The latest state of modelling Brexit, April 2018

by Patrick Minford, Professor of applied economics, Cardiff University and chair, Economists for Free Trade*

The state of World Trade Models for Brexit

There is now general agreement among modellers about how to model Brexit. The Cross-Whitehall Project to evaluate Brexit uses GTAP, a well-known internationally developed Computable General Equilibrium (CGE) Model of world trade.[1] This is a model of all countries, grouped into smaller groups, usually around 50, and of all goods and services sectors, usually around 40. Its equations are derived from trade theory, and the equilibrium in each market of supply and demand. This GTAP model has replaced the set of correlations (between trade agreements and trade; trade and FDI; FDI and productivity) previously used by the Treasury to produce its pre-referendum report on the long term trade effects of Brexit (HMTreasury 2016); such correlations are now generally agreed not to be a guide to causation and are no longer being used by the Civil Service, an important step forward.[2]

We have used a similar World Trade Model developed at Cardiff University – Minford and Xu (2017). The main difference is that it is smaller, consisting of 4 country groups, one of which is the UK (the main focus), and the others being NAFTA, the rest of the EU, and the rest of the world; also there are only 4 commodity sectors, namely manufactures, primary (including agriculture), traded services, and non-traded (home) goods and services. Being smaller, this model is capable of being tested against the UK 'trade facts' which has been an important project for the Cardiff research team.

When specifying such a model, choices must be made about the nature of markets and trade relations. So-called 'gravity' trade theory argues that trade is related to 'closeness' and 'size', the two 'gravity elements'.[3] Such ideas, which have a long parentage going back to Tinbergen (1962), obviously apply to the demand for imports and exports; they are incorporated into all trade models, including ours. Aspects of this theory extend to how 'imperfect' competition is between products in world markets; and also to what links exist between trade, FDI and productivity, where some gravity theorists posit a direct effect of trade on productivity via FDI. On these two aspects trade models can differ. GTAP for example has moderately imperfect competition between all 'country varieties', but assumes perfect competition in each industry's supply. It also makes no special assumptions about the effects of trade on FDI and productivity; rather it uses standard 'production functions' that relate capital inputs (from whatever source,

*I am grateful to David Blake for helpful comments.

[1] Global Trade Analysis Project at Purdue University.

[2] The Treasury's pre-referendum reports were heavily criticised, see, e.g., Blake (2016).

[3] We can think of the 'gravity model' as specifying the 'demand-side' of a trade model: the international demand for a country's output is positively related to the closeness and size of the country's neighbours.

foreign or domestic) and labour inputs to output in each industry.[4] GTAP can be considered as a model with quite limited gravity elements.

The Cardiff World Trade Model, otherwise similar to GTAP, has strictly limited gravity elements in its 'Classical' form: here perfect competition is assumed in all world markets for intermediate goods, implying that all countriesmust compete in these markets on the same terms at the same price. A limited degree of gravity is introduced at the retail level where different brands using these intermediate goods as inputs compete under imperfect competition.

However, because the extent of these gravity aspects can be important for analysing Brexit, we have created an alternative Gravity version of the Cardiff World Trade Model, where there is also imperfect competition among intermediate goods and a direct link from trade (via FDI) to productivity, so that we can test whether it is more appropriate by providing a better match to UK trade facts.

Our recent research testing the two versions, Gravity and Classical, has found that the UK trade facts reject the Gravity version but accept the Classical version (Minford, and Xu (2017)). A test of GTAP has never been attempted because of its size and indeed is probably infeasible. However GTAP, having much less of the gravity elements in it, probably comes closest to our Classical Model.

Another major finding we have made is that if the same basic assumptions – about general free trade of the UK with the rest of the world including the EU – are fed into the Classical and Gravity models, the results showing higher welfare/GDP are the same: on the assumption that the UK abolishes 10% EU trade barriers against other countries for food and manufactures, while keeping free trade against the EU, UK GDP rises by 4% (Minford et al, 2015, chapter 4). We may call this assumption of free trade either 'unilateral free trade' or 'free trade brought about by widely spread FTAs'.

Based on work by Ciuriak et al (2015), the same assumption in GTAP generates a 2% rise in UK GDP.

