Trade in Services: Does Gravity Hold?

A Gravity Model Approach to Estimating Barriers to Services Trade *

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Abstract

This paper assesses the determinants of trade in services using a gravity model, with particular attention given to the role of barriers to services trade. Initially, the application of the gravity equation to services trade is examined. A variety of econometric estimators are tested and the Hausman-Taylor model is found to be the best estimator. The gravity model fits services trade flows in a similar manner to trade in goods. Wealth of countries and a common language are the most important determinants of services trade, distance is generally found to be insignificant. A variable measuring barriers to services trade is introduced into the gravity equation. Although the variable is only found to be weakly significant, a quantified set of tariff equivalents of those barriers is estimated.

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1. Introduction

Services are the largest sector in the global economy and their importance is expected to continue to grow. Services account for approximately two thirds of world GDP and over half of employment in industrialised countries (WTO, 2005). However, the share of services in world trade has lagged behind. WTO (2005) estimates that services account for only 20 per cent of global trade flows. While this figure may underestimate the level of service trade slightly, due to the intangible nature of services compared to the goods and the interdependence of services and foreign direct investment flows that makes the measurement of services trade difficult, the difference is still significant.

The growing role of services and their increasing importance to trade flows led to the General Agreement on Trade in Services (GATS) in 1995. This agreement governs the rights and obligations of World Trade Organisation (WTO) member countries in the area of services trade. The outcome of the current Doha Round world trade negotiations is expected to continue the process of liberalisation in services trade. The aim of these negotiations is to further reduce the barriers that restrict trade in services.

One contribution of this paper is to further analyse the determinants of trade in services, with particular attention paid to the role and measurement of barriers to services trade. When an agricultural or manufacturing good is imported into a country, the most common form of protection imposed is a tariff. The level of a tariff is usually known and its impact on the price of the good can be estimated. This is not the case for service products. A commercial bank wishing to establish a branch in another country or a doctor hoping to set up a practice in a foreign country cannot simply pay a tariff and establish their business. Trade in services such as these typically requires the movement of people and capital between countries. In most countries there exist a range of legal and regulatory requirements that must be satisfied before the establishment of such services.[1]

The effects of these non-tariff barriers are difficult to measure. A second objective of this paper is to generate a series of quantified estimates of the barriers to services trade for a range of industrialised countries (primarily the OECD countries) and their main trading partners.

These objectives are achieved using a gravity model approach, which relates the level of trade between countries to their physical and economic characteristics. Introducing a variable measuring the level of a country's barriers to services trade into the gravity equation allows for a tariff equivalent of the barriers to be estimated. This set of estimates can then be used in further research.

The gravity approach has been applied to services trade before, but this paper makes several contributions to the existing literature. Previous research has generally focused on total services trade; in this paper the application of the model is extended to four disaggregated service sectors (government, travel, transport and other commercial services). The econometric specification of the model is also improved by the application of the Hausman-Taylor estimator. This type of estimator is increasingly used to estimate gravity models of goods trade flows but it has never previously been applied to services.

[1] For example, a commercial bank wishing to establish a branch in another country must satisfy the prudential and non-prudential regulations of that country. Many countries will only recognise medical qualifications from specific institutions or require doctors to be proficient in the language of the country.

Two observations should be noted at this point. First, while the analysis in this paper focuses on services trade, much of the methodology draws on similar research conducted on non-tariff barriers that exist in agricultural and manufacturing goods trade.

Second, the focus of this paper is on services that move across borders (the manner of this movement will depend on the nature of the service in question). The provision of services by affiliates of companies based in foreign countries is not considered. In other words, the role of foreign direct investment (FDI) as a conduit for trade in services is ignored.

The paper begins by presenting an overview of the types of barriers to trade in services and the methods that can be used to estimate their impact on trade flows. Section three presents the gravity model approach used in this paper and reviews the existing literature on gravity model applications to services. In section four the standard gravity model is estimated for services trade and the results are discussed. The model is then extended in section five to incorporate measures of the barriers to trade in services and from this tariff equivalents of those trade restrictions are calculated. Section six concludes.

