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An empirical analysis of the possible trade effects of Brexit for the United Kingdom

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Abstract
On the 23rd of June 2016, the United Kingdom decided through a referendum to leave the European Union. The Brexit is likely to have a significant effect on trade flows. In this thesis, I investigate the expected effects on the bilateral trade flows from and to the United Kingdom. Since negotiations are ongoing, I use three different scenarios for the future relationship between the UK and EU: the "Norway" scenario, "PTA" scenario and the "No deal" scenario. I calculate the potential effects of these scenarios by using an empirical gravity equation that includes the role of trade barriers. Specifically, I work with a recent measure of the depth of a trade agreement to measure the effect of trade barriers that will arise after Brexit and explore how this affects the bilateral trade flows. The main result of the study is a projected decrease in bilateral trade flows between 20% and 70%, depending on the scenario.

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List of abbreviations

CGE	Computational General Equilibrium
EC	European Commission
EEA	European Economic Area
EEC	European Economic Community
EFTA	European Free Trade Association
ESCS	European Coal and Steel Community
EU	European Union
EU27	European Union without the UK
FDI	Foreign Direct Investments
FTA	Free Trade agreement
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GNP	Gross National Product
H-O model	Heckscher-Ohlin model
H-O-V model	Heckscher-Ohlin-Vanek model
MFN	Most Favoured Nation
NAFTA	North American Free Trade Agreement
NiGEM	National Institute Global Econometric Model
NTB	Non-tariff barrier
NTT	New Trade Theory
OLS	Ordinary Least Squares
PPML	Pseudo Poisson Maximum Likelihood
PTA	Preferential trade agreement
TRIPS	Agreement on Trade Related Aspects of Intellectual Property Rights
TTIP	Transatlantic Trade & Investment Partnership
UK	United Kingdom
US	United States of America
WTO	World Trade Organization

1. Introduction

On the 23rd of June, the United Kingdom (UK) held a referendum to decide on its membership of the European Union (EU): remain or leave. Contrary to expectations, the UK voted, with a small majority, to leave the EU. With that decision, the unexpected had occurred. A lack of written constitution paired with an absence of a clear pathway made it uncertain which path the relations between the UK and the EU would take. The 2009 Lisbon Treaty has set some lines for a formal procedure on how a country can leave the European Union (Lisbon Treaty, 2009). The country must notify the EU on the intention of leaving, which Theresa May has done in March 2017 (White Paper, 2017). The notification is the start of negotiations on the withdrawal, which can take no more than two years. The negotiations for an agreement have been ongoing for almost a year, but still plenty remains uncertain. Although this agreement must cover a lot of different areas, the interest of this thesis will be trade.

The objective of this thesis is to provide an empirical analysis of the effects on the bilateral trade flows from and to the UK. Due to the uncertainties of the possible trade relationship between the UK and the EU, this thesis works with a scenario-based analysis for the possible outcome of the negotiations on trade policy.

The research question of this thesis is: *What is the effect of trade barriers as a consequence of the upcoming Brexit on bilateral trade flows of goods from and to the UK?*

The method used to estimate those effects is based on the method introduced by Egger *et al*. (2015), who estimated the effects of the Transatlantic Trade & Investment Partnership (TTIP). Egger *et al*. (2015) estimated the effect of the upcoming trade agreement between the United States of America (US) and the EU on bilateral trade flows. In the context of Brexit, the effect on the trade flows is measured by trade barriers, which consists of tariffs and non-tariff barriers (NTBs). NTBs are measures such as quotas, import licensing systems, sanitary regulations, prohibitions etc. (WTO, 2017). Where tariffs are relatively straightforward, percentages that need to be paid when importing a good, NTBs are difficult to quantify due to the plethora of different NTBs that exists. Egger *et al*. (2015) provide a method to quantify the trade barriers to evaluate their impact on bilateral trade flows.

The main assumption is that the trade barriers will be measured on the basis of the depth of trade agreements, which also exists of a combination tariffs and NTBs. According to Egger *et al*. (2015) the depth of trade agreement reflects the trade barrier between two countries. The deeper a trade agreement between two countries, the more rules they included in their agreement, and thus the lower the trade barrier between those two countries. In the case of Brexit, we will not calculate the decrease of trade barriers due to a trade agreement as Egger *et al*. (2015) did regarding TTIP. We will calculate the increase in trade barriers once leaving an agreement. Leaving a trade agreement will increase the trade barrier with the same amount they decreased when signing the agreement. When the UK is leaving the EU, those trade barriers will be increasing again. The increase will be dependent on the future relationship between the UK and the EU. We consider

three different scenarios. We then estimate a so-called gravity equation including a variable that catches the depth of trade agreements to reflect the trade barriers. We use data on 279 trade agreements among 189 countries over the period 1980-2015. The Pseudo Poisson Maximum Likelihood (PPML) estimator is ran to obtain the coefficient of the variable that reflects the depth of a Preferential Trade Agreement, the PTAdepth variable. This coefficient is used to simulate the mutations of the possible effects of bilateral trade flows from and to the UK in the three different scenarios.

The main results of the study show that Brexit in every scenario contributes to a decrease in the bilateral trade flows. The trade flow from and to the UK will decrease with 71.2% if there is no trade agreement after the UK disentangles itself from the EU. Should the UK and the EU agree on an average trade agreement, the bilateral trade flow from and to the UK will decrease with 57.2%. Lastly, if the UK decides to enter the EEA and adopt a model which is similar to the relation the EU has with Norway, the decrease in trade flows will be 20.3%. The percentages are based on the data from 1980 till 2015.

This thesis contributes to a growing body of literature that consider the potential impact of the Brexit. Whilst the British government is seeking to chart the path for a country outside the EU, the debate about the economy's prospects after the Brexit for the UK has gotten more intense. International organisations and national governments weighed in on the debate – citing research papers where mostly negative consequences were outlined. Some research provides clear evidence on the possible losses from Brexit, whilst other research remains open to interpretation.

Previous studies on the consequences focused on a broad spectrum of possible outcomes. Studies done by the OECD (2016), CEPR (2016), CPB (2016), PWC (2016) and HM Treasury (2016) all simulated the economic consequences of Brexit, though they did not include a clear estimation of the impact of a deep trade agreement. For example, PWC (2016) measured the NTBs by modelling the increase as equivalent of the different NTBs that the EU and a third-party country face. CPB (2016) used the estimates of the NTBs by Egger *et al*. (2015). The method by Egger *et al*. (2015) is explained in this thesis to evaluate the impact of a trade agreement on the bilateral trade flows. Though, Egger *et al*. (2015) used the DESTA dataset to measure the depth of trade agreement to reflect the trade barrier. The specific contribution of this thesis includes the use of a newly published (Januaruy 2017) database by the World Bank to obtain the depth of trade agreements. The DESTA database, by Dür *et al*. (2014) used preferential trade agreements signed up until 2009, whereas the database of the World Bank includes PTAs signed up until 2015. Additionally, whereas the DESTA database estimates the depth of trade agreement with a number between 0 and 7, the new database published by the World Bank calculates the depth of trade agreement on 52 provisions, which makes our results up to date and more precise (Hoffman *et al*., 2017).

The relevance of this paper can be found in that the UK is by no means the only country full of critical voices towards the EU. The effect of Brexit in the UK, will be an example for other

member states of what leaving the EU really contains. Parties in other member states such as the Finnish "Waren Finnen," the German "Alternative für Deutschland," the "Lega Nord" in Italy and the Dutch "Partij voor de Vrijheid" are all EU-sceptic movements that are gaining traction (Meijers, 2017). Fear of losing national identity and sovereignty, concerns about overregulation by the EU or transferring too much power to Brussels, are arguments used by those parties. Questions are raised whether EU membership offers any benefits at all for member states. The European Union and other trade agreements can be seen as results of globalization. Alongside the Eurosceptic voices, anti-globalization forces sweep across the world with Brexit as one of the consequences. It is perhaps too soon to say that Brexit is just the beginning of extreme anti-globalization, but the link is clear. The rejection of the UK towards Europe is a protest against the economic model that has been in place for the past three decades (Elliot, 2016). For years the idea was that a more integrated Europe would collectively serve as a safeguard that single countries could no longer administer anymore. Moving from a single market to a single currency and a single banking system, and perhaps eventually a single budget and one political entity. That was the European dream that dominated over the past years. But Brexit ended that dream. The importance of Brexit can be caught in a quote of Charles Grant from the Centre For European Reform think tank: *"Brexit is momentous event in the history of Europe and from now on the narrative will be one of disintegration not integration."* (Charles Grant cited in the Guardian, 2016).

The remainder of this thesis is organised as follows. Chapter 2 provides an overview of international trade theory, which leads to the gravity equation we use in the empirical analysis. We also consider the empirical evidence for the different theories. In Chapter 3 we give background information on the Brexit. We first consider the position of the UK with respect to the European Union and consider the possible scenarios for the UK and the EU27 after the Brexit, including a discussion of the trade barriers in each scenario. Chapter 4 reviews the literature on the possible economic consequences of Brexit, where we focus on the effects on trade. Chapter 5 then outlines the empirical methodology we use to calculate the trade barrier. Next, Chapter 6 considers the dataset used in the empirical analysis. Chapter 7 presents the empirical results for the gravity equation, and calculates the corresponding effects of the Brexit on trade flows under the different scenarios. Finally, in Chapter 8 we discuss our findings and conclude that there is trade-off between the depth of a trade agreement and de bilateral trade flows.

2. Theoretical Framework

This chapter contains the theory of international trade. We start with a historical overview of trade theory that ends with the New Trade Theory. We also consider the gravity equation, which is the main empirical relation used in modern empirical trade analysis, and also used in the empirical analysis in this thesis. Furthermore, we provide empirical evidence on the different theories.

2.1 International trade theory

Taking a historical perspective, the mercantilist view of the zero-sum game is typically considered the first theory of international trade (Langdana and Murphy, 2014). This theory, popular in the West between the 16th and 18th centuries, is focused on cross-border trade and policies. This philosophy argues that nations can increase their wealth by increasing exports, and collecting gold and silver in return. Furthermore, a country needed to discourage imports, through tariffs and quotas (Schumacher, 2012, pp. 55). This means that mercantilists did not believe that both nations were able to benefit from bilateral trade.

By the end of the 18th century, mercantilism was increasingly becoming a bottleneck for economic progress. Adam Smith (1776) refutes the mercantilist view in his famous book *The Wealth of Nations*: "Mercantilism has as its object to diminish as much as possible the importation of foreign goods for home consumption, and to increase as much as possible the exportation of the produce of domestic industry. Its two great engines for enriching the country, therefore were restraints upon importation, and encouragements to exportation." (Smith, 1776, IV.1.35) Smith argued that mercantilist policies were only helpful for producers and not for costumers. Smith (1776) stated that export is only profitable if you can import goods to satisfy customers instead of producing them in the international market. He wrote that trade is a consequence of the human "propensity to truck, barter, and exchange one thing for another" (Smith, 1776, pp. I.ii.1). Smith (1776) can be marked as the first theory that nowadays is recognized as part of the standard theory on international trade (Sen, 2010). Smith was the first one to describe the principle of *absolute* advantage. The principle contains the idea that one country is able to produce a greater number of products than competing countries while using the same amount of resources. An important aspect of Smith's theory of international trade was labour, since it was seen as the only output in his theory of *absolute* advantage. Smith stated that if there is division of labour, the costs of labour could be reduced. Those lower costs caused effective competition between different nations, so that *absolute* advantage is a comparison of the productiveness of labour between two countries (Sen, 2010). Schumpeter (1954, pp.607) stated in his book that Smith "believed that under free trade all goods would be produced where their absolute costs in terms of labour are lowest". Smith makes a clear connection between international trade and his idea of the division of labour. According to Smith, international trade is advantageous for nations because of the following:

> *"[it] gives a value to their superfluities, by exchanging them for something else, which may satisfy a part of their wants, and increase their enjoyments. By means of it then narrowness of the home market does not hinder the division of labour in any particular branch of art or manufacture from being carried to the highest perfection. By opening a more extensive market for whatever part of the produce of their labour may exceed the home consumption, it encourages them to improve its productive powers, and to augment its annual produce to the utmost, and thereby to increase the real revenue and wealth of the society" (Smith, 1776 pp. 31).*

Since the international market is always bigger than only a domestic one, trade with another nation ensures an expansion of the division of labour. Which makes "international trade advantageous to a nation" (Schumacher, 2012, pp. 59). Although Smith changed the way of thinking about international trade, he did not create a model that justified his idea (Meoqui, 2014). Smith never explained how two nations with an *absolute* advantage in the same factor, still could benefit from trade (Marrewijk, 2007).

It was David Ricardo (1817), a British economist, who developed the theory of *comparative* advantage and laid out the principles of the theory of free trade (Sen, 2010). He argued that it is beneficial for people to take part in activities that are profitable for them and have a *comparative* advantage (Todaro and Smith, 2009). The theory of *comparative* advantage explains the gains from trade for nations by factor endowments[1] as well as technological differences (Maneschi, 1998). A *comparative* advantage consists of the fact that a nation can produce products at relatively low opportunity costs[2], so with this theory one can make a comparison of opportunity costs of producing goods. Ricardo (1817) explains this theory in international trade by stating that if two countries that are producing products, will engage in the free market, and will increase their overall consumption by exporting the good for which the countries have a *comparative* advantage while importing the other good. This is under the condition that there are differences in labour productivity. This way of thinking brings one to the phenomena of specialization. Ricardo stated that specialization, internationally, is beneficial for countries per se (Golub & Hsieh, 2000). The model he developed argues that it is more beneficial for nations to specialize in the production, and with that, the trade of goods in which the nation is relatively more efficient. Nations need to specialize in the production of activities that could yield the biggest advantage from trade (Todaro & Smith, 2009). He has shown that "two countries can gain from trade if their (constant) labour input ratios were different, even if one of the countries had an *absolute* advantage in both of the goods" (Leamer & Levinsohn, 1995 pp. 1343). Trading between nations benefits not only the

[1] In economics a country's factor endowment is commonly understood as the amount of land, labour, capital, and entrepreneurship that a country possesses and can exploit for manufacturing (see e.g. Krugman, 1979; Leamer and Levinsohn, 1995).