The Policy Assumptions made by the Cross-Whitehall study

The Cross-Whitehall study has however made assumptions about 'general free trade via FTAs' that do not correspond to the one made above. It has stated that gains from their general FTA assumption are only a 0.5-0.8% rise in UK GDP. From this it would seem that they assume either that EU trade barriers are rather small or that barriers are reduced by much less than 10%. This is puzzling since current EU protection of food and manufactures including non-tariff barriers is authoritatively estimated at 20% (Minford et al, 2015, chapter 4; also for non-tariff barriers Berden et al, 2009). Our assumption is deliberately cautious at 10%; it can be thought of as assuming either that only half is abolished or that somehow the EU would itself

[4] We can think of the 'production functions' as specifying part of the 'supply-side' of a trade model: a country's output is positively related to its factor supplies (capital and labour) through its 'production functions'. These supplies are related to relative factor prices as well as natural endowments.

have abolished half anyway. If this 10% is fed into the GTAP model, then UK GDP would rise by 2%, as noted above.

The other key assumption made by the Cross-Whitehall study is that large costs arise at the EU border for UK-EU trade even if we negotiate 'free trade' with the EU. One element of this appears to be related to pure 'border costs'; such things as time to get paperwork agreed before ships are allowed to unload.

However these assumptions have been bypassed by the progress of technology and WTO rules for customs procedures. Computerisation has more or less eliminated border costs among developed countries, since almost all ships are cleared before reaching port, with only some 2 per cent or so physically inspected and even this is taking only around a day typically. Prof. Dr. Michael Ambühl (ETH Zürich), who negotiated one of the Swiss-EU bilateral free trade deals, estimated that border costs were as low as 0.1% of the value of trade (Ambühl (2018, slide 8)).

Another assumption in the Cross-Whitehall study appears to be that the UK-EU non-tariff protection would increase through Brexit policies. The idea seems to be that the EU and maybe the UK too would claim that exporters do not satisfy required product standards; thus non-tariff barriers would sprout on the UK-EU border, regardless of any trade negotiations. However, current WTO rules outlaw such behaviour as illegally discriminative. Furthermore one would have thought that, given existing product standards are exactly obeyed on both sides, trade negotiations would prevent such disputes.

Thus it is hard to understand the Cross-Whitehall assumptions on EU-UK border costs post-Brexit. Nevertheless, on the basis of these assumptions, the Cross-Whitehall GTAP model calculates large losses in GDP, variously amounting to between 3 and 7%, depending on the 'closeness' of the eventual EU arrangements. On our calculations, these costs are simply not there in the event of a free trade (Canada-plus) agreement with the EU. We also have an assessment (Minford, 2018) of the 'no deal' case, where again non-tariff barriers and customs hold-ups are illegal but tariffs do apply; as we have shown in that assessment the tariff element damages the EU but not the UK.

The Cross-Whitehall study therefore reaches its conclusions that Brexit reduces UK GDP on the basis of untenable assumptions. When reasonable assumptions are substituted for the extent of the trade barriers eliminated against the rest of the world and for the trivial UK-EU border costs, this reduction is turned into a substantial increase on both the GTAP model, and on the Cardiff World Trade Model. What is more this is true even on the Gravity version of the Cardiff model.

A summary of the Brexit modelling state of affairs

Hence we can summarise the state of post-Brexit trade effects as follows:

1. **During the referendum the Treasury and several other groups (including LSE and NIESR) used various correlations between trade and other variables, dubbed 'gravity-based relationships', to estimate the effects of Brexit: these estimates were**

flawed because one cannot extract causation from correlations. These studies have now been replaced in Whitehall by the Cross-Whitehall study using GTAP.

2. **GTAP is a large multi-country multi-sector model based on economic theory. A Computable General Equilibrium (CGE) model computes the long run effects of changes in tariffs and other trade barriers on these economies and sectors. 'Partial equilibrium' studies – such as those by the UK Trade Policy Observatory at Sussex (e.g., Gasiorek et al. (2018)) – only compute effects on the assumption that the economy at large does not change; however with Brexit this is not the case because the economy changes widely, so that 'general equilibrium' (where all these changes are accounted for) will differ markedly from 'partial equilibrium'.**
3. **While the GTAP CGE method is sound in principle, in practice one cannot be confident that it gives accurate results for the UK economy because these results are ground out by the relationships for ALL countries and sectors; testing such a model is likely to be impossible because it has so many variable parts. The Cardiff World Trade Model (CWTM) is constructed according to similar principles but is smaller, with only 4 country blocs (UK, Rest of EU, NAFTA, Rest of World) and 4 sectors (primary, manufactures, traded services, and non-traded). It can be tested to see whether its simulated behaviour matches UK facts; it does. A Gravity version of the same model is rejected by the UK facts.**
4. **Whichever model one uses, the policy assumptions made are crucial. EU protection is 20% for food and manufactures (there is no protection of UK services by the EU). If an FTA with the EU is negotiated then there would be no UK-EU tariffs nor any disputes about export standards since these are now compatible; customs procedures must be seamless by WTO rules. So there would be virtually no 'border costs' with the EU. It seems that the Cross-Whitehall study has assumed that little EU protection is eliminated via UK FTAs with the non-EU world; and also that huge EU-UK barriers would sprout up to block EU-UK trade. Such assumptions are at variance with international law.**
5. **If we assume as in the CWTM calculations on behalf of Economists for Free Trade that half the EU's protection would go and that EU-UK barriers would be kept negligible, then GTAP implies a rise of 2% due to trade effects, and CWTM implies a rise of 4%. The latter should be accurate for the UK according to model testing results. The GTAP result can be used as qualitative support.**