2. Overview – Barriers to Trade in Services

2.1 What Barriers Exist?

The service sector encompasses a largely heterogeneous selection of activities. The operation of the financial or communications sectors is very different to that of health services or transport for example. With some exceptions, the majority of goods are considered to be tradable. Many services are by their nature non-tradable. This heterogeneity gives rise to a range of different types of barriers to services trade. As noted in the introduction, these barriers tend to be qualitative or non-tariff barriers (NTBs) such as legal or regulatory restrictions on the import of services. The types of restrictions imposed will vary between service sectors and modes of supply that are relevant in each.

The GATS classification identifies four modes of supply: (i) cross-border supply (the service product crosses the border); (ii) consumption abroad (the consumer crosses the border, e.g., visiting a bank in a foreign country); (iii) commercial presence (a firm establishes a branch abroad, this includes foreign direct investment); and (iv) the presence of natural persons (the supplier of the service moves temporarily to the country of the consumer). The importance of each of the modes of supply will vary from sector to sector. As will be discussed in later sections, not all modes will be relevant for the data employed in this paper. However, the overview of the types of barriers that exist in this section is not restricted to any particular mode of supply.

Hoekman and Braga (1997) summarise the major barriers to services trade under four headings. Quantity based restrictions impose quotas or other types of quantity limitations. These tend to be imposed on the providers of the services rather than the flows of services themselves. Examples include local content requirements or bilateral air space agreements. An extreme case of this type of restriction is simply to ban the import of services entirely.

The second category is restrictions imposed on the price of services. In some sectors government-appointed industry regulators will impose controls on prices. Such restrictions act as barriers to trade if they differentiate between firms based on their origin. Although the discussion of barriers thus far has focussed on non-tariff measures, tariff measures occasional do apply in services. Some price measures that impose fees may effectively function as tariffs. Hoekman and Braga cite examples such as entry visa charges to travellers or airport landing fees.

A third type of restriction arises from more direct government involvement in services sectors. Individuals may be legally required to hold a licence or qualification from a particular institution to be allowed to offer a service. Such restrictions act as barriers to trade if they discriminate in favour of domestic service providers. This type of restriction is especially common in medical service sectors, but it frequently applies to legal or financial services also. In sectors in which the government is one of main consumers, public procurement regulations will often discriminate against foreign firms.

The final category of barrier identified by Hoekman and Braga (1997) occurs when importers of services' access to secondary services is restricted. If the service provider relies on local industries to supply their product, any discrimination against them will harm their competitiveness. Hoekman and Braga show that this can be a particular concern in transport and communication service sectors.

The Hoekman and Braga paper classifies barriers to trade in services. However, their classification is somewhat limited. The types of barriers they consider are discriminatory barriers that treat importers of services differently to domestic suppliers. Findlay and Warren (2000) show the importance of non-discriminatory barriers, i.e., barriers that restrict the supply of services by domestic and foreign producers equally. The role of such barriers needs to be considered in making cross-country comparisons of services trade.

In recent years the number of regional free trade agreements (FTAs) and customs unions promoting trade in goods has increased significantly. Many provide for free trade in goods but include few or no measures to facilitate trade in services. Crawford and Fiorentino (2005) show that only 17 per cent of FTAs notified to the WTO include some commitments to services trade liberalisation. The presence of FTAs and their relevance to services trade is discussed in later sections. It is generally accepted that the EU has made the biggest strides in liberalising services trade, thus it is useful to include a summary of the barriers that remain to trade within the European Union at this point.