[2] The loss of potential gain from the best alternative.

nations that possess *absolute* advantage in some goods, but also the nations with that are less efficient holding a *comparative* advantage in at least one good. (Ricardo, 1817).

Two Swedish economists, Eli Heckscher and Bertil Ohlin, expanded Ricardo's model.[3] They developed the Heckscher-Ohlin model (H-O model), which has been an important building block in the traditional theory of international trade. It builds upon the theory of comparative advantage by explaining trade flows and production in a country based on factor endowments of a nation. It uses the assumption that the production technology is the same in every nation and that the only difference is the proportion of available capital and labour.[4] Where in the Ricardian theory, labour productivity is exogenous, the H-O model allows for variable capital endowments generating endogenous variation of labour productivity across countries. For that reason, according to the H-O theorem, nations that have a surplus of certain factor (labour or capital) will produce and export goods that need the certain factor. Conversely, the nation will import goods that require the factor that the nation has in short supply (Miberg, 1996). Leamer & Levinshohn (1995) clarified the model as follows: "[it] identifies a mapping from exogenously given factor supplies and exogenously given external product prices (determined in the international market place) into internal factor prices, output levels and consumption levels, the difference between these last two items being international trade." (pp. 1346)

Ohlin wrote in his *Interregional and International trade* (1933) that (1) free mobility of commodities in international trade can serve as a partial substitute for factor mobility and (2) will lead to a partial equalisation of relative factor prices. In other words, the factors that are scarce have a high price and the factors that are abundant have a low price. Complete mobility of a certain factor assumes that the price will become equal in all the nations, so that in the end the price of all factors will become equal in every nation (Lerner, 1952).

This brings one to the Specific Factor (SF) model, which was analysed by Jacob Viner (1931) with a variant of the Ricardian model.[5] The SF model was further developed by Ronald Jones (1971). The name of the SF model refers to the feature of the model that one factor of production is assumed to be 'specific' to a particular industry. A specific factor is one that "is stuck in an industry or is immobile between industries in response to changes in market conditions." (Suranovic, 2012 pp. 261)

[3] They were awarded the Nobel Memorial Prize in Economic Sciences in 1977 "for their path breaking contribution to the theory of international trade and international capital movements".

[4] The assumptions of the H-O model are: (1) labour and capital flow freely between sectors; (2) the amount of labour and capital in two countries differ (difference in endowments); (3) technology is the same among countries (a long-term assumption) and; (4) 4astes are the same across countries.

[5] The assumptions of the model are: (1) two sectors: agriculture/food and manufacture; (2) there are three factors of production: labour, capital and land and; (3) perfect competition prevails in all markets.

2.2 New Trade Theory

The New Trade Theory (NTT), pioneered by Paul Krugman (1979)[6] stated that "consumers can gain from trade through access to new varieties." (Costinot and Rodriguez-Clare, 2014 pp.262) The NTT explains the gains from international trade focusing on increasing returns to scale and network effects. The essence of the NTT is that countries do not only specialise and trade in order to take advantage of their differences; countries also trade because of increasing returns, which makes specialisation advantageous per se (Krugman, 1990 pp. 425). In other words: trade is caused to an important extent by *increasing returns* instead of *comparative* advantage.

Krugman (1979) also developed a model of non-comparative advantage trade. Later on, Krugman (1980) developed a simple model of trade in differentiated goods that has increasing returns to scale.[7] Within the model, Krugman (1980) explained the intra-industry trade while making use of economies of scale, differentiated product and heterogeneous preferences. In other words, Krugman tried to explain the differences in production structures between different nations. His model could explain that nations with the same factor endowments will still engage in trade. As an explanation he used transportation costs, the possibility of economies of scale and the access to large markets. By way of explanation: economies of scale will make sure that the production of a good takes place on the same location the whole time and transportation costs make sure that a producer will locate near the largest market in terms of demand. In other words, countries will export the products they also have home markets for (Krugman, 1980).

2.3 Empirical evidence on the international trade theory

Classical trade theory explained "the extent to which a country exports and imports relates to its trading pattern with other nations" (Morgan & Katsikeas, 1997). In other words, different countries are able to gain if that country has resources of goods and services in which the country has an economic advantage (Ricardo, 1817; Smith, 1776). Adam Smith (1776) pioneered the analysis on the causes of the wealth of the nations and suggested that economies need to export goods in exchange for generating revenue to finance imported goods which could not be produced domestically (McCombie & Thirwall, 1992). Smith (1776) failed to create a trade model about his statements, but one can suggest that the indicators of 'the wealth of nation' are a country's gross domestic product (GDP) (Morgan & Katsikeas, 1997). GDP is a measure that values goods produced by a certain economy in a given period (Tayeb, 1992). Several economists found

[6] He was awarded the Nobel Memorial Prize in Economic Sciences in 1980 for his "for his analysis of trade patterns and location of economic activity".

[7] The assumptions of the model are: (1) labour is the only factor of production, (2) 1 product, 2 countries; (3) identical technologies between countries; (4) similar factor endowments; (5) Dixit-Stiglitz preferences; (6)monopolistic competition with many firms; (7) differentiated goods (number of firms equals the number of varieties); (8) a large number of identical consumers-symmetric demand of all available varieties - love-for-variety (more varieties lead to greater utility) and; (8) increasing returns to scale implies that countries specialize in producing a subset of goods.

empirical evidence on the assumption that GDP can be influenced by international trade (e.g. Meier, 1984; Marin, 1992).

Ricardo (1817) introduced the idea that comparative advantage contributes to the explanation of intra-industry trade.[8] Ricardo (1817) stated that technological differences are the key to cross-country variation of production. Some empirical studies adopted this Ricardian theory (MacDougall, 1951; Stern, 1962; Balassa, 1963), but over the past decades this model has been almost completely ignored (Golub & Hsieh, 2000). Leamer and Levinsohn (1995 ppp. 1344) stated that they "are unaware of any recent work testing or estimating the applicability of the Ricardian model." They argued that the model is too simple for empirical analysis.

It took 134 years after Ricardo (1817) before his model was tested by MacDougall (1951) empirically. MacDougall (1951) constructed a new method to do a cross-section study considering two countries: the UK and the US. This method has become known as the 'third-country' method. MacDougall (1951) used data from 1937 for 25 products. As explained in *International Trade: Causes and Consequences* by Borkakoti (1998): "instead of studying bilateral trade between the two selected countries, MacDougall (1951) examined the relationship between the inter-country ratio of sectoral labour productivities and the inter-country ratio of the quantities of exports of the same sectors to the rest of the world (i.e. the 'third' country)." The hypothesis that MacDougall tested was that if the US ratio of wage in 1937 was around twice that in the UK, the US firms should have an export advantage in manufacturing sector with US labour productivity exceeding twice the level in the UK. Using the measures of the labour productivity, MacDougall (1951) discovered that in terms of export to the same third world countries by US and the UK, for 20 out of 25 products, the ratio of the US exports to UK exports exceeded one. In the rest of the cases this ratio was less than one. The results are for those 25 products in line with the Ricardian model (MacDougall, 1951). Stern (1962) followed MacDougall (1951) with a comparison in trade between the US and the UK in 1950. Stern (1962) found out that the wage in the US was 3.4 times the UK wage in that year. Using the Ricardian model the hypotheses suggested that the ratio of export in the US to UK exports should be bigger than one in those sectors where the labour productivity exceeded 3.4. Stern (1962) used 39 sectors and in 33 sectors the results were consistent with the Ricardian model. Balassa (1963) did a similar study on UK and US exports. The evidence presented in the paper indicated that: "there is a high correlation between productivity ratios and export shares, and the introduction of further explanatory variables only slightly modifies the results" (Balassa, 1963 pp. 237). More recently, Golub and Hsieh (2000) conducted a contemporary statistical analysis of the relationship between relative productivity and trade patters as stated in the Ricardian model. In their conclusion, they stated that within the most cases "relative productivity and unit labour cost help to explain US bilateral trade patterns,

[8] Ricardio (1817) means by this the international exchange of one set of goods to another.

particularly when sector-specific purchasing-power-parity exchange rates are used", which gives strong support for the Ricardian model (Golub & Hsieh, 2000 pp. 231). Constinot *et al*. (2010) tested the prediction done by Ricardo that countries produce and export the products from industries in which they are relatively more productive. The theoretical prediction of the theorem turned out the be consistent with the data: "relative export levels across countries and industries, corrected for trade-driven selection, are positively correlated with relative productivity levels across countries and industries (Constinot *et al*., 2011 pp.600).

Nevertheless, some of the assumptions of the Ricardian theory of comparative advantage are criticized. For example, Ohlin (1993) argues that the model is static, which means that the model only reflects the conditions at a certain point in time. Golub and Hsieh (2002) underlined that the Ricardian model ignored factors of production that are not labour, for example the factor capital.

Much more of the empirical analysis of traditional trade theory is focused on the H-O model (Heckscher, 1919; Ohlin 1924). Early empirical research on the H-O model is done by Leontief (1953), who studied the international trade flows of the US to test the H-O model. According to the H-O model the US should be a country exporting capital intensive products, since the US is a capital rich country. Surprisingly Leontief's study showed that the opposite was true: his research was entirely inconsistent with the H-O theory. Referred to as the Leontief paradox, it undermined the validity of the H-O theory. Baldwin (1971) also concluded that the pattern of trade of the US is not explainable the H-O model. The sign of the capital-labour ratio is significantly opposite from the expectations that he had from the model. With his research, he underlined the existence of the Leontief paradox. Leamer (1980) showed that the comparison made by Leontief (1953) had not acknowledged the relative abundance of capital and labour in a world with multiple factors. He questioned the methodology used by Leontief, namely comparing factors contents of an equal dollar value of imports and exports. Vanek (1968) added a simple formula to the H-O model including the factor endowment and the countries' share in consumption of the world: the Hecksher-Ohlin-Vanek (H-O-V). Bowen, Leamer, Sveikauskas (1987) for 27 countries, with 12 factors of production (324 comparisons), finds that the H-O-V model predicted very poorly. Empirical support for the H-O-V model was found by Davis and Weinstein (2001). They allowed for technical differences and found that technical differences matter, even in the rich OECD countries. In 2003 Debaere tested the H-O-V model for bilateral trade between a developed ("North") and a developing ("South") country. For a North-South country pair the H-O-V model provided support, were capital-labour ratios are comparable, but not for a North-North pair.

Classical trade theory emphasized inter-industry trade, which is trade of products that are produced in different industries. With the classical trade theory, no empirical support for intra-industry trade between developed nations was found (Grubel and Lloyd, 1975; Linder, 1961; Debeare, 2003). This led to the 'new trade theory' pioneered by Krugman (1979, 1980), who explained those characteristics of international trade in terms of consumer preferences and increasing returns to scale (Redding, 2006). Empirical evidence to support the new trade theory

was obtained by Helpman (1987). Helpman (1987) reported supporting hypotheses for theory pioneered by Krugman's (1979, 1980) "(1) using cross-country comparisons the larger the similarity in factor composition, the larger the share of intra-industry trade; (2) in time series data the more similar the factor composition of a group of countries becomes over time, the larger the share of intra-industry trade within the group" (Helpman, 1987 pp. 63). Both hypotheses are consistent with the data used from 14 OECD countries over the period 1959 to 1981. Brülharts (1998) findings also support the relevance of the new trade theory. He stated in his research on industrial specialization in the European Union (EU) that: (1) more possibilities for economies of scale in a certain industry lowers the level of intra-industry trade; (2) industries that make intensive use of resources have the lowers intra-industry trade, whereas labour-intensive industry the highest and; (3) clusters of industries are mostly located in central European countries, which can be explained due to the good market access. (Brulharts, 1998: pp. 341) While the empirical evidence supports the new trade theory, it is interesting that Hummels and Levinshon (1995) discovered that the same levels of trade existed between countries that are not OECD member. For this group, the assumptions that are made by new trade theory, homothetic preferences and differentiated products, are less appropriate.

2.4 The theoretical gravity equation

To model international trade empirically, gravity equation models are used. The gravity model offers an empirical approach to international trade, but is based upon the trade theory explained in the previous section. After we provide the traditional gravity equation, we will show the link between the international trade theory and the gravity equation.

Tinbergen (1962) and Linneman (1966) introduced the gravity model which has since been widely used to explain flows of trade between countries. The model applied Newton's formula for the gravitational pull between two physical bodies to bilateral trade flows.

The original form of the gravity equation for international trade is based on the law of universal gravitation in physics developed by Newton (1687):

$$F_{ij} = G\frac{M_i^{\beta} M_j^{\beta}}{D_{ij}^2} \qquad (1)$$

The gravitational force F_{ij} is related to the product of two masses M_i and M_j proportionally and is related inversely proportional to the squared distance D_{ij} that keeps the masses apart. In this equation G is a gravitational constant. In the context of international trade and economics, the law of universal gravity by Newton provides the following equation:

$$X_{ij} = A\frac{Y_i Y_j}{D_{ij}} \qquad (2)$$

This gravity equation is the most simplified standard form of the gravity equation in international trade. X_{ij} is referred to as the export from country i to country j. The masses are replaced by the gross domestic product (GDP) of a country (Y_i and Y_j) and D_{ij} represents the geographical distance between the two capitals of the countries (Head, 2003). McCallum (1995) shows that the explanatory power of this equation is 80 %, which makes this equation an empirical success.

The standard specification of the gravity equation in the context of international trade is provided by Tinbergen (1962) who assumed the following relationship.

$$X_{ij} = A\frac{Y_i^{\alpha}Y_j^{\beta}}{D_{ij}^{\gamma}} \qquad (3)$$

The exponents α, β and γ can take values different than 1, which implies based on the work of Tinbergen (1962), that there is not necessarily a proportional relationship between the explanatory variables and the variable that needs to be explained. The exponents respectively refer to the elasticity of the exporting country's GDP, the elasticity of the importing country's GDP and the elasticity of distance.