Free Trade Agreements: estimated effects on GDP

There are a huge number of studies using CGE models to estimate the gains from FTAs and other commercial policy changes. In chapter 7 of Minford et al (2015) Table 7.6 lists the results of 8 largescale studies of potential EU FTAs involving a variety of sectors and a variety of liberalisation strategies, some multi-lateral, some unilateral by the EU. The largest gain to the EU, at 4.7% of GDP, comes from a 50% unilateral liberalisation of goods and services.

A recent study of a potential China-US FTA by Cai Songfeng et al (2018), using the GTAP model, came up with an estimated gain to GDP of 2.4% to China and 1.2% to the US.

A study of Australia's 30-year (1986-2016) liberalisation of its trade policies has been done by CIE (2017), again using the GTAP model. Its finding is that Australia's GDP has been boosted by 5.4%.

These are just some examples of recent studies using CGE modelling methods to estimate the gains from trade liberalisation via Free Trade Agreements.

In many cases liberalisation of trade requires the undertaking of many FTAs with a variety of trading partners. Australia, for example, has concluded a wide range of such agreements in its liberalisation strategy. This would also be the case for the UK post-Brexit. The 4% of GDP gain we estimate using the Cardiff World Trade Model from 'free trade' assumes that the UK manages via its FTA programme to eliminate 10% protection of food and manufactures put in place by the EU. To achieve this, the UK would conclude FTAs with major world suppliers of the food and manufactures that it imports. These would include the US, Australia, New Zealand, and probably also China, Japan and South Korea. As can be seen from the examples for other studies, **the gain of 4% of GDP is by no means untypical of large-scale liberalisation programmes such as Brexit**.

Conclusion

A lot of heat of was generated both before and after the referendum on the apparently significant differences in the trade models used to estimate the effects of Brexit on UK GDP. On the one hand, there were a large number of models predicting that UK GDP would fall significantly (e.g., HM Treasury, LSE, NIESR, OECD, IMF etc). On the other hand, there were a small number of models that predicted that the UK's GDP would either increase or change very little after Brexit. The most prominent of these was the Cardiff World Trade Model, a full CGE model.[5] The reality was that all the models predicting a negative outcome from Brexit either used essentially the same methods, namely correlations thought to derive from the gravity model; or if they used a CGE model with policy assumptions very different from those in Mrs. May's Mansion House speech, namely a broad zero-tariff free trade agreement between the UK and EU. By contrast, the Cardiff World Trade Model estimates on behalf of Economists for Free Trade were based on long term general equilibrium and policy assumptions in line with that speech.

[5] Other more recent studies include Kee and Nicita (2017) who estimate that UK exports to the EU would fall by just 2% in a 'no deal' scenario and Coutts et al (2018) who estimate that, by 2030, per capita GDP would be unchanged, while GDP would be 2% lower than otherwise, due to lower immigration. Kee and Nicita (2017) use a direct model of trade which directly calculates the additions to production costs from tariffs and non-tariff barriers and uses sector- or commodity-specific elasticities to estimate the impact on demand for exports and imports. Coutts et al (2018) use a macro-economic model – similar to that used by both Cambridge Econometrics and Oxford Economics – estimated using actual historical data rather than derived from general equilibrium theory and assumptions as in the original Treasury model.

