CGE models that different shocks work through different channels to produce different trade elasticities. Thus tariffs on food, for example, have pronounced effects on land prices which in turn affect costs and outputs in other sectors; whereas tariffs on manufactures have effects through wage costs. The implied elasticities of trade (which aggregate all these different channels) are different. Indeed some will be zero, according to the Classical model which alone passes the test of matching UK trade data, as explained above: for example UK tariffs on EU goods will have no effect, once UK tariffs on non-EU goods have gone due to new FTAs. The only way of estimating these various elasticities is to simulate effects in a full, empirically satisfactory, CGE model.

**NIESR (Hantsche, Kara and Young, 2018):**

Essentially, this NIESR study (its latest, made in November 2018) follows the same procedure as the Treasury's (2016) original study, discussed above in Appendix 1. There is no attempt at a general equilibrium analysis of trade. The NIESR findings are therefore similar to that of the Treasury study. For the case of an EU FTA, GDP is projected to fall by 3.9%; for a WTO exit, by 5.5%. Our critique of these NIESR partial equilibrium approach is

accordingly the same as the one above of the Treasury's: by using these partial relationships, the NIESR has ignored the indirect effects on trade via factor markets, prices and wages. Its results are therefore fallacious.

**Sussex Trade Observatory (Gasiorek, Serwicka and Smith, 2018):**

The approach taken by this Sussex University group is unapologetically partial equilibrium and limited to the manufacturing sector. They estimate at a highly disaggregated level the effects of different trade policies on manufacturing prices, exports, imports and output. In these estimates they hold constant UK aggregate GDP, prices and wages; hence no attempt is made at a general equilibrium analysis; nor at estimates of effects on GDP.

The pessimistic nature of these results can be gauged from those for the WTO-rules Brexit case (but where no trade deals are done). For the manufacturing sector, when all subsectors are added up, they obtain**:**

**Manufacturing:** exports -19.5%; imports -7.3%; output -5.5%; prices +5.0%

Even with an FTA with the EU and rolling over the EU's 67 FTAS with other countries, the figures are little different, with manufacturing output for example falling 4%.

They do not model a policy of free trade (zero tariffs and other trade barriers) with the Rest of the World, which would have reduced prices at least.

The problem with this study is the same as that of the Treasury's original (2016) study, that it makes no attempt to allow for general equilibrium effects via GDP, or home wages and prices. These effects are substantial even if one is only concerned with manufacturing sectors, because resources will shift as factor prices change, and manufacturing output and productivity will react to these shifts. The main gains to GDP through CGE analysis of free trade with the Rest of the World come through falling home manufacturing and food prices driving down home costs, raising home productivity in previously-protected sectors and shifting resources to more productive sectors.

Unfortunately this failing makes the Trade Observatory estimates largely valueless from a general equilibrium perspective.

# Appendix 3: The Treasury's CGE model post-referendum calculations understate the gains from free trade even on their wrong model

After discarding use of its widely criticised 'gravity-like' model used in the initial ' Project Fear' Referendum forecasts, discussed in Appendix 1, the Treasury has now adopted use of a Computable General Equilibrium (CGE) model (GTAP from Purdue University) that is similar to the World Trade Model Gravity Version model at Cardiff University in modelling general equilibrium behaviour.

In this comment we ignore the migration calculations made by the Treasury which imply large extra costs; however, these costs are based on the assumption that the flow of migrants will be abruptly cut off. As it is now government policy that skilled migrants will be flexibly treated under a points-based immigration system, while unskilled migrants will be allowed in temporarily but without access to state benefits), this assumption is the opposite of the truth.

While this more recent Treasury work adopts a full CGE approach and so avoids the criticisms we advanced above of its and its allies' partial equilibrium approach, there remain two main difficulties with what it has done. First, the CGE model it has used adopts a 'weak gravity' model, which we find does not fit the UK trade facts- as explained above. Second, and just as damaging, it adopts within this model policy assumptions that are highly questionable; we will show that when these are altered to reflect more realistic assumptions, the evaluation of Brexit turns from negative on UK welfare to strongly positive, *even on this mistaken gravity model*.