EC (2002) surveys the barriers that remain to trade in services in the internal market of the EU. The findings suggest that physical or technical barriers to intra-EU services trade have been replaced by legal barriers. In addition to cultural and linguistic barriers across countries, several categories of legal restrictions are found to be common across the (at the time) fifteen member countries: barriers to establishment (qualification requirements); restrictions on use of inputs (employment of workers and use of equipment); barriers to the promotion of the services (control on commercial communications varies across member states); sales restrictions (legal requirements and price controls); and differences in legislation governing after-sale requirements (differing post-sale liabilities for example). The majority of the restrictions fit into the classification of Hoekman and Braga (1997). For most of sectors and countries, the "rule of origin" or "rule of destination" principles don't apply as many service providers face regulatory

restrictions in both the origin and destination countries. Overall, EC(2002) concludes there is a strong bias against foreign producers in the supply of services in the EU and serves to underline the importance of the services directive currently under debate within the EU.[2]

2.2 Estimation of Tariff Equivalents

Much analysis has already been undertaken on quantitatively assessing the effects of non-tariff barriers (NTBs). Anderson and van Wincoop (2004) survey and critique the literature on modelling and quantifying trade costs. Ferrantino (2006) provides a more detailed review of literature that focuses specifically on quantifying NTBs to trade.

In this section, the three most widely used methods for quantifying NTBs and the subsequent generation of the tariff equivalents of these barriers are described: frequency indexes, price-based measures and quantity-based measures. These techniques can be applied to goods or services trade, although the majority of the literature to date has focussed on the former.

A frequency index is essentially a list of the barriers that are in place, in this case the barriers to the import of services into a country, which is used as a measure of the policy stance of that country. Typically in the case of services, a country's GATS commitment schedule is used as the source for information on barriers imposed by each country.[3] Hoekman (1995) was one of the first to construct such as frequency index. The tariff equivalents are calculated by assigning a tariff equivalent to the most protectionist country for the sector in question. Other countries' tariff equivalents are calculated by comparing their coverage ratios (the level of their commitments) relative to this benchmark.

There are severe limitations to this method, the principal being the arbitrary estimate of the tariff equivalent of the most protectionist member. In addition, the effect of the same barrier may vary across sectors or countries (Whalley, 2004) and the index is based on the GATS classification rather than information on actual policies.[4] Despite these drawbacks, Hoekman's (1995) estimates and approach have been widely used in the literature.

Others have developed ways to improve frequency indexes to better reflect actual barriers. Researchers at the Australian Productivity Commission (APC) have developed a series of augmented frequency indexes for a range of sectors and countries.[5] Improved data sources (in many cases based on surveys) are used to assemble data on actual barriers to trade (rather than based on GATS commitments), allowing a better distinction

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[2] For more information on the services directive see: http://ec.europa.eu/internal_market/services/services-dir/index_en.htm

[3] Under the General Agreement on Trade in Services (GATS) each WTO member country must list the level of market access and degree of national treatment they provide for each of the four modes of supply in each service sector. This is referred to as a country's schedule of commitments. A low number of commitments implies a relatively protectionist policy position.

[4] There is some evidence to suggest that GATS commitments are close to actual policies. For example, Mattoo (1999) finds a close resemblance in many cases in the financial services sector.

[5] Most of the APC research is published in Findlay and Warren (2000) and is available at http://www.pc.gov.au/research/rm/servicesrestriction/index.html. Dee (2004) provides a broad summary of the APC methodology.

of different types of barriers and the development of a more accurate system for weighting the barriers.[6]

The OECD has assembled a database on the level of product market regulation (PMR) in a number of OECD countries (Nicoletti *et al.*, 2000). The regulations are classified and weighted by their distortionary effect on the market to give an aggregate measure of the regulatory burden for each country.

Price impact approaches are based on the assumption that barriers to trade will result in differences in prices. In an undistorted market domestic and world prices would be equal. Whilst Deardorff and Stern (1997) and others have econometrically estimated the impact of NTBs on the gaps between domestic and world prices (price wedges), many of the applications to services trade have been by APC researchers.