In practice, gravity models are typically estimated with ordinary least squares (OLS) regression analysis. Taking the natural logarithm of equation *(3)* and adding an error term provides the log-linear relationship used in empirical work. The log-linear equation "specifies that a flow from origin i to destination j can be explained by economic forces at the flow's destination and economic forces either aiding or resisting the flow's movement from origin to destination" (Bergstrand, 1985 pp. 474). This relationship takes the following form:

$$\log(X_{ij}) = \log A + \alpha \log(Y_i) + \beta \log(Y_j) - \gamma \log(D_{ij}) + \varepsilon_{ij} \qquad (4)$$

Particularly, this log-linear equation explains that: if the exporting country's GDP (Y_i) increases by 1 per cent, the volume of export will increase by α per cent, *ceteris paribus*. Similarly, if the distance between the two countries i and j increases by 1 per cent, the trade flows will decrease by γ per cent, ceteris paribus. This is under the assumptions that the error term ε_{ij} is independently distributed.

2.5 Empirical evidence on the theoretical gravity equation

The theoretical foundation of the gravity equation was weak for the first 20 years of the gravity equation in international trade theory.[9] Although equation *(3)* provided high explanatory power,

[9] The theoretically grounded gravity equation is based on four assumptions on the micro-level. Those assumptions will be satisfied in the empirical gravity equation that I use in the empirical analysis. (1) Dixit-Stiglitz preference: those preferences explain the demand side of the gravity equations and provides a utility function for a representative consumer in country i. The utility function of the representative consumer is: $U = \sum_{j=1}^{i} q_{ij}^{\frac{\sigma-1}{\sigma}\frac{\sigma}{\sigma-1}}$ where q_{ij} is the quantity of products of the exporting country j consumed by

two main issues emerged. First, the traditional equation does not account for trade costs between countries *i* and *j*. Second, the equation does not take into account the possible change in trade costs across countries (Shepherd *et al*., 2013). Those issues caused new developments for the theoretical foundations of the gravity equation. Since the 1980s research of different economists[10] contributed to this theoretical foundation of the gravity model, by showing that the equation is based on the earlier theories on international trade as explained in the previous section. Deardorff (1998) for example has shown that the gravity model as in equation *(3)* can be derived from the H-O model. Deardorff (1998) argued that the gravity equation is the basic implication of specialization and homothetic preferences. In line with Deardorff (1998) Evenett and Keller (2002) contributed to the theoretical foundations of the gravity equation by stating that increasing returns and factor endowments can explain the success of the empirical gravity equation. They used a cross-section of both developed and developing countries and identified with gravity equation that increasing returns are better in explaining North-North trade, while factor endowments are better in explaining North-South trade (Evenett and Keller, 2002). Eaton and Kortum (2002) suggest the Ricardian model as the theoretical foundation by interpreting geographic distance between country *i* and *j* deflated by the price level to trade weighted average of all other trading partners. Eaton and Kortum (2002) use the assumptions that there are differences in technology, constant returns to scale and homothetic preferences as in the Ricardian model. Comparing the work of those researchers, we can conclude that the theoretical foundation of the gravity equation cannot be imputed to one theory.

The most notable empirical evidence of the gravity equation is the work done by McCallum (1995). McCallum (1995) used the gravity equation to study whether trade amongst Canadian provinces was greater or less than trade between Canadian provinces and the US. His equation simply used a "dummy variable which was equal to 1 for interprovincial trade and 0 provinces to state trade" (McCallum, 1995 pp. 616). This has been called the McCallum 'border puzzle'. McCallum (1995) showed that trade increased significantly within the Canadian provinces when compared to trade with the US.

Anderson and van Wincoop (2001), however, showed that the model used by McCallum obtains an omitted variable bias. They showed that trade between two regions is not dependent

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the importing country *i*. σ represents the elasticity of substation between products. Shepherd *et al*. (2013) explains this utility function as the `love-of-variety' by consumers. The utility of consumers increases if they are able to consume more differentiated products. These are also called constant-elasticity-of-substitution (CES) preferences; (2) Linear cost function: this assumption makes sure that the produces in a particular country *i* have a linear cost function if they produce differentiated products. The function shows the fixed costs and variable costs: $c_i = \alpha + \phi\omega_i$. In this function c_i denotes the total cost of production, α denotes the fixed costs and $\phi\omega_i$ the variable costs; (3) One factor of production*:* the models have only one factor of production: labour. All the countries *i* have a particular amount of labour. Labour is assumed to be internationally immobile and inelastic with respect to the wage ω_i and; (4) Perfect or monopolistic competition: this assumption includes that the gravity equations, derived from different theories of international trade, are characterized by perfect competition or monopolistic competition.

[10] Among those researches are for example Anderson (1979), Deardorff (1998), Eaton and Kortum (2002) and Evenett and Keller (2002).

only on the trade costs between two regions, but also on the trade costs with all other regions. Anderson and van Wincoop (2001) built on the work of Anderson (1979) and extended the gravity equation with two variables. Those variables provided an explanation for the resistance to trade from the involved countries with all other countries. Anderson and van Wincoop (2001) introduced this as the so-called multilateral resistance term. By way of explanation, the higher the multilateral resistance between the importing country and all other countries, the higher the trade flow between the importing country and the related exporting country. Anderson and van Wincoop (2001) explained that trade flows between two different countries are dependent on the trade barriers between those two countries relative to the average trade barriers those countries face with all other countries. Through including this multilateral resistance term, the theoretical gravity equation does account for trade costs between the involved countries and does take into account the possible change in trade costs across countries. They estimated that the borders of country reduce trade with 44% in the case of the US and Canada and that national borders have a more significant impact on inter-regional trade flows than international trade (Anderson and van Wincoop, 2001). Empirical evidence for the New Trade Theory and the 'home market effect' can be found, which is the effect that "an increase in expenditure leads to more than proportionate increase in domestic production of a good" (Redding, 2006 pp. 11). Davis and Weinstein (2003) discovered evidence of the home market effects for a large group of manufacturing industries. Also in international trade data, more support for the home market effects is found (see e.g. Feenstra *et al*. 2001).

The gravity equation is now widely used to explain the impact of certain events on trade. Events differ considerably, but one could presume various examples, such as policies, borders, transport costs, tariffs, common currencies, common language, WTO membership, and so forth. The model has also been applied to other bilateral flow data than trade flows, such as migration, traffic, remittances and foreign direct investment. Baier and Bergstrand contribute to the success of the gravity equation explaining the impact of trade agreement, which is the interest of this thesis. For example, they used the gravity equation to estimate the impact of a trade agreement on bilateral trade flows by including the tariff reductions (Baier and Bergstrand, 2002). Their analysis shows 23-26% of the mean growth in trade is explained by the presence trade agreements (Baier and Bergstrand, 2002). Another example is a study for the EC by Bergstrand *et al*. (2010), in which they estimate the *ex-post* effect of trade agreements signed by the EU on bilateral trade flows from and to the EU. The results of this study show that export of the EU increases significantly in most cases. Other important work is done by Head and Mayer (2013) who used the gravity equation with a dummy variables for membership to test of effectiveness of the North American Free Trade Agreement (NAFTA) and the World Trade Organization (WTO). Being a member of the NAFTA or the WTO has positive effect on trade flows.

3. Brexit

The day following the results of the referendum on the 23rd of June 2016, newspapers both in the UK and in the EU reported: "What does it actually mean to leave the EU?" Google announced that this question had an increase in search volume by 250% that morning, which suggests that nobody actually knew what Brexit really meant (The Independent, 2016). In this Chapter, we take a closer look at what Brexit actually represents. To get a better understanding of what Brexit really means, we first provide some context. We recapitulate the history of the EU, with a focus on the role the UK played within the EU. Then, we provide a short explanation on the UK's 1975 referendum and the rebate that the UK obtained. Next, we move forward to the 2016 referendum, when the people of the UK voted to leave the EU. We briefly introduce the reasons behind the leave-vote and the process of leaving the EU (the Article 50 procedure). Further, we outline the three most-likely to happen scenarios for the future relationship between the EU and the UK. To conclude this chapter, we introduce the barriers to trade.

3.1 The UK in the EU

In the aftermath of the Second World War the precedent of the European Union was founded as the European Coal and Steel Community (ECSC). This community[11] was set up to unite European countries with the purpose to secure lasting peace. The Treaty of Rome in 1957 created the European Economic Community, also known as the EEC. This Treaty was signed by the original members of the ECSC. In 1967 the EEC and ECSC together with EURATOM were combined in a merger treaty, and the European Commission, European Parliament and the European Council were enacted. In 1973, 1981, 1986 and 1990 further countries[12] became a member of the European Communities, a single market was created, and the Schengen Agreement was signed allowed free movement between most of the member states. In 1993 the Treaty of Maastricht meant the start of the European Union as we know it today. The Single Market was complete, with the four pillars of freedom of movement: goods, services, capital and people. In 1995 three new members[13] were accepted and in 1999 the common currency was introduced: the euro. In 2004, 10 more member states joined[14]. More members[15] got accepted to the European Union with Croatia being the last one in 2013. Currently, the European Union counts 28 members, but this will most likely decrease to 27 in 2019 – due to the Brexit.

The United Kingdom applied for membership of the EEC in 1961. It was 1973 when the UK became part of the European Communities, along with Denmark and Ireland. The UK

[11] Belgium, France, Germany, Italy, Luxembourg and the Netherlands.
[12] Denmark, the UK and Ireland (1973), Greece (1981), Portugal and Spain (1986), Germany (1990)
[13] Finland, Sweden and Austria
[14] Cyprus, Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Slovenia, Hungary, Malta
[15] Bulgaria and Romania (2007)

government, under Prime Minister Edward Heath, decided, without a mandate of its people, to enter the EU:

"There are some in this country who fear that in going into Europe we shall in some way sacrifice independence and sovereignty. These fears, I need hardly say, are completely unjustified." (Heath in Podmore, 2008)

3.2 The 1975 Referendum

Since the day they started thinking about EU membership in the 1960s, there has always been anti-Europe groups in the United Kingdom (Usherwood, 2002). Aspinwall (2000) states in his research that it is not only the people, but also party politics that caused unfavourable sentiment towards the EU. He argued that there are two reasons behind this dissatisfaction: (1) The tension within parties to take care of different positions on integration; and (2) the force that this tension within the party creates pushes party policy away from the notional centre of Parliament's attitudes towards integration (Aspinwall, 2000). According to his model, any movement away from the centre means an increase in opposition. As such, when there is a small majority in Parliament there is more chance for anti-integration policy proposals and outcomes. This was the case in the mid-1970s. The reasons that the UK joined the EEC in the first place were the hopes of increasing exports and reduce the costs of trade. However, GDP was decreasing in the UK during the 1970s and inflation was accelerating (Pettinger, 2012). In 1974 the UK was in a recession.

The conservative government of Heath, who joined the EEC or Common Market in 1973, fell in 1974 and the Labour Administration took over. It was one of the election promises of the Labour Party that people would decide 'through the ballot box' to stay in or exit from the European Communities (Labour Party, 1974). The electorate voted with 67.23% in favour of remaining in (Williamson, 2015).

3.3 The rebate

In 1979 Margaret Thatcher took over the government during a time the UK was in need of structural changes. The first two decades of the membership proved to be difficult for the UK as it had not brought the benefits that the UK hoped for. Margaret Thatcher felt that the UK needed change and she negotiated for a rebate on the European membership, which was introduced in 1985. Arguments in favour of having a rebate included the fact that the UK was paying a relatively large contribution into the budget of the EU, compared to its GDP, without apparently gaining much (Fitchew, 2004). More precisely: the UK had a relatively small agricultural sector, whereas most of the EU budget was spent on agriculture (around 70% in 1985). Another argument for the rebate is that the system of contributing to the EU budget had as a main source the payments based on the Member States VAT incomes. This system can be considered progressive. In the UK,

the VAT base in comparison with the Gross National Product (GNP) was proportionally higher than in other Member States. The basic concept of the rebate nowadays remains the same, though the complexity of the calculating method has grown.[16]

Since the introduction of the rebate for the United Kingdom, other member states of the European Union argued that their commitments were also too excessive. Member States started to request a form of reduction on their budgetary commitment, which caused a growing number of ad hoc agreements and corrections. There is a mechanism in place that calculates the rebate for other countries related to the rebate the UK is receiving.

3.4 The 2016 Referendum

On the 23rd of June in 2016 the same question was asked as in the 1975 referendum the UK. Now it was Prime Minister David Cameron who asked the question: *"Should the United Kingdom remain a member of the European Union or leave the European Union?"* After a period of "Vote leave" and "Vote remain" campaigns, in the morning of the 24th of June 2016 it became clear that 51.9% of the United Kingdom had voted to leave the European Union, supported by a turn-out ratio of 72.2%. (The Guardian, 2016). In the book *Brexit, Why Britain Voted to Leave* Clarke *et al*. (2017) try to explain why the people voted to leave the EU. They draw their conclusions on data of about more than 150.000 voters over 12 years and analyse the factors and concerns that led people to the leave-vote.[17] By taking into account the 12 years of data, they discovered that the attitude that shaped the leave-vote was already the attitude before the idea of a referendum existed. The authors used the work of Hooghe and Marks (2005) to explain what it is that shapes the public attitudes towards the European Union. The main argument is that Brexit is not driven by only one factor, but the vote to leave the EU reflects what Clarke *et al*. (2017) refer to as: "a complex and cross-cutting mix of calculations, emotions and cues. Within this, immigration was key." Their findings also pointed to an important role for Boris Johnson in particular. Johnson, of the conservative party, has been the face of the Leave campaign in the UK . The authors stated that: "…if you liked Boris then even after controlling for a host of other factors you were significantly more likely to vote for Brexit." (Clarke *et al*., 2017) Kaufmann (2017) conducted an extensive analysis also concluding that the referendum was very much about immigration. He states that the Brexit story is mainly about values, not economic inequality (Kaufmann, 2017).

