One of the most long-standing and robust statistical relationships in economics is that trade flows between countries increase the closer they are to one another: an unsurprising result given the costs and risks of transporting goods between markets. But rapid technological progress, increasing efficiency in transport and logistics, and increased globalisation begs the question: does distance still matter for international trading relationships, especially with the rise of service-driven economies? The Gravity Model of International Trade provides some insights into this question. In this note, we explore what the model says about the importance of distance in international trade, how this has evolved over time, and what the implications might be for the UK’s future trading relations.

**The gravity model:**
What does the data say about international trade and distance between countries?
Physicists are fortunate to encounter natural 'Laws' describing relationships between phenomena precisely. Newton's 'Law of Universal Gravitation', for instance, explains how the pull between two objects depends on their size and the distance between them.

The Gravity Model of International Trade

Rarely can economists rely on such orderly 'Laws' to explain relationships in the complex and multi-dimensional modern global economy. But one exception is the Gravity Model of International Trade. Mirroring its cousin in physics, the model holds that the amount of trade between two economies depends (largely) on two things: the size of the economies and the distance between them.

The theory helps explain why historically the world has broadly evolved into geographically-based trading blocs (notably the ASEAN, EU, MERCOSUR and NAFTA blocs) and why Britain’s trade with the EU27 therefore accounts for so much (almost half) of its international trade.

The map in Figure 1 illustrates the distance effect by showing how intensively the UK trades with different countries, once the size of the economies has been taken into account.

Recently, the Gravity Model has been brought back into the spotlight as the concept of distance has evolved in today’s globalised world. Falling transport and communication costs due to improved technology and infrastructure – along with advances in e-commerce that have reduced information and trust frictions across geographies – are sometimes thought to have reduced the importance of distance in determining trade flows. But have we really experienced the ‘demise of distance’? And what does the evidence say about the shift of modern economies towards services and the growth of their importance in trade?

Gravity: Exploring the statistical evidence

Starting with the area of trade in goods where there is the most data, we examined the evidence about the importance of distance to trade – and how this relationship has evolved over time – by conducting a ‘meta-analysis’ of the large body of existing research on the subject. Meta-analysis is a method of statistically evaluating and summarising the results from multiple empirical studies – a sort of statistical literature review (see Box 1 for more details on our research). We used this approach to analyse how distance has influenced trade flows over time.

Our analysis draws on a dataset initially developed by Head and Disdier (2008), but which we have updated with a decade of new data points to cover around 1,700 estimates from over 100 publications from the economics literature. Our meta-analysis focuses on trade in goods (rather than services), although we explore trade in services at a high level later in this note.

Taking all studies together, which cover trade over the period 1870 – 2010, our analysis suggests that halving distance roughly doubles the volume of trade. Even more interestingly, we find that the importance of distance as a determinant of trade in goods has not diminished over time and, in fact, seems actually to have even increased in recent decades (see Figure 2). The evidence suggests that while halving distance was associated with a 97% increase in trade in goods in the 1970s, during the 2000s the increase in trade from halving distance was 111%. Put simply, trade in goods seems to have become more responsive to distance over time, despite falling transport costs.
Distance coefficients show how trade volumes (usually defined as the sum of imports and exports) change as a result of a 1% fall in distance, and our particular focus was on how these changed over time.

Based on a seminal meta-analysis by Head and Disdier (2008), published in the Review of Economics and Statistics, we collected a dataset covering 1870 – 2010 for over 1,700 distance coefficients. Note that, due to data availability, the focus of this study is on trade in goods (rather than services).

Our methodology and approach

A meta-analysis is a statistical procedure for combining the findings from multiple empirical studies. Instead of analysing trade and distance data from scratch (which has been done many times before), we conducted a meta-analysis of so called ‘distance coefficients’ or ‘distance elasticities’ in the existing Gravity Model literature. Distance coefficients show how trade volumes vary with the sum of imports and exports as a result of a 1% fall in distance, and our particular focus was on how these changed over time.