Based on the latest Treasury Report and its Technical Annex, the assumptions are flawed in three fundamental ways:

**1. They assume de-minimis benefits for the UK economy from future free trade agreements with non-EU countries**

- Only a 0.2 per cent boost to GDP is forecast; yet an estimate for Australia on the same model found a more than 5 per cent of GDP boost from its 30 years of trade liberalisation.
- It gets this by assuming
  - Quite low estimates of EU Non-Tariff Barriers (based on econometric work)

    around 7% for goods (other estimates suggest 16%). For services, it assumes UK NTBs after leaving the EU would be 15% (our estimate is zero as the UK has a liberal regime for services trade)
  - Only half of the goods NTBs can be abolished, and only one third of the services NTBs, giving the resulting NTBs to fall as follows:

Table 3.A: Summary of estimates of changes to UK-Rest of World NTB compared to today's arrangements for all scenarios

| Compared to today's arrangements (per cent change) | NTBs into the UK for ROW trade partners (per cent) | NTBs into ROW trade partners for the UK (per cent) |
|---|---|---|
| Manufactured Goods | -3.3 | -2.3 |
| Agri-food | -3.6 | -3.8 |
| Services | -2.6 | -4.2 |
| Financial Services | -5.0 | -5.6 |
| Networks | -3.8 | -3.6 |

*Negative figures reflect a reduction in NTB costs compared to today's arrangement.*

Source: HMT Tech Annex

– Adding these abolishable NTBs to the average tariffs on goods gives a total eliminable of 8% on goods (average tariffs 4%); and 5% on services (no tariffs here)

- Under GTAP if these were abolished via FTAs that achieved the same barrier reduction on our imports as unilateral free trade, the gain would be 1.6% of GDP

– However, in practice HMT assumes only around half of these gains would be achieved by FTAs, because of limited coverage. This brings the gain down to 0.8% of GDP.

– Then HMT assumes that only one quarter of this programme will occur as it is 'under development' - see following para 76 from annex

76. The Government's approach to agreements between the UK and prospective trade partners is currently being developed. In this illustrative and indicative approach, representing ambitious agreements including but not limited to FTAs, it is estimated that under the central ambition case, 25 per cent of the actionable goods and services barriers might be reduced. These are applied in all the modelled EU exit scenarios. As set out in section 2.3.3 of the analysis document, the analysis does not model any constraints that the Government's policy could impose on future UK-RoW agreements.

Source; HMT Tech Annex

This reduces the gain to the headline 0.2% of GDP. Yet, based on the assumption that Brexit leads to FTAs with virtually the rest of the non-EU world, as intended by the government, we calculate using the standard GTAP model as set out by Ciuriak et al (2015, 2017) that there would be UK gains of 4% of GDP.

2. **High border costs are assumed for the processing of customs declarations, rules of origin certificates, and goods inspections.** This reflects a lack of understanding of how modern computerised, pre-declared border procedures work

- Typical actual costs of modern procedures are well below 1 per cent and the Swiss customs authority reports costs of 0.1 per cent

- Inspections are intelligence-led and a rarity (typically only 1 to 3 percent of shipments). They often require only confirmation of computerised documentation and can take place away from the border.

These Treasury-assumed but unrealistic costs across goods and services give rise to a loss of 1.8% of GDP from border costs introduced on EU trade.