By triggering Article 50 the new Prime Minister Theresa May officially started the legal procedure of leaving the European Union (The Economist, 2017). Article 50 states that after notification the country will leave the EU within two years, unless the other 27 unanimously agree to extend this period (Lisbon Treaty, Article 50, paragraph 3). The Article 50 negotiations will

[16] For further explanation on the EU budget and the way it is calculated see: httpp.//ec.europa.eu/budget/library/biblio/documents/financing/2007final_uk_corr_working_doc_en.pdf

[17] Clarke, Goodwin and Whiteley (2017) used representative national surveys conducted each month from April 2004 until June 2016.

exist of two parts: (1) the divorce terms, including e.g. the Brexit-bill, assets, liabilities, British nationals in EU institutions etc. and; (2) a possible future trade relation between the UK and the EU. Donald Tusk, President of the European Council, has been very clear about the order of the negotiations: "Once, and only once we have achieved sufficient progress on the withdrawal, we can discuss the framework for our future relationship. Starting parallel talks will not happen." (Tusk cited in The Guardian, 2017) The negotiations are done by David Davis (UK's Brexit Secretary) and Michel Barnier (EU's chief negotiator) and their teams. The EU published their guidelines for the negotiations[18], which is agreed by all member states, "in order to ensure transparency and build trust." (Barnier cited in Politico, 2016) The real negotiations started on the 17th of July 2017 and the official 2-year period after notification will end on the 1st of April 2019 (The Guardian, 2017).

3.5 Possible scenarios for the future relationship between the EU and the UK

Various studies have been conducted to make an estimation of the possible economic consequences of the Brexit. The majority of the studies are working with different scenarios. The number of scenarios that studies used differ a lot. We can conclude that the earlier the study, the more scenarios that are used. This is due to the fact that after the referendum researchers started to work on their Brexit studies while the UK government had not taken a position yet on the future trade relation with the EU. Since there is more information now, this overview will only include the three most likely scenarios for the future relation between the UK and the EU. Where the first scenario is not likely to happen, the latter two are the most plausible options according to earlier research and current development in the ongoing negotiations (see e.g. Rojas-Ramagosa, 2016; Dhingra *et al*. 2016a; White Paper, 2017). The latter two benefit from a deeper understanding of the World Trade Organizations and Preferential Trade Agreements, and thus will be explained in more detail.

3.5.1 The "Norway" scenario

This scenario is based on the principles of the European Free Trade Association (EFTA), which is the agreement of Norway, Iceland and Liechtenstein with the EU. Members of EFTA are members of the EEA (European Economic Area), which is the free trade area between the EU and the EFTA (excluding Switzerland).[19] This Internal Market is not given free. Members of the EEA do still need to apply all the rules of the EU. Members of the EEA contribute to the EU budget to be part of that single market (Dhingra *et al*., 2016a). In this scenario, the UK would apply for a membership of the EEA. As stated above, this scenario seems not plausible. The White Paper "The

[18] The complete list of guidelines can be find here: http.//g8fip1kplyr33r3krz5b97d1.wpengine.netdna-cdn.com/wp-content/uploads/2017/03/FullText.pdf

[19] Switzerland is a part of the EFTA but did not ratify the EEA Agreement.

United Kingdom's exit from, and new partnership with, the European Union", last updated in May 2017, gives a good overview. The paper states: "We do not seek to adopt a model already enjoyed by other countries. We will not be seeking membership of the Single Market, but will pursue instead a new strategic partnership with the EU, including an ambitious and comprehensive Free Trade Agreement" (White Paper, 2017). The British government is aiming for "the greatest possible access to it through a new, comprehensive, bold and ambitious Free Trade Agreement" (Theresa May cited in the Telegraph, 2017). A central element of the "leave campaign" was being able to get rid of EU immigration rules (free movement of people), contribution to the EU budget and EU regulations. The British government regards the acceptation of the freedom of movement as a *quid pro quo*. Being a member of the EEA will not satisfy those elements, since a large contribution to the budget still needs to be paid and EU regulation will apply. For example, Norway pays two third of what the UK is paying to the EU budget (Dhingra *et al*., 2016a; House of Lords, 2016).

3.5.2 The "PTA" scenario

The European Commission (EC) provides the definition of a Free Trade Agreement (FTA). The EC states that a FTA is an agreement that eliminates or cuts customs duties, remove quotas and reduce the amount of other trade restrictions for commerce in goods and services between two (bilaterally) or more (multilateral) countries (EC, 2017). PTA and FTA are used interchangeably, since they are very similar. The difference is that the FTA is the main goal of PTA, with all tariffs eliminated, whereas a PTA can consist of a lot of different levels of integration (WTO, 2017). This thesis uses the PTA instead of FTA, since it is consistent with the dataset used.

The EC explains the reason behind closing a trade agreement as strengthening the domestic economy and create employment due to the increase in trade flows between the countries. Those trade flows are a result of the reduced trade barriers; it allows a country to compete more efficiently and increase exports to other countries. It also permits better access to intermediate products and other necessary products from all over the globe (EC, 2017). The World Trade Organization (WTO) oversees those agreements. The WTO can be explained as: "the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business." (WTO, 2017) The WTO consists of 164 member countries, which all have to comply to the rules of the WTO. Those rules are in place to mitigate the negative effects of global trade. Member countries are not free to decide on setting up a new trade agreement with another party. The rules of the WTO on trade agreements can be roughly be explained as: (1) the agreement should encompass substantially all trade, (2) have positive effect on the trade flows between participating countries and (3) may not create trade barriers towards non-participating countries (WTO, 2017). The third point is one of the core principles of the WTO: the non-discrimination

principle. If there is no trade agreement in place between countries, the most-favoured-nation (MFN) principle applies. The MFN states that: "treating other people equally under the WTO agreements; countries cannot normally discriminate between their trading partners." (Article 1, GATT; Article 2, GATS; Article 4; TRIPS) An FTA is a way to bypass the Most Favoured Nation principle that is imposed by the World Trade Organization (WTO). This Most Favoured Nation treatment contains the principle of not discriminating between one's trading partners (WTO, 2017). The only exceptions to the MFN principle are the countries that entered into a trade agreement and countries that can give preferential market access to developing countries. In other words, grant someone a special favour (such as a lower customs duty rate for one of their products) and you have to do the same for all other WTO members (WTO, 2017). Although a trade agreement is discriminatory, since only participating countries enjoy the benefits, the WTO acknowledged the important role in international trade and therefore monitors it. This monitoring is done by the notification process, which has to be done in advance of the trade agreement. All the data and information on the potential agreement is assessed by the WTO to estimate the impact on the member countries. The WTO also makes sure that all WTO-rules are part of the potential agreement. The WTO decides after this extensive process if a FTA can be ratified or not (WTO, 2017).

The "PTA" scenario in the context of Brexit contains a new negotiated PTA between the EU and the UK. According to the OECD (2016) the main characteristics of this scenario are: (1) mostly tariff-free Single Market access, but compliance needed with EU standards and product regulations; and (2) no full access for services and no automatic pass porting rights for banks. It is important to acknowledge that the content of the potential PTA depends on the ongoing negotiations. It is likely that the PTA will not determine all the standards and regulations, which means that there still will be, though not necessarily directly visible, barriers. These are called the non-tariff barriers (NTBs). Several studies estimated those barriers in goods and services around 6% when the EU and the UK will agree on a PTA (see e.g. HM Treasury, 2016; Kierzenkowski *et al*., 2016).

3.5.3 The "No deal" scenario

The "No deal" scenario means reliance on the WTO-rules only. The UK is a member of the World Trade Organization (WTO) since 1948 (WTO, 2017). [20] The UK will still be a member of the WTO after leaving the EU, though membership of the WTO only provides limited access to the European markets for non-EU members of the WTO. The UK will have the same access and the same rules and conditions as all other WTO members to the EU without a preferential trade agreement. As explained above one of the main principles of the WTO is the Most Favoured Nation (MFN) principle, which can be found in the first article of the GATT (1947). The MFN principle ensures

[20] In that time, it was the GATT, the predecessor of the WTO.

that all 161 members of the WTO are treated equally. Countries cannot normally discriminate between their trading partners. If they grant one country special favours, for example lower customs duty rates, that country has to apply those lower rates for all other WTO members (GATT, 1947: Article I). The so-called "No deal" scenario for the future relation between the EU and UK implies that the EU and the UK will trade reciprocally on the basis of the MFN principle. The tariffs that will be used in this scenario vary a lot per product or service.[21] The average of the EUs external tariffs in 4.2%. Some products have a significantly higher tariff; agricultural and food products have tariffs around 15% and cars around 10%. As in the "PTA" scenario, non-tariff barriers will arise alongside the tariffs.

In the table below, we provide an overview of the three different scenarios with the most important components concerning this thesis. The table is partly based on the context provided above and partly on the meta-analysis done by Busch and Matthes (2016):

Table 1. *Overview of the main components of the three scenarios*

	"Norway" scenario	"PTA" scenario	"No deal" scenario
Decision making rights and representation in EU	No	No	No
Tariffs on the UK export the EU	No	Partial	Yes
Non-tariff barriers	Yes	Yes	Yes
Free movement of goods	Yes	Depending on the agreement	No
Free movement of persons	Yes	Depending on the agreement	No
Free movement of capital	Yes	Depending on the agreement	No
Free movement of services	Yes	Depending on the agreement	No, depending on GATS
Financial contribution to the EU	Yes, partial	Depending on the agreement	No
Influence on EU regulation	Very limited	Depending on the agreement	No

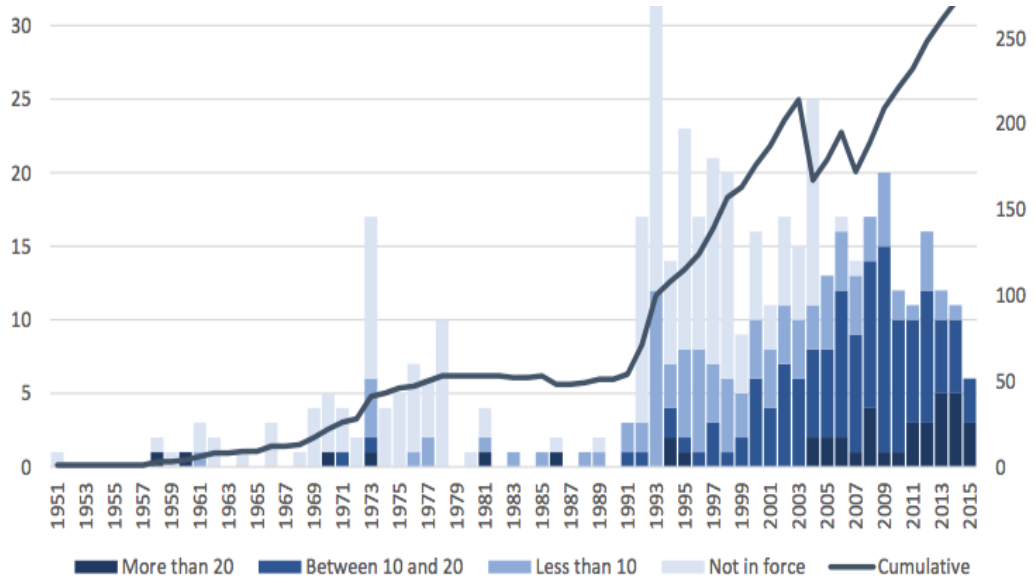
[21] An overview of the EU external tariffs can be found on: httpp.//stat.wto.org/CountryProfiles/E28_e.htm

3.6 Barriers to trade

An important part of the scenarios discussed above are the possible tariffs arising after Brexit, but there are other barriers to trade which will arise after the UK has disentangled itself from the EU: NTBs. The combination of tariffs and NTBs, is what we call the barriers to trade. Over the last two decades, globalization has become a well-known concept with growing importance. The effects of globalization are far-reaching. The WTO is playing a major role in this trend via multilateral and bilateral efforts. The landscape of trade and therefore trade agreements has dramatically changed the past 30 years. In 1990 only 51 PTAs were established, by 2017 279 agreements were notified to the WTO (WTO, 2017). In negotiation rounds with the member states, the WTO has been a success due to the tariff cutting deals. Multilateral negotiation rounds have led to a low level of tariffs around the world. These tariffs are relatively straightforward to negotiate. Alongside with increasing regulation and different standards, the number of non-tariff barriers to trade has risen. NTBs can be described as measures such as quotas, import licensing systems, sanitary regulations, prohibitions etc. (WTO, 2017). With the rise of NTBs, there has been an increasing focus on negotiation commitments of not exclusively tariff nature, but on NTBs as well (Egger *et al*. 2015). The plethora of different NTBs makes their regulation at a multilateral level almost impossible (Bektasoglu *et al*., 2016). Instead of the multilateral framework, negotiations on NTBs are mostly in a bilateral or regional framework. Literature from the past years also shows that decreasing NTBs has a bigger impact on the welfare than normal tariff reductions in most trade agreements. NTBs and tariffs form the trade barrier, which can be quantified by the depth of the trade agreement. The depth of trade agreement concerns the fact that those agreements do not only cover tariff reductions, but also regulatory issues and policies that go beyond tariffs (Mulabdic *et al*., 2017). This will be addressed more extensively in Chapter 5. Figure 1 shows the increasing number of trade agreements over the past years together with their depth. Lawrence (1996) introduced this distinctions between 'deep' and 'shallow' agreements, where 'deep' agreements cover not only tariffs, but also border measures. Deep agreements can include e.g. services, investment, competition and intellectual property rights protection (Mulabdic *et al*., 2017).

The EU has always been a precursor of deep integration. The EU has the deepest PTA among the 279 current in force according to the new data provided by the World Bank (Hoffman *et al*., 2017). The relationship between the UK and the EU is regulated by the Treaty of the European Community and the subsequent enlargements that are covered in the Treaty. This Treaty covers 44 policy fields, e.g. labelling rules, competition policy, standards, movement of capital and labour.

Figure 1. *Number of trade agreements and their depth over the years (Hofmann et al., 2017)*



4. Existing studies on the economic consequences of Brexit

Independent economists, think thanks and official institutions have published a vast amount of research, of both quantitative modelling and literature based nature. Following the media and the White Paper from the UK government, as stated above, the number of scenarios for the future relationship for the UK and the EU has been narrowed. In this Chapter, we discuss a number of those studies from both official (OECD, HM Treasury) and independent sources, using those scenarios. Although some of the papers estimate the impact of Brexit on the UK, the EU and global economy through many different channels, this overview focusses on the trade effects. The overview is organised by year of publication.