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The results of the analysis are set out in the body of the text, and the table opposite sets out some important summary statistics in respect of the work.

Box 1: Meta-analysis

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The meta-analysis involved regressing the distance coefficients found in the various studies on a variety of explanatory factors, including:

• ‘Dummy’ variables to account for the time period being considered by each study.

• A variable capturing the quality of the study (for example, whether it appeared in a peer reviewed journal).

• A variable capturing the research method employed by the study.

The specification used in our analysis was:

\[ d_{ij} = \alpha + \beta_1 D_{10} + \beta_2 S_1 + \beta_3 M_1 + \beta_4 Q_1 + \epsilon \]

Where

\[ d_{ij} \]: estimated distance coefficient in paper i

\[ \alpha \]: random paper effects

\[ D_{10} \]: time period ‘dummies’ for each decade

\[ S_1 \]: structural variables relating to geography and trade volume

\[ M_1 \]: method variables

\[ Q_1 \]: paper quality control

The results of the analysis are set out in the body of the text, and the table opposite sets out some important summary statistics in respect of the work.

Robustness checks

In order to assess the robustness of our results, we carried out multiple robustness checks:

• Because the quality of methodology differs among papers, we controlled for the standard of the journal in which papers were published. Similarly as in Head and Disdier (2008), we concluded that journal quality had no significant impact on the distance coefficients estimated.

• Another issue is how different estimates and studies are ‘weighted’. For example, should a study that applies three different methodologies – and therefore yields three different estimates – receive the same weight as one that employs just one methodology? We adopted a number of different approaches to weighting studies, and our overall conclusions continue to hold in these cases.

Explaining the findings

So what explains this trend that – despite improvements in technology and reductions in transport costs over time – the importance of distance does not appear to have diminished, and may even have increased?

The first part of the answer lies in understanding modern, integrated supply chain dynamics. Recent years have seen significant growth in trade in ‘intermediates’ (goods used in the production process by other firms): today, trade in intermediate goods accounts for more than a fifth of global trade.

In many UK industries – automotive, manufacturing and aerospace for example – components cross the English channel several times and at various stages in the manufacturing process (see our case study and Figure 3 for examples). The key point is that – due to transport costs and, in particular, requirements for timely delivery of inputs at factory gates – trade in intermediate goods is only economically viable over relatively short distances.

Second is the increasing tendency for businesses to avoid the costs and risks of moving physical goods over long distances, and instead sending ‘instructions’ to local manufacturing facilities to fulfil demand in their local markets.

This is not a new phenomenon: for example, since the 1970s, Japanese firms have established and employed manufacturing facilities, concentrated in places like Wales and the North East, to export to the European market and produce everything from flat screen TVs to car parts. But today’s emerging technologies – for example 3D printing, which may allow designs to be sent around the world to be produced by local facilities in an instant – may well mean that manufacturing supply chains become even more localised in future.

Of course, it could be argued that the apparent increased importance of distance in determining trade flows could simply be on account of trade deals having been struck on a regional basis in recent decades. This has encouraged the growth of intra-regional trade as opposed to over longer distances – consider the birth of the EU and of the ASEAN and NAFTA trade agreement.

However, we took account of preferential trade agreements (PTAs) in our analysis, and found our results still hold true. This means the figures presented in this paper are ‘net’ of the effects of PTAs and that distance seems to matter no less than it used to, even when the effects of regional trade agreements are stripped out.

Supply chain dynamics in action: the journey of a BMW crankshaft

One example of modern supply chain dynamics was reported in the Guardian newspaper (06-02-17) – the case of the BMW crankshaft:

1. A cast of the crankshaft is produced in France
2. It is then shipped to a BMW plant in Warwickshire to be drilled into shape
3. It travels back across the Channel and is then sent on to Munich to be inserted into the engine
4. The engine then makes another journey back to the UK, to be put in a BMW in Oxford
5. A fourth journey across the Channel is in store for cars that are sold abroad

This multi-geography assembly line for just one part of car illustrates the importance of distance for intermediate goods trade.