**3. Imaginary high compliance costs are assumed for exporters/importers to meet hypothetical new non-tariff barriers springing up immediately after Brexit**. These NTBs (see next Table) include the border costs discussed in the previous paragraph**.**

Table 2.D: Summary of estimates of changes to UK-EU NTBs by sector compared to today's arrangements

| Compared to today's arrangements (per cent change) | Modelled no deal | Modelled average FTA | Modelled EEA-type[48] | Modelled White Paper | Modelled White Paper with 50 per cent NTB sensitivity[49] |
|---|---|---|---|---|---|
| All Goods[50] | +10 (+6 to +15) | +8 (+5 to +11) | +5 (+3 to +7) | +1 (0 to +1) | +4 |
| All Services | +11 (+4 to +18) | +9 (+3 to +14) | +2 (+1 to +3) | +6 (+2 to +10) | +7 |

*Central estimates and ranges in brackets.[51] Note: estimates are rounded to the nearest per cent. Owing to rounding, narrow ranges (less than one per cent) are not distinguishable in the table.*

Source: Treasury Technical Annex

- This is based on the mistaken belief that the EU will suddenly determine that UK exporters do not meet product standards - despite over 20 years of shared rules and standards

- Such behaviour would be illegal under WTO anti-discrimination rules that require importers from all countries to be treated the same – ie, a UK importer cannot be required to meet a standard that is not required of, say a US importer or indeed an internal producer from the EU. In other words they must be existing EU standards- which we meet.

- HMT fails to understand how trade actually works – ie, each importer makes independent decisions as to set their product configurations and the attractiveness of export markets. Hence even as standards change in future, exporters will make sure, from their own commercial interest, that their goods continue to meet these standards, as occurs throughout the world with export trade.

In reply to our criticism of these estimates, the Treasury evades the point, simply saying the WTO rules may not be implemented:

63. Rather than model NTBs with the EU, an Economists for Free Trade study[56] assumes no additional NTBs. They argue that given the UK's current regulatory alignment with the EU, any attempt to impose trade barriers would be illegal under WTO rules. The OBR notes that 'this appears to be based on Economists for Free Trade's interpretation of the WTO's MFN requirements. But most trade experts interpret these rules as meaning that the EU would be forced to impose the same NTBs that the rest of the world currently faces, unless the UK and EU sign a trade deal to lessen them'.[57]