Ottaviano *et al*. (2014) conducted a study on the impact of Brexit on the United Kingdom using a New Quantitative Trade Model (NQTM), which is based on a gravity model. The scenarios they used are slightly different from other research. Ottaviano *et al*. (2014) used in the optimistic view a scenario where the UK would have the same amount of access to the EU's internal market as it has a full member of the EU. A scenario that only Kierzenkowski *et al*. (2016) used as well: the EEA/EFTA scenario or "Norway" scenario. A large number of commentators, as stated above, declared that the UK probably would not be able to negotiate those favourable terms. Moreover, the UK stated several times that it wants a tailor-made solution (White Paper, 2017). The use of this scenario is explained by the fact that this research is done in 2014, when Brexit was still an unlikely, not thought out, idea. Ottaviano *et al*. (2014) sketches the pessimistic scenario with an increase in trade costs which may come from tariff barriers, NTBs and the UK missing out on the further steps that the EU will make towards deeper integration. In the optimistic scenario, the authors assumed that intra-EU barriers will fall 20% faster than in the rest of the world, while in their pessimistic scenario it will decrease 40% faster. The results from those static events are converted in loss in welfare for the United Kingdom. The welfare is measured "by the change in real consumption" (Ottaviano *et al*. 2014 pp. 4). The pessimistic scenario will give a loss of 3.09% and the optimistic scenario 1.13%. This research is very similar in assumptions and comparable results as the research conducted by Dhingra *et al*. (2016a). The different outcomes can be explained by the fact that Dhingra *et al*. (2016a) used reduced fiscal benefits, namely +0.09% and +0.31% in respective the optimistic and the pessimistic scenario. Ottaviano *et al*. (2014) used a +0.53% on GDP in both scenario. Those fiscal benefits represent the save on net contribution to the EU budget. Those losses are based on static events and do not take into account other dynamic effects, such as FDI, immigration and deregulation.

Booth *et al*. (2015) conducted a very detailed model-based study which is published by Open Europe, a British think tank. This research is based on a CGE model to estimate the ex-ante effects. The authors assumed that the UK would leave the EU on the first of January in 2019 and made an estimation for the UK in 2030 using different scenarios. Booth *et al*. (2015) concluded that in the worst-case scenario, which is comparable to the "No deal" or WTO scenario, GDP

would be 2.2% lower for the UK compared to remaining a member of the EU. In a best-case scenario, compared to the "PTA" scenario, the GDP in the UK would be 1.6% higher, taking into account ambitious deregulation and almost fully openness to trade with the rest of the world. The increase in GDP is remarkable, but the researches admit that these are the outliers and that it will most likely be something in between those numbers. The authors made use of the CGE model, which takes into account a wide range of dynamic effects comparable to those in Kierzenkowski *et al*. (2016). Nevertheless, the authors noticed that "overall constraints on the size and complexity of the model mean that the impact of domestic regulatory changes are not captured, which may miss changes in the overall potential of the economy over time" (Booth *et al*, 2015 pp.78).

Aichele & Felbermayr (2015) used, like Ottaviano *et al*. (2014), the NQTM with a gravity model. They estimated the consequences of the UK leaving the EU in different scenarios, not only for the UK and the EU as whole, but also for different countries within the EU. They use a soft scenario where there are NTBs to trade, but no tariffs (comparable to "Norway" scenario). A 'deep cut' scenario, which is comparable to our "No deal" scenario and a scenario the authors call 'isolation of the UK', where the UK loses all the privileges member states have being in the EU. Their conclusion is that the Brexit in the long-term could lead to drop in the UK's real GDP per capita ranging from 0.6% in the soft exit scenario and 3% in the so-called 'isolation of the UK'.

The research by Kierzenkowski *et al*. (2016) from OECD is a policy paper in which they outline the economic consequences of Brexit. Kierzenkowski *et al*. (2016) used OECD's METRO model and fed the estimations into the National Institute Global Econometric Model (NiGEM) macro model for the world economy (OECD, 2015). In their research, they use seven channels through which the impact of Brexit will be felt: risk premia, confidence, trade, immigration, Foreign Direct Investments (FDI), skills and deregulation. additionally, they split up the research in two parts: near term (2020) and long term (2030). In the near term, the UK would lose access to the EU's Single Market and trade under the rules of the WTO, whereas in the long term there are three scenarios used. Those scenarios are central, optimistic and pessimistic, which are comparable to the three scenarios used in this thesis. The main results of this research are the effects of Brexit through those seven channels on GDP. Kierzenkowski *et al*. (2016) estimated a decrease of 3.3% in the near term on the GDP in the UK and -2.5% (optimistic), -5.1 % (central) and -7.7% (pessimistic) in the long term. The GDP of the EU would decrease by 1.0%. Considering the effects of trade, in the "PTA" scenario UK export in total decreases with 6.4% and 8.1% if the UK would trade on the MFN principles with the EU and other countries. A part of the decrease in the "PTA" scenario is due to "a complementarity between services and manufacturing: services are necessary to enable manufacturing and trade in goods, and when production shrinks, so does services activity" (Kierzenkowski *et al*. 2016: 20). Limitations of this research can be the underestimation of the importance of possible new barriers to trade in services, since this research only takes into account the barriers to financial services. Another point of discussion is the use of the NiGEM model, which is not a trade model and leaves policy shocks exogenous.

Rojas-Romagosa (2016) of the CPB Netherlands Bureau for Economic Policy Analysis conducted research on the trade effects of Brexit for the Netherlands. Rojas-Romagosa (2016) used WorldScan to simulate the different Brexit scenarios. WorldScan is an in-house CGE model for the world economy (Lejour *et al*., 2006). In this study two scenarios are used: the FTA-option and the WTO-option (or respectively in our terms "PTA" scenario and "No deal" scenario). According to Rojas-Romagosa those are the two most likely scenarios. The study uses the assumption that Brexit will happen in 2019. The new trade costs under the WTO-option will be imposed from 2019 onward, hence the FTA option will start in 2029. In the FTA-option, trade will be the same as under the WTO-option between 2019 and 2029. The main results of this study are a decrease in GDP in the FTA-option of -0.6% EU27 and -3.4% UK. In the WTO-option the decrease is estimated -0.8% for the EU and -4.1% for the UK. Those estimations are changes with respect to the baseline in 2030 (the business-as-usual baseline) and based on the GTAP9[22] database. Like Kierzenkowski *et al*. (2016), Rojas-Romagosa (2016) includes a link between trade volumes and productivity. This report uses several other studies to estimate to total effects on trade. Rojas-Romagosa (2016) adopted the gravity estimations of the HM Treasury (2016) report. For the NTBs that are arising in the WTO-option, he works out his estimations using the gravity estimations of Egger *et al*. (2015) for goods and Jafari and Tarr (2015) for services. The results of the GDP estimation, making use of the trade-productivity link, are comparable to Kierzenkowski *et al*. (2016). In the FTA-option, GDP will decrease by 5.9% in the UK and 1.1% for the EU. GDP is predicted to decrease by 8.7% for the UK and 1.5% for the EU under the WTO-option. The trade-productivity link is a complex and quantifying the dynamical effects of trade has been proofed to be rather difficult. Rojas-Romagosa (2016) therefore used examples (Feyrer, 2011; Melitz & Trefler, 2012) where the results empirically support that trade will lead to more innovation and thus increase productivity. Hence, he stated that it is important that the degree of generalisability of the trade-productivity link should not be read as the exact truth. The precise value of this elasticity is certainly not robust and justifies more research. Therefore, in the sensitivity analysis the report chooses for a conservative estimate of 0.1. This is in line with Kierzenkowski *et al*. (2016). Concerning trade, in the FTA-option trade from the UK to the EU27 the export value will decrease with 31% and in the WTO-option with 51.3% compared to the baseline in 2030. The trade flow, the other way (EU27 to UK) decreases with 31% in the FTA-option and 56.6% in the WTO-option. This study shows that in all cases, the potential extra trade with non-EU regions will not compensate for the loss in trade between the UK and the EU. A limitation of this research can be found in that Rojas-Romagosa (2016) only considered trade-related effects of Brexit and not like Kierzenkowski *et al*. (2016) other economic impacts.

[22] The GTAP9 database is a publicly available global data base which contains complete bilateral trade information, transport and protection linkage. For more information see: https://www.gtap.agecon.purdue.edu/databases/v9/default.asp

Dhingra *et al*. (2016a) estimated the effects of the consequences of Brexit for the living standards and trade for the United Kingdom by also using a NQTM. Dhingra *et al*. (2016a) used an optimistic scenario where the UK obtains complete access to the single market (our "Norway" scenario) and a pessimistic scenario, which is comparable with the "No deal" scenario and the MFN principle as outlined in the above section. Under the pessimistic scenario, NTBs play an important role and are estimated to increase by 6% for goods and services. This study also includes the UK's contribution into the EU budget. In the optimistic scenario, this means that the UKs contribution will be 17% less and will still be in the single market. This is based on the fact that Norway's contribution to access to single market is 83% of the payment of the UK (House of Lords, 2016). In the pessimistic scenario, the UK is outside of the EEA and this study assumes that the UK in that case will save the public finance components (essentially costs from the Common Agricultural Policy), which is 0.31% of GDP in fiscal benefit. The percentage change in the level of income per capita in the UK is -1.4% in the optimistic scenario caused by trade effects and -2.92 % in the pessimistic scenario (MFN-tariff + increase in EU/UK non-tariff barriers of 6%). The fiscal benefit is 0.09% and 0.31% in respective the optimistic and the pessimistic scenario. Besides the effects on the UK itself, Dhingra *et al*. (2016a) also estimated the effects of Brexit on living standards in other countries. The EU's GDP is predicted to fall with 0.12%-0.29%. This study only focused on the consequences of Brexit caused by trade effects. Changes in for example migration, investments and regulation are not taking into account.

HM Treasury (2016) released a detailed report on the impact of the EU membership and the alternatives, which contributed largely to the discussion on Brexit and international trade. This report is based on scenarios and uses the NiGEM model, which is also used by Kierzenkowski *et al*. (2016). This research includes the link between trade volume and productive, which is also used in Kierzenkowski *et al*. (2016). HM Treasury (2016) based their research on three models for the new EU-UK relationship. They use three scenarios: optimistic ("Norway"), central ("PTA") and the WTO option ("No deal"). This research considers also the dynamic economy of the European Union and its single market by taking into account trade and foreign direct investment. HM Treasury (2016) uses a three-step process. First, the way Brexit would affect FDI and trade. In this step, the gravity model is used, which followed best practice in earlier academic literature. The gravity model consists of certain dummy variables to include the different scenarios as stated above. The following variables were included: EU membership (where both trade partners are in the EU), EU trade diversion (where only one trade partner is in the EU), FTA membership (where both trade partners are in the FTA) and EEA membership (where both trade partners are in the EEA, which includes all EU member states). Second, the consequences of the reduction in trade and FDI for production. This step captures the dynamic effects. Here the same considerations are made concerning the trade-productivity link and the FDI-productivity link. They find an elasticity of 0.04 for the link between productivity in the broad industry level to the level of the FDI stock. This is line with the Kierzenkowski *et al*., (2016) and Rojas- Romagosa (2016). Third, combining

the results of step 1 and 2 in different models to predict the impact on the UKs national income. HM Treasury (2016) used the NiGEM macroeconomic model to predict the effects of Brexit on the GDP in the UK in 15 years. In this last step HM Treasury (2016) also took into account additional effects of Brexit, namely: (1) short-run shocks (1% decline in GDP) which will derive from uncertainty and other channels which will cause a loss of capacity; (2) the impact of the fall in productivity growth on the aggregate capital shock; and (3) the NiGEM model captured complex relations between trade, prices and investments. The results of those steps showed that the GDP level in the UK will be decreasing by 3.8% in EEA scenario, 6.2% in FTA-scenario and 7.5% in a WTO-scenario.

As a response to the analysis by HM Treasury (2016), Dhingra *et al*. (2016b) from the LSE Centre of Economic Performance wrote a commentary stating that HM Treasury were too conservative in the assumptions they made. Dhingra *et al*. (2016b) summed up the criticisms on the HM treasury report (2016). This criticism is based on the link between trade and productivity that is used in the report of HM Treasury (2016). The numbers used to calculate the impact of trade on productivity in the report of HM Treasury (2016) have their roots in the research conducted by Feyrer (2011), who provided the elasticity of 0.2 to 0.3 for the link between trade and productivity. Feyrer (2011) looked at the decrease in trade costs due to the closing of the Suez Canal, a natural experiment. The criticism by Dhingra *et al*. (2016b) consisted of the point that Feyrer (2011) "only looks at the effects over an eight-year horizon, whereas the long-run horizon the Treasury is considering is 15 years, leading to larger dynamic effects" (Dhingra *et al*, 2016b pp. 6). Rojas-Romagosa (2016) and Kierzenkowski (2016) both also used the estimation made by HM Treasury (2016) to shape and quantify their trade-productivity link. According to Dhingra *et al*. (2016b) this is elasticity is too conservative and underestimated the effects.

PriceWaterhouseCoopers (PWC) (2016) conducted a comprehensive study on the impact of Brexit on the United Kingdom, through various channels that can have an impact: change in migration policies, trade, FDI, uncertainty in the short run, fiscal policies and regulations. The authors in this research made use of a CGE model, which captures different sectors of the economy, households and governments (PWC, 2016). This model is also partly used by Rojas-Romagosa (2016) in his research, though that study also incorporated extra losses due to the decrease of innovation caused by the decrease in trade. This can be seen as an explanation of the different figures they found, namely the lower costs in PWC's FTA- scenario (Rojas-Romagosa, 2016). PWC (2016) estimated the impact of the UK exiting the EU in two possible scenarios: the WTO-scenario and the FTA-scenario, both in the short term and the long term (2020 and 2030). PWC added a scenario in which the UK will remain a member of the European Union, where the EU is reformed under the deal that UK Government secured in February 2016. In this scenario, the economy will be growing in the long-run with 2.3% per year (PWC, 2016). PWC (2016) estimated that in 2020 the GDP in the UK will be around 3% lower in the case that there is Free Trade Agreement and 5.5% lower in the WTO-scenario, compared to the UK staying in the EU. In 2030,

Brexit could cause a 1.2% to 3.5% lower GDP in the UK respectively in the FTA- scenario and the WTO option. By 2030. the post-exit uncertainty shock is concerned resolved. These percentages could be lower still, since there is a possibility that the population of the UK will decrease due to migration policy changes. The largest effects are due to migration and trade.