Figure 2: To produce an Airbus A400M military transport plane, parts arrive from all over Europe

The importance of intermediate goods trade for Airbus
A note on services – defying gravity?

The focus of our meta-analysis has been on trade in goods. But services already account for two-fifths of the UK’s international trade (as well as 80% of the UK economy), and are expected to grow more quickly than trade in goods in the future. So what does the evidence say about gravity and trade in services?

It has been suggested that since services do not require the movement of physical commodities, they are not subject to the same gravity forces as goods. This is accentuated by the nature of new technology and transport which enable ideas and people to move rapidly across geographies in a way that often cannot happen for goods.

However, the evidence base is much less well developed for trade in services, not least because measuring trade in services is notoriously difficult. Moreover, the limited empirical evidence that does exist is very mixed: some studies suggest that services may indeed be less susceptible to the forces of gravity than goods, while others have concluded that gravity effects are significantly stronger for services.1

Overall, given the current state of the empirical research, it is difficult to conclude with certainty the true extent of gravity effects in services. More research is needed into this area to assess how distance does (or doesn’t) impact on trade in services, and the associated policy implications, to inform new trade deals and export promotion strategies. In our view, three areas merit particular attention.

First, trust is the basis of trade, and developing trading relationships often needs direct human interaction as part of the process of winning and delivering services. For instance, the Department for Transport highlights in its research that being able to readily hold face-to-face meetings can be central to successful business relationships.

Second, central to UK trade in services are a range of business, financial and legal services. These too may be associated with gravity effects, but how strong are they? There is evidence that time zones add significantly to the cost of doing business abroad (Christen, 2017). Hence, sharing a common – or at least overlapping – time zone could be fundamental in explaining trade in these services. The harmonisation of regulations and other non-tariff barriers is also important to trade in services: as this tends to occur at the regional level, often as part of FTAs or customs unions, distance by definition remains important.

Thirdly, trade in services may also display strong gravity effects because – very often – it is intrinsically linked to trade in goods. To illustrate, trading in goods creates linkages and promotes trust between customers and suppliers, which can then form the basis of trade in services in support of the trade in goods.2 Likewise, an initial exchange of goods might be associated with ongoing servicing arrangements: the initial export of an aircraft (trade in goods), for example, might be followed up with a software upgrade (trade in services).

What does this imply for the UK’s future trading relationships?

So what does all of this imply for the UK as it seeks to navigate successfully a new trading universe?3 It is important to remember the Gravity Model tells us that the size of an economy is as important in determining trade relations as distance. So while it is important to maintain trading relationships in markets with close proximity, equally important are emerging markets which may form the largest economies of tomorrow.

Indeed, our World in 20503 research tells us that emerging markets (E7 countries) could grow around twice as fast as advanced economies (G7) on average. As a result, six of the seven largest economies in the world are projected to be emerging economies in 2050 led by China (1st), India (2nd) and Indonesia (4th). With an improvement in the institutional infrastructure that supports trade, these countries will increasingly become a strong source of demand for UK exports.

As such, our analysis suggests that the UK government is right to pursue new trade deals and other trade promotion initiatives in the growth markets of Asia, Africa, Australasia and the Americas,4 while seeking to maintain and foster trading links with established partners closer to home. Equally it is important to understand better how distance impacts on trade in services, in the same way that we know it impacts on trade in goods.

The bottom line: gravity – perhaps the economic relationship that comes closest to the ‘Laws’ enjoyed by physicists – dictates that emerging long distance trading relationships should be enthusiastically developed with large growing economies while not losing focus on the ties with our nearest geographic neighbours as we shape a new Global Britain.

Bibliography


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2 For example, see Egger and Nelson (2015).
4 PwC research (2017), UK Economic Outlook Series No. 183.
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