Chen and Schembri (2002) summarise the APC method of measuring price impacts as follows: an econometric model of the determinants of prices is estimated (based on a suitable proxy for domestic prices). One of the explanatory variables in the model is a measure of the NTBs in the sector in question. Typically this is based on an augmented frequency index. The estimated coefficient for the NTB variable can then be used to calculate the tariff equivalents of the restrictions to trade.

Whalley (2004) notes several limitations of price based approaches. First, differences in prices and costs may reflect differences across countries of domestic policies that regulate firm activities (many of the APC studies take this into consideration). Second, price differences may simply arise because of differences in quality across countries rather than differences on policies.

Quantity based methods to estimating the impact of NTBs on trade focus on comparing actual levels of trade flows to potential (or benchmark) levels of trade. The most commonly used quantity based method is the gravity model approach, in which potential trade flows are predicted based on the physical and economic characteristics of countries and their trading partners.

There are several difficulties that arise in the use of this approach. Initial studies on services were severely limited by the lack of available data. As Findlay and Warren (2000) note, research tended to use domestic service consumption data rather than data on services trade between countries. Although the quality of the data has improved significantly in recent years, the availability of information on services trade is still quite poor relative to that for trade in goods.[7]

Problems also arise in calculating tariff equivalents based on the results of quantity based models (Whalley, 2004). Taking the total difference between actual and predicted trade flows will likely overestimate the importance of any NTBs present. Factors other than the presence of NTBs are also likely to generate deviations of trade flows from their predicted values (tariff equivalents may even be generated in the absence of any barriers). This has led to the refinement of the specification of the models to include an

[6] The APC's estimates of tariff equivalents are widely used in the literature and often incorporated in GTAP and other CGE models (e.g., Dee and Hanslow, 2000).

[7] Another issue related to the lack of data, shown in Egger (2002), is the problem that arises in making predictions for a group of countries using data from a different set of countries (Egger refers to this as out-of-sample projection), rather than the countries themselves (in-sample projection).

explanatory variable measuring NTBs in the gravity equation. The variable in question is often based on the frequency index and price based approaches discussed above. This the approach followed in this paper. The precise specification of the gravity model used is described in later sections, as is the methodology used to calculate tariff equivalents of NTBs based on a comparison of actual and predicted trade flows.

3. The Gravity Model and Services Trade

3.1 Historical Development and Theoretical Foundations

The concept of the gravity model is based on Newton's Law of Universal Gravitation relating the force of attraction between two objects to their combined mass and the distance between them. The application of gravity to the social sciences was first proposed by James Stewart in the 1940s (Fitzsimons *et al.,* 1999). Originally applied to international trade by Tinbergen (1962), the gravity model predicts bilateral trade flows between any two countries as a function of their size and the distance between them.

Economic size is measured as Gross Domestic Product, population or per capita income. Distance is typically measured as the distance between the countries capital cities, in some studies this is replaced by measures of remoteness that weight distances by GDP or measure bilateral distances relative to the country's average distance from all trading partners.

The gravity model has been widely applied in international trade studies. Its popularity is due to the simplicity of the concept, the fact that it appears to fit the available data well and the ease with which models can be estimated econometrically.[8] Increasingly, the model specification has been augmented through the addition of other variables that are thought to impact on trade flows such as dummy variables for a common language, common borders or historical relationships between countries. The gravity model is also used for policy analysis, for example the effects on trade flows between countries of membership of trade agreements or common currency areas can be assessed. A common extension of the gravity approach is to calculate the trade cost of different types of barriers and various other restrictions (observed and unobserved) on trade flows by comparing predicted and actual levels of trade.

As the empirical applications of the gravity model have grown, the theoretical foundations of the model have also been developed. Beginning with Anderson (1979), who showed that the gravity framework is consistent with a model of world trade in which products are differentiated by the country of origin (the Armington assumption), a series of papers have shown the gravity model framework to be consistent with a number of standard trade theories such as Heckscher-Ohlin and monopolistic competition.[9] Deardorff (1995, p8) goes as far as to state that "just about any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life."