The table below provides an overview of the estimations of the authors that are discussed in this section. We can conclude that Brexit will lead to a decrease in GDP for the UK and that the trade flows from and to the UK will be lower after the Brexit in every scenario. On average GDP will decrease with 1.3 % in the average optimistic scenario and 4.2% in the average pessimistic scenario.

Research	Type of model	Impact on GDP in the UK	Impact on trade for the UK	Comments
Ottaviano *et al*. (2014)	New Quantitative Trade Model[23]			The use of a potential benefit of the UK, which is of 0.53% of GDP due to the save on net contribution to the EU.
Optimistic / "Norway"[24]		-3.1%		
Pessimistic/ "No deal"		-1.1%		
Booth *et al*. (2015)	Computable General Equilibrium model[25]			The increase in GDP is remarkable. This 'best case' scenario is based on ambitious deregulation and almost fully openness to trade with the rest of the world. The authors stated that the more realistic would be an impact on GDP between -0.8% and +0.6%.
Best case		+1.6%		
Pessimistic/ "No deal"		-2.2%		
Aichele & Felbermayr (2015)	New Quantitative Trade Model			The 'Isolation of the UK' is a new scenario. This scenario takes into account that the UK loses all the privileges from the trade agreements the EU has with third countries.
Soft/ "Norway"		-0.6%		
'Deep cut'/ "No deal"		-2.8%		
'Isolation of the UK'		-3.0%		
Kierzenkowski *et al*. (2016)	NiGEM macroeconomic modelling			Dynamic effect of Foreign Direct Investment (FDI) and productivity are considered.
Optimistic/ "Norway"		-2.7%		
Central / "PTA"		-5.1%	-6.1%	
Pessimistic/ "No deal"		-7.7%	-8.4%	
Rojas-Romagosa (2016)	WorldScan - CGE			Those results include a dynamic effect between trade volume and productivity. The trade results are the export value from the UK to EU27.

FTA/ "PTA"		-5.9%	-31%	
WTO/ "No deal"		-8.7%	-51.3%	
Dhingra *et al*. (2016a)	NQTM			The trade effects reported in this table is the impact of trade effects to the total change in income per capita.
Optimistic/ "Norway"		-1.3%	-1.37%	
Pessimistic/"No deal"		-2.6%	-2.92%	
HM Treasury (2016)	Gravity model approach, macroeconomic & NiGEM modeling for productivity and FDI impacts			Dynamic effect of FDI and productivity are included. Welfare effects are also covered.
Optimistic / "Norway"		-3.8%		
Central / "PTA"		-6.2%		
Pessimistic / "No deal"		-7.5%		
PWC (2016)	Computable General Equilibrium model			The effects in this table are the short run effects in this study (2020). In the long run the effects are reported to be lower. The largest impact on GDP is due to trade and migration effects.
FTA / "PTA"		-3%		
WTO/ "No deal"		-5.5%		

Table 2. *Main findings of the previous studies on Brexit*

[23] A NQTM is a recent class of trade models, which can simulate the *ex ante* effects of a trade agreement (Busch and Matthes, 2016). Those models build on the CGE model and gravity equations.

[24] The names of the scenarios are presented in the following way: the name that the authors used/ the name that we use.

[25] A CGE a model is an often-used tool to estimate the impact of trade policy measures. In this case the CGE model captures the effect of a trade agreement on endogenous target variables, such as GDP (Busch and Matthes, 2016).

5. Empirical methodology

In this Chapter, the methodology that is used to obtain the main variable of interest is explained. The empirical gravity equation is outlined, followed by the formula to calculate the impact on the bilateral trade flows. The problem of zero trade flows, which is common problem in trade data, is explained and the ways to solve it will be introduced.

5.1 Quantifying trade barriers

Barriers to trade consist of both tariffs and NTBs. Where tariffs are straightforward percentages that need to be paid when importing a good, NTBs are more difficult to quantify. Egger *et al*. (2015) provide a method to quantify NTBs as if they were tariffs. This research will partly follow the method described by Egger *et al*. (2015).[26] In this thesis, we quantify those barriers to trade, both tariffs and NTBs, by the depth of a trade agreement. The deeper a trade agreement between two countries, the lower the barriers between those two countries. The reverse is also true, leaving a PTA will increase barriers. In the case of Brexit, when the UK leaves the EU, the barriers will increase with the amount they decreased when a country enters the EU. The increase depends on the future relationship between the UK and the EU and therefore on the different scenarios we use.

5.2 The empirical gravity equation

We use the gravity equation from Head and Mayer (2013) to estimate the NTBs, following Egger *et al*. (2015). Head and Mayer (2013) use a basic expression of the gravity equation which holds under the micro-level assumptions as explained in Chapter 2. Recall that those assumptions were: Dixit-Stiglitz preferences, the linear cost function, one factor of production and perfect or monopolistic competition. Recall also that the two main issues of the basic theoretical gravity equation can be solved by variables of multilateral resistance. The following form will be used to derive the basic gravity equation that explains trade flows:

$$X_{ij} = \pi_{ij} X_i \qquad (5)$$

X_{ij} represents the imports in country *i* (importer) from country *j* (exporter). π_{ij} reflects the share of products from country *j* in comparison to the total imports of country *i*. X_i is the sum of the total imports in country i.

A critical requirement is that π_{ij} can be explained in the following separable form:

[26] Egger *et al*. (2015) use this method to estimate the possible impact of TTIP on trade between the US and the EU. TTIP is the upcoming trade agreement between the US and the EU, which ought to have an impact on their bilateral trade flows.

$$\pi_{ij} = \frac{S_j \phi_{ij}}{\Phi_i} \quad (6)$$

Where S_j represents all the characteristics of the exporter as a supplier to all countries and ϕ_{ij} reflects the trade barrier between country *i* and country *j*. In this equation $\pi_{ij} \geq 0$ and $\sum_j \pi_{ij} = 1$. X_{ij}. π_{ij} still provides the share of the number of products from country *j* in all the imports of country i. Φ_i can be explained in the following way:

$$\Phi_i = \sum_k S_k \, \phi_{ik} \quad (7)$$

Φ_i is the weighted sum of the exporter capabilities and therefore measures the degree of competition in the market. Furthermore, the following equations hold,

$$S_j = \left(\frac{Y_j}{\Omega_j}\right) \quad (8)$$

Where S_j represents all the characteristics of the exporter as a supplier to all countries and Y_j contains the total value of the production of country *j* ($Y_{j=} \sum_i X_{ij}$) and $\Omega_j$is an index of market potential or access, which is commonly used in economic geography (Head and Mayer, 2013).

Combing equation *(7), (8)* and the expression for S_j, the following structural gravity equation can be derived according to Head and Mayer (2013), including the multilateral resistance term (Φ_i) as explained by Anderson and van Wincoop (2001)

$$X_{ij} = S_j \frac{X_i}{\Phi_i} \phi_{ij} \quad (9)$$

If $\frac{X_i}{\Phi_i}$ contains the importer fixed effects (M_i) and recall that Φ_i from equation *(7)* and S_j from equation *(8)* represents the importer fixed effects the multiplicative form of the gravity equation takes the following from (Head and Mayer, 2013):

$$X_{ij} = S_j M_i \phi_{ij} \quad (10)$$

So that bilateral trade flows X_{ij} can be explained by ϕ_{ij} that represents all barriers to trade. S_j and M_i are respectively the exporter and the importer fixed effects, which will be explained in Section *6.4*.

To obtain the empirical equation, we use the Poisson Pseudo-Maximum Likelihood Estimator (PPML) for a number of reasons, which will be explained in the next part. The PPML form of the multiplicative constant-elasticity gravity equation is (Santos Silva and Tenyero, 2006):

$$y_i = \exp[x_i\beta] + \varepsilon_i \qquad (11)$$

In this equation y_i is the conditional mean given x_i. y_i is the dependent variable and x_i explains all the independent variables. β is the parameter corresponding to the independent variable and ε_i is the error term. This equation can be made linear in the parameters by taking logarithms of both sides of the equation:

$$\ln y_i = x_i\beta + \ln \eta_i \qquad (12)$$

which leads in the context of this paper to the following equation that we use in the remainder of the thesis:

$$X_{ij} = \exp[\ln S_j + \ln M_i + \beta \ln \phi_{ij} + c(m_{ij})] + \epsilon_{ij} \qquad (13)$$

This equation is comparable to equation *(10)* where ϕ_{ij} gives barriers to trade with β representing the coefficients of the other trade cost factors. S_j and M_i are respectively the exporter and the importer fixed effects and $c(m_{ij})$ are the pair fixed effects that is an added variable to control for the endogeneity of the PTAdepth variable. The use of the PPML estimator is in this case used to control for zero trade flows, which is a common phenomenon in international trade data. We elaborate more on the use of the PPML in Section *5.4* and the reason why we include importer- and exporter fixed effects is explained in Section *6.4*.

Now we have obtained the gravity equation *(13)* with the dependent variable as the bilateral trade flow and the necessary independent variables (see Section *5.4* and *6.4)*, we will move forward the empirical gravity equation in the context of our research. As independent variables we use the same variables as in Egger *et al*. (2015). The main variable of interest is the depth of a PTA, since this reflects the barriers to trade.

Table 3. *Independent variables*

Name	Description	
PTA depth	Depth of trade agreements	PTAdepth
Contiguous	Dummy for common border	Contig
Common language	Dummy for the same ethnic language	Comlang
Ever colony	Dummy for former colonial relationship	Evercol
EU	Dummy for intra-EU trade	bothinEU
Ln distance	Log of shipping distance in kilometres	Distw

The empirical gravity equation, based on equation *(13)* including those variables, takes the following form:

$$X_{ij} = \exp[lnS_i + lnM_j + \beta_1 * PTAdepth + \beta_2 * ln(Distw) + \beta_3 * Evercol + \beta_4 * Comlang + \beta_5 * Contig + \beta_6 * bothinEU + c(m_{ij})] + \epsilon_{ni} \quad (14)$$

The explanatory variables that enter as logarithms (*ln*) should be interpret as elasticities, where the dependent variables are expressed in levels. According to Shepherd *et al*. (2013), the coefficients on these levels can be seen as a semi-elasticity due to the PPML.

5.3 Measuring the impact of trade barriers on bilateral trade flows

Now that we have obtained the empirical gravity equation, we can derive the effect of PTAdepth from the coefficient of this variable, $\beta_1$in equation (14). We follow the paper of Mulabic et al. (2017) to calculate the impact of this PTAdepth on the dependent variable, the bilateral trade flow. Considering the fact that for Brexit, this thesis uses a scenario analysis, we calculate the impact in the three different scenarios. Since we are interest in the impact on the bilateral trade flow, we calculate the mutation in comparison to the current situation. With current situation, we mean the UK being a member of the deepest trade agreement: the EU. The formula to calculate the impact for the bilateral trade flows from and to the UK is as follows (Mulabdic *et al*., 2017):

$$Impact = 100\ x\ \frac{e\left(\mu * \frac{scenariodepth}{current\ EUdepth}\right)}{e\left(\mu * \frac{base\ value\ depth}{current\ EUdepth}\right)} - 1 \quad (15)$$

In this equation μ is the coefficient of the PTAdepth (β_1) as a result of the empirical gravity equation. The depths that are represented in the formula are all average weighted against the trade flows, also taking into account zero trade flows.

5.4 Solving for zero trade flows

As already stated in the explanation of equation *(11), (12)* and *(13)* the Poisson Pseudo Maximum Likelihood estimator (PPML) is used to obtain the empirical gravity equation. Santos Silva and Tenreyro (2006) compared in their research the different estimation methods regarding the gravity equations and came to the conclusion that the PPML method gives the most reliable estimation for gravity equation in the context of international trade. Santos Silva and Tenreyro (2006) explain two advantages of the PPML estimation method compared to the Ordinary Leased Squares (OLS) estimation method. First of all, PPML can deal with zero values of the dependent variables. This is a common phenomenon in trade data, since not all countries trade with each other. Compared to OLS it is more consistent, since OLS estimations use log-linearized gravity equations. The log of zero is undefined, so OLS gives inconsistent and unreliable results, since you drop all the zero values of trade. The second advantage is that PPML is consistent if there is heteroscedasticity present in the error term. This is different compared to OLS, where there is an assumption needed that the error term is homoscedastic. In the context of trade data, Santos Silva and Tenreyro (2006) state that the error term is often heteroskedastic.

When using the PPML estimator the following assumption needs to be made: all observations have the same information on parameters in the equation (Santos Silva and Tenreyro, 2006). As mentioned in Section *5.2*, the final empirical equation will make use of the exporter and importer fixed effects as in Head and Mayer (2013). According to Shepherd *et al*. (2013) the PPML estimator provides consistent estimations while using those fixed effects as dummy variables in the gravity equation. To deal with all those fixed effects, we use more specifically the fast PPML is used, which is method developed by Larch *et al*. (2017).[27] Since we need to include pair-wise fixed effects in our equation to control for endogeneity (*see Section 6.4)*, there are computationally big obstacles. Recall the term m_{ij} of equation *(13)* and *(14)*. This represents the pair fixed term. A unique m_{ij} needs to be computed for each possible pair of country *i* and *j*. This m_{ij} grows rapidly when the number of countries is increasing. Taking into account that our database covers 189 countries over 35 years, the number of country-pair fixed effects is enormously. The 'fast' estimation 'manipulated the first order condition of a Poisson distribution to produce analytical expressions for each of the fixed effects.' (Larch *et al*., 2017 pp. 4)

[27] For the use of PPML estimator in Stata see: http://www.tomzylkin.com/uploads/4/1/0/4/41048809/help_file.pdf

6. Data

To be able to compare the different specifications of the gravity equation, we set up a database for this research. The data behind the variables as shown in Table 3 are explained in this Section.