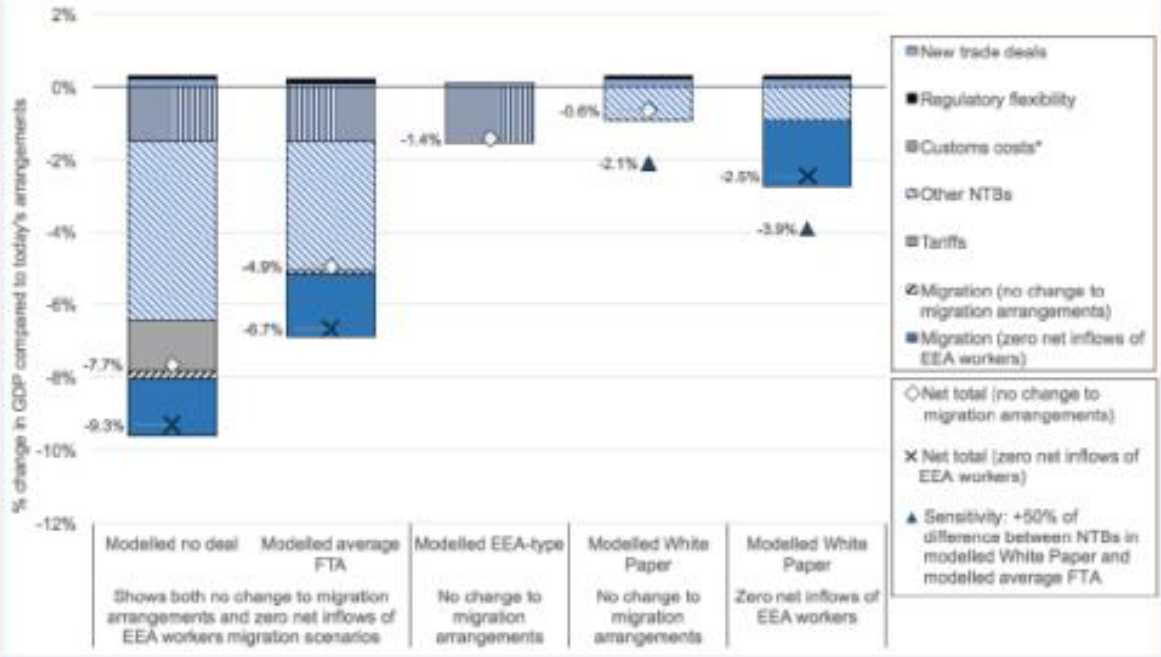
Source: HMT Tech Annex

Note that the EU imposes standards that the UK currently meets; these are 'the same EU standards that the rest of the world currently faces'. These standards of course act as NTBs to countries such as the US which cannot meet them.

The combined total effect of these assumptions is that– beginning with product standards and regulations identical to those of the EU –it would be as if the UK faced an EU tariff-equivalent cost **on goods and services combined of around 14.5 per cent (of which only 4.5% is actual goods tariffs), if trading under WTO rules. This is about three quarters of the effective tariff actually faced by the US that, in fact, trades with the EU under WTO rules.**

**When these flawed assumptions are fed into the Treasury's GTAP model, it forecasts a reduction to UK GDP of 7.7 per cent (see** bar chart below). This is astonishingly large considering that total EU trade accounts for only 12 per cent of total UK GDP and only about 40 per cent of this trade is exports that could be affected by such EU restrictions.

**Figure E.3: Decomposition of total impacts on GDP compared to today's arrangements for the illustrative no change to migration arrangements and zero net inflows of EEA workers scenarios.**




*Central estimates only. *NTB estimates for the modelled no deal and modelled average FTA scenarios are derived from econometric modelling, which does not isolate individual NTB components. Customs costs for these scenarios are shown illustratively in line with the modelled EEA-type scenario estimates.*

*This considers trade, migration and regulatory flexibility effects.*

Source; Main Treasury Report

The table below – Trade Effects under Brexit scenarios-compares the result of HMT model results with the estimated results that would be obtained from the same model if assumptions more reasonable than those used by the Treasury were fed into the model.

It should be noted that. due to the use of econometric estimates, the new EU trade barriers now assumed are lower than the judgements used in an earlier draft of the report (Civil Service2018a), and indeed have been roughly halved. But the response of the UK part of model in the new report has been raised (more than doubled) to compensate and give a similar-sized hit to UK GDP from WTO and FTA scenarios. This alteration of the GTAP model the Treasury is using is puzzling and suggests outsiders need to have access to discover just why these changes have been made as well as their empirical justification.

**Table: Trade Effects under Brexit Scenarios According To GTAP-type model used by Whitehall**

| | **A: Whitehall Assumptions** | | **B:AltAssptions** | |
|---|---|---|---|---|
| **Trade Barriers expressed as % Tariff Equivalent; Effect on GDP shown as % of GDP in italics** | | | | |
| | **Canada+** | **WTO** | **Can+** | **WTO** |
| Tariffs | - | 4.5 | - | 4.5 |
| *Effect on GDP* | - | *-1.4* | - | *-1.4* |
| New Standards | 16.2 | 5.5 | - | - |
| *Effect on GDP* | *-3.6* | *-4.0* | - | - |
| New Customs costs | 5.8 | 4.5 | - | - |
| *Effect on GDP* | *-1.3* | *-1.4* | - | - |
| **Total Tariff Equivalent (%)** | **22.0** | **14.5** | **-** | **4.5** |
| ***Total Effect on GDP (% of GDP)*** | ***-4.9*** | ***-6.8*** | **-** | ***-1.4*** |
| FTAs with rest of world | | | | |
| *Effect on GDP (% of GDP)* | *.....+0.2....* | | *…… +4.0*…….* | |
| ***All Trade Effects on GDP*** | | | | |
| ***(% of GDP)*** | ***-4.7*** | ***-6.6*** | ***+4.0*** | ***+2.6*** |

*Assumes all EU protection of food and manufactures (20% average on each) eliminated via FTAs