However, since the publication of the Cross-Whitehall study in January 2018, the debate on methods has changed for the better. That study uses the GTAP Computable General Equilibrium model with a supply side and some limited gravity features. Meanwhile, the Cardiff World Trade Model has set up and examined the behaviour of a Gravity version, embodying the two key gravity elements of generally imperfect competition and direct links from trade volumes (via FDI) to productivity. The Classical version has pure competition between intermediate goods (eg in supply-chains) and productivity depends on policy and other general economic factors outside the Trade model; at the retail level brands made up of intermediate goods are imperfectly competitive, providing a minor gravity demand-side effect.

The various models are therefore broadly of the same type which makes comparisons easier. They also behave rather similarly in response to Brexit. The debate can now therefore shift to a careful consideration of the different policy assumptions to be used. Specifically, the Cardiff estimates assumes that the UK will reduce tariffs on imported goods from all parts of the world by 10% and a UK-EU FTA will keep UK-EU border costs at trivial levels, whereas the Cross-Whitehall GTAP study seems to assume extremely limited reductions in UK trade barriers against non-EU countries and extremely large rises in UK-EU trade barriers.

It is on these assumptions that the quantification of the costs and benefits of Brexit now depends. This is where the debate should now be focused. We have explained in this note the basis for our assessment of these assumptions and we hope to see a full explanation as soon as possible of the basis for the Cross-Whitehall study's very different assumptions.

References

Ambühl, M. (2018) 'Where Next on Brexit? Lessons from the Swiss Model', Policy Exchange presentation, London, 19 April.

Berden, K., Francois, J., Tamminen, S., Thelle, M., & Wymenga, P. (2009) 'Non-Tariff Measures in EU-US Trade and Investment: An Economic Analysis,' Final report, Ecorys; cited in *Brexit 2016- Policy analysis from the Centre for Economic Performance,* (London, 2016); [Table of ntbs on p 123.]

Blake, D. (2016) 'Measurement without Theory: On the extraordinary abuse of economic models in the EU Referendum debate', City University of London.

Centre for International Economics (2017) 'Australian Trade liberalisation - analysis of the impacts', Report prepared for the Australian Ministry of Foreign Affairs, CIE, Canberra and Sydney.

Ciuriak, D. & Jingliang X., with Ciuriak, N., Dadkhah, A, Lysenko, D., and Badri Narayanan G. (2015) 'The Trade-related Impact of a UK Exit from the EU Single Market'- a Research Report prepared for Open Europe by Ciuriak Consulting, 2015. Available at http://ssrn.com/abstract=2620718

Coutts, K., Gudgin, G. and Buchanan, J. (2017) 'How the Economics Profession Got It Wrong on Brexit', Centre for Business Research, University of Cambridge Working Paper No. 493, January. https://www.cbr.cam.ac.uk/fileadmin/user_upload/centre-for-business-research/downloads/working-papers/wp493.pdf

Gasiorek, M., Serwicka, I., and Smith, A. (2018) 'Which Manufacturing Sectors are Most Vulnerable to Brexit?' Briefing Paper 16, UK Trade Policy Observatory, University of Sussex, February.

HM Treasury (2016) 'HM Treasury analysis: the long-term economic impact of EU membership and the alternatives', Ref: ISBN 978-1-4741-3089-9, PU1908, Cm 9250PDF, 8.97MB, 206 pages (2016)

Kee, H. L., and Nicita, A. (2017) 'Short-term impact of Brexit on the United Kingdom's export of goods', World Bank Policy Research Working Paper No. 8195, November. Available at SSRN: https://ssrn.com/abstract=3036712

Minford, P., with Gupta, Le V., Mahambare, V. and Xu, Y. (2015) 'Should Britain leave the EU? An economic analysis of a troubled relationship', second edition, December 2015, pp. 197, (Cheltenham, 2015)

Minford, P. and Xu, Y. (2017) 'Classical or gravity: which model best matches the UK facts?' forthcoming *Open Economies Review*, https://link.springer.com/content/pdf/10.1007%2Fs11079-017-9470-z.pdf

Minford, P. (2018) 'The numbers behind No Deal- why the EU is a loser', www.economistsforfreetrade.com/wp-content/uploads/2018/01/EFT-The-No-EU-Trade-Deal-Calculation-Jan-2018-2.pdf

Cai Songfeng, Zhang Yaxiong, Yuan Jianqin (2018) The Effects of China-US Free Trade Agreement (CHUSFTA), State Information Centre, China.

Tinbergen, J., (1962) *Shaping the World Economy: Suggestions for an International Economic Policy*. New York: The Twentieth Century Fund, 1962.