6.1 The dependent variable (FLOW)

Equation *(19)* shows that the dependent variable is X_{ij}. This variable is the estimation of the trade flow between the importing and exporting country in million British Pounds in a specific year. This variable, named FLOW, concerns all trade flows between all possible country-pairs in the world every year from 1980 up to and including 2014 and is derived from the CEPII database by Fouquin & Hugot (2016). Whenever possible, the data is reported "on merchandise trade, excluding trade in services, bullion and species. Special import is favoured over general import data and re-exports are excluded" (Fouquin and Hugot, 2016, pp. 9).

6.2 Measuring trade barriers

The variable of interest in this research, to simulate the potential effect of Brexit on trade flow is PTAdepth. Recall from gravity equation *(13)* that ϕ_{ij} provides the trade costs between country *i* and country *j* and that ϕ_{ij} included trade costs related factors. Anderson and van Wincoop (2004) explored the source and size of trade barriers, but they recognize that it is a major challenge to measure overall trade barriers since "measures are remarkably sparse and inaccurate" (Anderson and van Wincoop, 2004, pp. 692). The trade barriers are strongly affected by being a member of a PTA, as explained in Section *5.1*. Using a variable reflecting the PTA, the impact on the bilateral trade flows in calculated. In order to get estimates of trade barriers, evidence from past PTAs will be used. The data on past PTAs is taken from the recent dataset on the depth of PTAs provided by Hofmann *et al*. (2017) of the World Bank: *Horizontal Depth A New Database on the Content of Preferential Trade Agreements*. This database covers 279 agreements signed by 189 countries between 1958 and 2015, which reflects the entire set of preferential trade agreements in force and notified to the World Trade Organization as of 2015.

The depth of the PTAs is quantified by the amount of policy areas that is covered in the agreement. The dataset uses 52 policy areas that are divided into two groups. Fourteen in WTO+ and 38 in WTO-X areas. The WTO+ areas refer to provisions that are existing commitments, whereas WTO-X areas on the contrary refer to policy areas that are not yet regulated under the WTO rules. Table 4 shows the policy areas. A policy area is considered as being 'covered' by an agreement: 'if the agreement contains an article, chapter or provisions, providing for some form of undertaking fields' (Hofmann *et al*., 2017, pp. 6). All the information that can be derived from the texts of the agreements is organized and used to construct synthetic indices to capture the depth of PTAs. All the provisions included in the table can get the value of 0 or 1. The total depth is defined as the simple sum of provisions (k) included in the agreement:

$$Total\ Depth = \sum_{k=1}^{52} provision_k \qquad (16)$$

Table 4. *Provisions that capture the depth of a trade agreement*

WTO +	WTO-X	
▪ Tariffs agricultural goods	▪ Anti-corruption	▪ Human Rights
▪ Customs administration	▪ Competition policy	▪ Illegal immigration
▪ Export taxes	▪ Environmental laws	▪ Illicit drugs
▪ SPS measures	▪ IPR	▪ Industrial cooperation
▪ State trading enterprises	▪ Investment measures	▪ Information society
▪ TBT measures	▪ Labour market regulation	▪ Mining
▪ Countervailing measures	▪ Movement of capital	▪ Money laundering
▪ Anti-dumping	▪ Consumer protection	▪ Nuclear safety
▪ State aid	▪ Data protection	▪ Political dialogue
▪ Public Procurement	▪ Agriculture	▪ Public administration
▪ TRIMS measures	▪ Approximation of legislation	▪ Regional cooperation
▪ GATS	▪ Audiovisual	▪ Research and technology
▪ TRIPS	▪ Civil Protection	▪ SMEs
	▪ Innovation policies	▪ Social Matters
	▪ Cultural cooperation	▪ Statistics
	▪ Economic policy dialogue	▪ Taxation
	▪ Education and training	▪ Terrorism
	▪ Energy	▪ Visa and asylum
	▪ Financial assistance	
	▪ Health	

Using equation *(16)*, all trade agreements get a score between zero and 52, according to the amount of provisions covered in the agreement. We normalize the PTAdepth variable by dividing the depth of the specific agreement which is derived with equation *(22)* is divided by 52, the maximum score. A score of 1 means that all provisions as in Table 4 are covered. Now every existing trade agreement, 279 in total, has a score between 0 and 1. In case there is no trade agreement, the PTAdepth variable will have no value. Since our dependent variable (FLOW) is pair-wise, the PTAdepth variable is linked to all possible country pairs as well. This means that for example two countries that are both in the EU get the score that belongs to the EU trade agreement: a score of 44 out of 52. Another example is that concerning the depth of the EU - Colombia and Peru

(01.03.2013) trade agreement, this depth is linked to all pairs where one of the countries is a member of the EU and the other one Colombia or Peru.

6.3 The other barriers to trade

The trade barrier that we just explained is not observable, but there are other barriers to trade that count as trade costs factors that are observable. Those variables are included in the gravity equation.

Distance (Distw) is measured in kilometres. This variable is derived from the paper written by Mayer and Zignago (2011). This distance is a city-population-weighted mean of the great-circle distance between the pair of countries.

The variable concerning a colonial relationship (Evercol) is derived from the CEPII database. Rose (2004) stated that the past colonial status can be translated into higher levels of trade currently. Evercol is a dummy variable which will have a value of one if the importing and exporting country are aver been in a colonial relationship and will take the value of zero in all other cases.

The Common ethic language (Comlang) is derived from the GeoDist database of CEPII (Mayer & Zignago, 2011). Comlang is a dummy variable that will only have the value of one if the importing and exporting countries share a common ethic language spoken by at least 9% of the population. In all other cases the value will be zero.

The Contiguous variable (Contig) will be a dummy variable that will take the value of one if the countries involved share the border, and zero otherwise.

The variable European Union (bothinEU) is a dummy variable that counts for intra-EU trade. This variable will take the value of one if the importing and exporting countries are member of the European Union. In all other cases the value will be zero.

6.4 Solving the endogeneity problem

In previous literature where the gravity equation is used to calculate the impact of a free trade agreement, the endogeneity problem is raised. The endogeneity problem arises when one of the explanatory variables is correlated with the error term. The endogeneity problem is a familiar problem in the case of trade agreements in gravity equations. Krugman (1991) noted that most PTAs tend to be among 'natural' trading partners. Baier and Bergstrand (2003) showed that most PTAs exist among country pairs that are in a close distance, remote from other countries and have large trade flows. To summarize, Lawrence (1996) stated that the coefficient on the variable that represents the PTA will maybe not explain that PTAs have an impact on trade, rather that the country pairs already traded large volumes before agreeing on a PTA. This line of logic can also be followed in this research in the context of the PTAdepth variable. The PTAdepth variable is most likely correlated with the error term, since intuitively countries that have similar

characteristics will have larger trade flows. Those countries probably therefore have a deeper trade agreement.

Controlling for this problem is important, since the main interest of this research is the individual effect of a PTA on the trade flow, which is measured by the PTAdepth variable. To control for this problem, there are several solutions.

Egger *et al*. (2015) explains a method to solve for the problem of endogeneity. This method includes the calculation of the probability that a certain country has a certain level of PTAdepth taking into account the characteristics of that country. This probability will be used in the estimation done with empirical gravity equation to obtain the individual effect of a PTAdepth level. Egger *et al*. (2015) expanded the model of Egger *et al*. (2011). In general, the approach used is based on some instrumental variables that will split up the PTAdepth variable into two different components. This will be one that contains the exogenous variation only and one that contains both the exogenous variation and the endogenous variation. More specific Egger *et al*. (2015) used a control function approach which is based on the generalized Mill's ratios that are derived from the ordered probit model of depth-of-trade-agreements.

Baier and Bergstrand (2002) first attempted to solve this issue by using instrumental variables. Magee (2003) expanded on this work by using instruments that are characteristics of trade for the countries involved. Both results were inconclusive, since there existed correlation between the instruments and the trade flows. In 2007, Baier and Bergstrand conducted a panel study and used fixed effects to control for endogeneity. They argued that the gravity equation suffers from endogeneity bias, due to the presence of time-invariant heterogeneity in the gravity equation (Baier and Bergstrand, 2007). Bergstrand *et al*. (2015) expanded the gravity equation by employing exporter-year and importer-year fixed effects to control for endogenous prices and time- varying country multilateral heterogeneity. They also include country-pair fixed effects and a time trend to control for time-varying bilateral trade flow effects. Including those pairwise country fixed effects, we control for the endogeneity problem of our PTAdepth variable. We add fixed effects for all exporter and importer specific country characteristics to control for the multilateral resistance problem (Feenstra, 2002).

Dai, Yotov, & Zylkin (2014) also show that the large number of pair-wise fixed effects are needed to consistently identify the effects of time-varying trade policies such as regional trade agreements or in the context of this thesis, the depth of a trade agreement. Other theory implies that proper estimations of the gravity model should include the origin-by-time and destination-by-time fixed effects (e.g. Matyas, 1997). To absorb country-pair fixed effects, origin-by-time and destination-by-time fixed effects the method developed by Larch *et al*. (2017) is used. With absorbing all those fixed effects, we represent all unobservable factors that possibly impact the trade flows. With all those fixed effects, this thesis aims to avoid any bias caused by omitted or endogenous variables.

7. Results

In this section, we show the empirical results of the gravity equation. We obtain the PTAdepth coefficient by running the PPML estimator and use the gravity equation. With the estimated coefficient, we simulate the effects of the different scenario on the trade flows from and to the UK. To conclude this chapter, we consider robustness checks.

7.1 Coefficient of the PTAdepth variable

To show the importance of the role of endogeneity and the multilateral resistance term as explained in Section *5.4*. We first consider the regression results of the PPML estimator without fixed effects. Recall that the multilateral trade resistance is explained as the barriers to trade that each country faces with all trading partners. In column *(1)* of Table 4 we outline the results without fixed effects. Those results are counterintuitive. A negative PTAdepth variable can intuitively not be clarified, since it can be interpreted as that having a deep PTA with another country would reduce trade flows. With the inclusion of the importer- and exporter fixed effects as in colum *(2)*, the regression accounts for the multilateral resistance terms as in Anderson and van Wincoop (2001) and Feenstra (2002). Those results produce theoretically consistent results. This is in line with our empirical gravity equation, equation *(14)*, where the importer- and exporter fixed effects are included. The exporter fixed effects, which cover all the factors that can influence a trade flow from that country are captured in the S_j. The importer fixed effects are M_i. In column *(3)* time-fixed effects are added to control for certain events or shocks in a particular year that are not captured. Interpretation of the column can be done in the following way. The PPML estimator coefficient of for example the variable Comlang is 0.0286. Comlang is the dummy variable which will have the value of 1 if the same ethnic language is spoken. The dependent variable (FLOW) is a count variable and the PPML estimator models the log of the expected count as a function of the independent variables. In this case Comlang is the independent variable which means that for one unit change in Comlang, the difference in the logs of expected counts is expected to change by 0.0286, *ceteris paribus*. All dummy variables, like Comlang, can be interpreted as approximately semi-elasticities. Another example is the Lndist, which is a logarithm of a city-population-weighted mean of the great-circle distance between the pair of countries, measured in kilometres, provides a negative sign. The larger the distance between two countries, the lower the trade flow will be. This interpretation differs from the dummy variables, because the distance is measures as a logarithm. The relationship can now be measured as an elasticity.

Table 5. *Results of the PPML regression with and without Fixed Effects from 1980-2015*

	(1)	(2)	(3)	(4)
VARIABLES	FLOW	FLOW	FLOW	FLOW
PTAdepth	0.0974***	0.0394***	0.00661***	1.359***
	(0.00365)	(0.00236)	(0.00223)	(0.263)
Contig	0.0908***	-0.00816***	-0.0136***	
	(0.00156)	(0.00103)	(0.000974)	
Comlang	0.0362***	0.0255***	0.0286***	
	(0.00175)	(0.00136)	(0.00130)	
Evercol	0.0939***	0.0350***	0.0302***	
	(0.00191)	(0.00141)	(0.00132)	
Lndist	0.0365***	-0.0936***	-0.104***	
	(0.000876)	(0.000710)	(0.000689)	
bothinEU	0.212***	0.0671***	0.0542***	
	(0.00158)	(0.00177)	(0.00178)	
Constant	3.085***	3.239***	3.515***	
	(0.00698)	(0.0118)	(0.0154)	
Observations	120,814	120,814	120,814	15,140
R-squared	0.353	0.847	0.866	0.997
Time fixed effects	NO	NO	YES	
Importer fixed effects	NO	YES	YES	
Exporter fixed effects	NO	YES	YES	
Country-pair fixed effects	NO	NO	NO	YES
Origin-by-time fixed effects	NO	NO	NO	YES
Destination-by-time fixed effects	NO	NO	NO	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The dependent variable FLOW represents the bilateral trade flow between two countries. The variable PTAdepth reflects the depth a trade agreements. Contig is a dummy variable which is one if the countries have common border. Comlang is dummy variable which is 1 if the same ethnic language is spoken. Everol is a dummy for former colonial relationship. BothinEU is a dummy which will have the value of 1 if both countries are member of the EU. LnDist is a logarithm of the shipping distance between the two countries.

Although the results in column *(3)* of Table 4 solve for the multilateral resistance problem, the outcomes are not reliable. As stated in Section *6.4* the problem of endogeneity needs to be solved. Following previous studies, the PTAdepth variable is considered to be endogenous (Baier and Bergstrand, 2003; Lawrence, 2006;). The coefficient on the variable that represents the PTA will most likely not solely explain the impact of PTAs on bilateral trade flows, rather that the country pairs already traded large volumes before agreeing on a PTA (Lawrence, 2006). We take those empirical results of this research into account when estimating the PTAdepth variable of this thesis. As explained in Section *6.4*, Baier and Bergstrand (2007) suggest that the endogeneity can be solved using country-pair fixed effects in the model. The disadvantage of including country-pair fixed effects is that it will drop all time invariant variables. Since the main variable of interest is PTAdepth, which is not time invariant, the country-pair fixed effects can be included in the regression. Column *(4)* of the table shows the PTAdepth variable absorbing all the suggested fixed effects as in section *6.4*. Those results control for the multilateral resistance term, the endogeneity of PTAdepth problem and particular events in time such as the financial crisis. The variable is still significant on at least 1%. Moreover, the significance is increasing moving from column *(1)* to *(4)*, which suggests that without the inclusion fixed effects the PTAdepth variable is underestimated due to correlation.