Anderson and van Wincoop (2003) show that the estimation of the gravity model can be greatly improved by incorporating what they refer to as multilateral resistance measures. Trade between any two regions depends negatively on the trade barriers of each region

[8] Traditionally the gravity model has been estimated using Ordinary Least Squares (OLS). As is discussed later in this paper, it is increasingly the case that more sophisticated estimation techniques are employed.
[9] See Anderson (1979), Bergstand (1985, 1989), Helpman and Krugman (1985) and Deardorff (1995).

relative to the average barrier of the two regions with all trade partners. If a country has a relatively high average trade barrier, it will trade more with a country with which it has a low bilateral barrier. Anderson and van Wincoop argue that multilateral resistance cannot be measured using remoteness variables based on measures of distance as this does not capture border effects, rather the gravity model must be solved taking into account the impact of barriers on prices.[10]

The importance of Anderson and van Wincoops' (2003) contribution is acknowledged in the literature. However, as Feenstra (2004) and others note, it has not been widely adopted in empirical research given the difficulties in its implementation (a customised programme is needed as the endogenous nature of the price terms requires a non-linear solution). Feenstra (2004) shows that the inclusion of country specific fixed effects generates the same results as Anderson and van Winccop (2003) with little loss of efficiency.[11] A limitation of this approach is that it does not allow for the multilateral resistance (price) effects to be calculated explicitly. An alternative solution proposed by Baier and Bergstrand (2005a) is to use a Taylor series expansion to approximate for the price effect terms. The results are consistent with Anderson and van Wincoop (2003) and, unlike the fixed effects approach, this method allows for the multilateral resistance terms to be solved explicitly.

Recognising the nature of trading flows between countries as relationships that develop and change over time, there is an increasing use of panel (longitudinal) data approaches to the estimation of gravity models and this method is chosen in this paper. Anderson and van Wincoop (2004, p29) note that "improved econometric techniques based on careful consideration of the error structure are likely to pay off." The use of different panel data methods, such as random or fixed (within) effects estimators, allows for various assumptions regarding trade flows to be analysed and tested. In particular, as is discussed in a later section, in panel data analysis of gravity models possible heterogeneity and endogeneity issues can be examined by isolating the effects of country pair effects (factors that influence trade between two countries).

3.2 Existing Studies Applying the Gravity Model to Services Trade

The existing literature on the application of the gravity model to services trade is quite limited. One of the first papers on the subject is Francois (2001), with the methodology further developed in Francois *et al.* (2003). Francois models the demand for imports of services as a function of the recipient country's GDP per capita and population. Data on services trade flows are taken from the Global Trade Analysis Project (GTAP) database.[12] The gravity equation is estimated using OLS and the resulting levels of predicted trade between countries are compared to actual trade flows to calculate tariff equivalents of the barrier to services using a constant elasticity import demand function. Francois's estimated tariff equivalents have been widely employed in other studies.

[10] Ferrantino (2006, p25) refers to this as taking into account the endogenous nature of prices in a general equilibrium context.

[11] The inclusion of country dummy variables for importers and exporters is now widely employed, including in research by van Wincoop (e.g., Rose and van Wincoop, 2001). Another option discussed but rejected by Feenstra (2004) is to include price indexes in the gravity equation to model the multilateral resistance terms.

[12] This data is based on IMF Balance of Payments statistics.

In an extension of this approach, Park (2002) also uses services data from GTAP to calculate tariff equivalents for a larger selection of countries and sectors. The gravity model is modified to include price indices to capture differences in prices between countries. This approach combines the price-based and quantity based methods of tariff equivalent estimation discussed in section 2.2. The inclusion of price indices in the gravity equation is first suggested in Bergstrand (1985, 1989). However, Feenstra (2004) argues that an aggregate domestic price index does not accurately capture the cost of importing a service into a country and that a comparison of differences between c.i.f. and f.o.b. prices would be more useful. The approach of Anderson and van Wincoop (2003) is based on such an approach, in that it implicitly solves for differences in prices to measure border effects.