7.2 Scenario-analysis of the impact of trade barriers

After obtaining the PTAdepth coefficient from the PPML estimator, we can simulate the potential effects of the different Brexit scenarios. Recall that we consider three scenarios, which are the most likely scenarios, also used in previous work. These scenarios are characterized by different degrees of depth of the trade agreement with the EU. The depth of the scenarios will follow Mulabdic *et al*. (2017). With the different degrees of depth, the mutation can be calculated in the following way. First, the mean of PTAdepth is calculated taken into account the weights of the bilateral trade flows where either the importer or the exporter is the UK. Subsequently, we calculate the PTAdepth for different scenarios by taking the score (the number of provisions included) as outlined in the previous section divided by the total score. This means, that for the "PTA" scenario, the depth of 14 will be divided by the total possible depth 52. This score will be calculated only for trade between the UK and the EU and vice versa. We calculate the mean of this depth in a certain again weighted with the bilateral trade flows of the UK. Using the outcome of this steps, the mutation can be calculated following equation (*16)*.

The "Norway" scenario is the scenario in which the UK and the EU will bargain an agreement which is the similar to the agreement between the EU and the EEA countries. This scenario is very unlikely, since it also includes the four freedoms and the Single Market. The agreement will then have a depth of 36, since the EEA agreements are covering 36 policy areas, following Mulabdic *et al*. (2017). In this scenario, the bilateral trade flow for the UK will decrease with 20.3%.

The "PTA" scenario assumes a preferential trade agreement between the UK and the EU after the Brexit. Taking into account all the agreements that the EU signed in the past with countries that are not member of the EU, the resulting depth of the agreement will be 14 provisions. We estimated that for the UK this would mean a decrease in bilateral trade flow of 57.2%.

The most pessimistic scenario is the scenario where the UK and the EU will not sign a preferential trade agreement at all. This is called the "No deal" scenario. The depth of this agreement will be 0, meaning that there will no provisions covered. The trade flows in this scenario decrease with 71.2%

Table 6. *Mutations in different scenarios in three different scenarios after Brexit, 3- year moving average 1980-2015*

	(1) "Norway" scenario	(2) "PTA" scenario	(3) "No deal" scenario
Mutation in bilateral trade flow UK – EU27	-20.3%	-57.2%	-71.2%

The outcome of these changes can be interpreted in the following way. If the UK and the EU27 will come to an agreement which has the depth of the average PTA that the EU has signed in the past, the bilateral trade flows from and to the UK will decrease with 57.2% compared to the current situation. Those results are comparable to the results of Egger *et al*. (2015), who estimated the increase of bilateral trade flows for TTIP. They estimated the shift from no agreement to a deep agreement around 84%. The difference can be explained in the fact that Egger *et al*. (2015) uses the DESTA database and provides TTIP with the highest score (7/7). In this thesis, the EU has the highest score, which is 44/52.

When comparing the results to earlier Brexit studies, as discussed in Chapter 4, we see that one on one comparison is difficult. The nuances in the scenarios differ and also the channels through which the impact is estimated is different. Besides that, studies only showed the outcome of the NQTM or CGE modelling, which provides an estimation of GDP.

Nevertheless, the research done by the CPB estimated that the export value from the UK to the EU27 will decrease with 31% in the scenario that is called the "PTA" scenario in this thesis and with 51.3% in the scenario compared to our "No deal" scenario and (Rojas-Romagosa, 2016). The export for the UK alone will decrease with 12.5% and 21.8% in the "PTA" scenario and the

"No deal" scenario respectively. The paper published by the World Bank estimated the decrease in trade flows from the UK to the EU27 with 12%, 38% and 50% in respectively the "Norway", the "PTA" and the "No deal" scenarios (Mulabdic *et al*., 2017). The difference can be found in that Rojas-Romagosa (2016) used the GTAP9 database with base-year 2011. The time-frame used by Mulabdic *et al*. (2017) is 1995-2011. Therefore, the deepest agreement in their sample 41, while in our sample it is 44. This causes that the results are more comparable to the results we outline in the Section on robustness checks with time-frame 1995-2015 (*see Table 9)*.

7.3 Robustness checks

7.3.1 Different scenarios

The number of provisions that reflect the depth of the PTA that are used in the scenarios are obtained using the research of Mulabdic *et al*. (2017). Though, the "PTA" scenario now uses a depth of 14, which is the amount of provisions in the WTO+ area. This is the amount of provisions that is normally covered by the WTO (Hofmann *et al*., 2017). One could also argue that this will be the "No deal", considering the fact that trade is than based on the principals of the WTO. To get a bigger picture, four different amounts of depths are added in the following table. Those provisions are based on four different existing agreements. The first scenario is called "WTO+", which is the depth that will arise if only the provisions of the WTO+ areas are covered. Those provisions are outlined in table 2. The second scenario is named "EU-Japan" and it reflects the depth of the trade agreement of Japan and the EU. This agreement covers 21 provisions, and thus has a depth of 21 out 52. This scenario is outlined since the European Commission's chief negotiator said that the he United Kingdom's post-Brexit trade deal with the EU will be "along the same lines" as the ones signed between the union and countries like South Korea, Japan, and Canada (The Independent, 2017). The third scenario is based on the agreement that the EU has with Ukraine, which covers 32 provisions. The European Committee of the House of Lords cited, during their debate on the options of trade, Michael Emerson of the Centre for Public Policy Studies. He stated in his paper (2016) that the 2016 Association Agreements between the EU and Ukraine and Georgia should be regarded as recent examples. He argued that these provided a high degree of access to the Single Market for three of the four freedoms (goods, services, capital, but not the free movement of persons). He also suggested that such agreements provided for the first time a "departure from the doctrine that all four freedoms always come together in an indivisible package" (Emmerson, 2016 pp. 6). The fourth scenario used is the average depth of all North-North agreements provided by Hofmann *et al*. (2017). North-North trade is trade between countries with similar endowments and technology trading similar products, which is applicable to the UK and the EU27. The depth of this agreement is 22.

Table 7. *Mutations in different scenarios in three different scenarios after Brexit 1980-2015*

	(1) "WTO+" scenario	(2) "EU-Japan" scenario	(3) "EU-Ukraine" scenario	(4) "Nort-North" scenario
Mutation in bilateral trade flow UK – EU27	-57.2%	-47.9%	-28.8%	-46.4%

7.3.2 Control variables

Taking into account country-pair fixed effects, origin-by-time and destination-by-time fixed effects implies that the effect of all time-invariant variables cannot be separately identified. Baier and Bergstrand (2003) provide empirical evidence that interaction terms of log GDP and log population are economically and statistically significant when regressing it on a variable reflecting trade agreements. More specifically, this term contains the interaction between the GDP (population) of the importer country and the GDP (population) with the exporter country. GDP is also part of the original gravity equation as seen in equation *(2)*. To control for those variables, the information is obtained from the CEPII database of trade history (Fouquin & Hugot, 2016). This database includes 14,837 observations of GDP (GDP) in a country and 16,351 of population (POP). Both variables exist for both the importer country and the exporter country. The results of the PPML estimator with country-pair fixed effects, origin-by-time and destination-by-time fixed including those control variables are showed in the following table. The coefficient of the value of PTAdepth increases somewhat, and is and is significant at the 1% level.

Table 8. *Result of the PPML estimator including country-pair fixed effects, origin-by-time, destination-by-time fixed effects and control variables GDP and POP, 3-year moving average 1980-2015*

VARIABLES	(1) FLOW
PTAdepth	1.824***
	(0.264)
GDPexp* GDPimp	0.00113
	(0.0285)
POPexp*POPimp	-0.0175
	(0.183)
Observations	14,837
R-squared	0.997
Country-pair fixed effects	YES
Origin-by-time fixed effects	YES
Destination-by-time fixed effects	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.4.3 Time frame 1995-2015 with 3 year moving average

Fouquin and Hugot (2016) argued that the amount of useful data available increases over time. They explained that "this can be a consequence of the easier access to primary sources for recent years, due to conservation issues and the difficulties in locating historical statistics for more ancient times." (Fouquin and Hugot, 2016 pp. 9).

To control for that, the result of a 3-year moving average from 1995 to 2015 will be shown. As shown in Table 8, the PTAdepth variable is not significant over this shorter time period.

Table 9. *Result of the PPML estimator including country-pair fixed effects, origin-by-time and destination-by-time fixed effects, 3-year moving average 1995-2015*

VARIABLE	(1) FLOW
PTAdepth	0.431 (0.285)
Observations	19,870
R-squared	0.997
Country-pair fixed effects	YES
Origin-by-time fixed effects	YES
Destination-by-time fixed effects	YES

Table 10. *Mutations in different scenarios of the non-tariff barriers arising in three different scenarios after Brexit, 3-year moving average 1995-2015*

	(1) "Norway" scenario	(2) "PTA" scenario	(3) "No deal" scenario
Mutation in bilateral trade flow from and the UK	-6.9%	-23.6%	-32.6%

8. Discussion and conclusion

With the ongoing negotiations of Brexit, it is imperative to obtain a clear understanding of the consequences of the Brexit on trade. The aim of this research is to determine the effect of the depth of a trade agreement on bilateral trade flows. We used the PTAdepth variable as the trade barrier in the empirical gravity equation. Due to the ongoing negotiations concerning the relationship between the UK and the EU, we applied three different scenarios to account for the scope of the possible outcomes.

The results show that there is an effect of having a trade agreement on the bilateral trade flow. We estimated that if the UK would become a member EEA, such as Norway, the UK's trade flows would decrease by 20.3% compared to the current situation – in which the UK is part of the EU's Single Market. If the UK and the EU agree on an average trade agreement, the bilateral trade flows for the UK decrease by 57.2%. In the final scenario, the EU and the UK will not conclude on a trade agreement after the Article 50 negotiations, and the bilateral trade flow for the UK will decrease by 71.2%. In the robustness checks, we estimated the impact in new scenarios, based on previous statements by representatives of the government. We estimated that the trade would decrease by 28.8% if the UK is able to agree on a trade agreement similar to the EU and Ukraine. The bilateral trade flows will decrease by 47.9% if there is an agreement comparable to the one that the EU obtains with Japan. An average North-North agreement would decrease bilateral trade flows by 46.4%, and only including the WTO+ provisions – as in Table 4 – would decrease the bilateral trade flows for the UK by 57.2%, compared to the current situation. Including interaction terms of the importers- and exporters GDP and population, increases PTAdepth variable. If we apply a different time-frame (1995-2015), we estimate the PTAdepth coefficient considerably lower. The mutation in bilateral trade flows for the UK is lower in every scenario: -6.9% in the "Norway" scenario, -23.6% in the "PTA" scenario and -32.6% in the "No deal" scenario. Consequently, we can conclude that there is trade-off between the depth of an agreement and the intensity of bilateral trade.

As stated in the previous Chapter, the results are in line with Egger *et al*. (2015). Egger *et al*. (2015) estimated that "the semi-elasticity associated with shifting from no agreement to a deep agreement is around 84% (Egger *et al*., 2015 pp. 553). Using their CGE model, they estimate that bilateral trade flows increase by 78-82% for trade between the EU and the US, after agreeing on the deepest possible trade agreement. We estimate that the bilateral trade flow for the UK will decrease by 71.2% shifting from a deepest possible agreement (EU) to the "No deal" scenario. The results which use a shorter time-frame (1995-2015) are comparable to the results of Kierzenkowski *et al*. (2016) and Rojas-Romagosa (2016) – whom also used a shorter time frame.

Nevertheless, the existing gaps and uncertainties in this thesis should be acknowledged, and certain questions remain unanswered. A trade agreement, especially the one of the EU, is a complex and far-reaching agreement. As such, certain assumptions have been imposed, and the estimated results should be taken with a grain of salt. We used the previous depth

of trade agreements to estimate the impact, causing an underlying assumption this depth will have the same impact once you leave an agreement. Whilst the data used belongs to earlier trade agreements, the nature of trade agreements has changed over the past. There is also still substantial uncertainty on the content of possible trade agreement between the UK and the rest of the EU. We did not consider, for instance, the fact that the UK, post-Brexit, may choose to sign new trade agreements with partners across the world. We also did not consider the EU continuing its process of deeper integration, so including more provisions in the trade agreement. Mulabic *et al*. (2017) argued that "a high level of trade integration requires some form of political integration for its legitimacy and long-run stability." (pp. 21). In other words, if you are outside the EU it is perhaps difficult to seek deep trade agreements. The UK as a member of the EU, profits from the agreement the EU has signed up until now. Liam Fox, the British trade chief, stated that the UK will not "cut and paste" existing European trade agreement once a deal for Brexit is in place (Liam Fox to CNBC, 2017). For example, the import quotas that are part of the trade deals that the EU has made need to be disaggregated. These events would move the trade relation in different directions, which are difficult to predict. Lastly, we estimated the impact only through trade. We did not include a link between trade and productivity or the dynamic effects of FDI. Channels such as immigration, confidence and deregulation are not considered in this thesis. A limitation of this research, which could also be seen as a recommendation for further research, is the lack of tariff rates. Egger & Larch (2011) made an important point that the impact of NTBs on PTAs cannot be estimated as 'beyond tariff reductions', which means that the effect corresponds to the combined effect of PTAs on tariffs and the depth of PTAs. In other words, they are associated with tariffs increasing (Egger *et al*., 2015) Another recommendation would be to use the coefficient and the mutations to predict the full economic consequences of Brexit. We can employ CGE modelling or NQTM to estimate the impact of the trade barriers on, for example, GDP. Another suggestion would be to perform similar estimations for the services sector. Especially for the UK, with a relatively large services sector, this is deemed relevant. Focusing on different sector, and estimating the impact separately, could also be useful recommendation for further research.

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