Grunfeld and Moxnes (2003) apply a gravity model to the bilateral export of services and FDI flows using data from the OECD. Their regressors include the level of GDP and GDP per capita in the importing and exporting countries, the distance between them, a dummy variable if they are both members of a free trade area (FTA), a measure of corruption in the importing country and a trade restrictiveness index (TRI) to measure the barriers to services trade in the importing country. The TRI is the augmented frequency index based on research by the Australian Productivity Commission.

Their results suggest that the standard gravity model effects found in studies on trade in goods apply to services too. Trade between two countries is positively related to their size and negatively related to the distance between them and barriers to services in place in the importing country (measured by the TRI). They find that the presence of a FTA is not significant in the case of services. This result might be expected as many FTAs do not cover trade in services.

Grunfeld and Moxnes then proceed to model the impact of trade liberalisation on the flows of services using the estimated coefficients of the TRI variable. To model full liberalisation, they calculate the percentage change in services trade from reducing the TRI to equal that of the lowest country in the sample (arguing that simulating the effect of reducing the TRI to zero is unrealistic as it is unlikely that all barriers to trade would be removed entirely).

Kimura and Lee (2004) apply the standard gravity framework to services trade with the aim of comparing the results to the estimates for trade in goods. As with Grunfeld and Moxnes (2003), they use the OECD statistics on trade in services. They include the standard gravity model variables including adjacency and language dummies and in addition they include a measure of remoteness as a regressor (a trade weighted measure of the distance between the two countries).[13]

Kimura and Lee estimate their gravity equation using a mixture of OLS and time-fixed effects. The major difference they report is that distance between countries is more important in services trade than goods trade. They suggest this implies there are higher transport costs for services but fail to provide any reason why this may be the case. Unlike Park (2002), who found language to positively influence trade in several service sectors, common language between importer and exporter is not found to be significant. FTAs are found to correlate positively with trade, which contradicts the finding of Grunfeld and Moxnes (2003) discussed above. The authors argue that whilst many FTAs

[13] As noted in the previous section, this type of measure of remoteness does not correspond to the underlying theory of the gravity model.

do not explicitly cover trade in services, their presence may indirectly facilitate the process.

Lejour and de Paiva Verheijden (2004) also compare gravity model estimates for trade in goods and services, examining intra-regional trade in Canada and the EU using the OECD services trade statistics used in the above studies and data from the official Canadian statistical agency. Unlike Kimura and Lee (2004), distance is found to be less important for services compared to goods.

The opposing nature of the results of Lejour and de Paiva Verheijden (2004) and Kimura and Lee (2004) regarding the importance of distance in services trade are reflected elsewhere in the literature. Portes and Rey (2005) examine international equity flows with a gravity model and find distance to be negative and significant, which they note is counter-intuitive given the weightlessness of the commodity. They argue that distance proxies for informational frictions that restrict international equity flows. Park (2002) also finds distance to be negative and statistically significant across all service sectors examined. Tharakan *et al.* (2005) find distance to be insignificant in a gravity model analysis comparing Indian software exports to overall goods trade flows.

In addition to the standard gravity model features, Lejour and de Paiva Verheijden (2004) also incorporate the OECD's product market regulation (PMR) indicator (described in section 2.2) as a measure of the non-tariff barriers to trade, which they find has a significant negative impact on trade in services. The use of this measure is further explored in Kox and Lejour (2005), building on the approach of Nicoletti *et al.* (2003) who estimate a gravity equation using relative levels of PMR in the importing country compared to its trading partners, which they find to have a negative impact on trade in services. As well as the standard gravity model regressors in estimating trade between two countries, Kox and Lejour (2005) include the level of PMR in both countries and a variable measuring the level of heterogeneity between the PMR of the two countries. They argue that it is the differences between regulations across countries that are an important determinant of trade flows.

Their model employs the OECD services trade statistics and is estimated using OLS, several fixed effects models and a SUR model. Due the limits of the PMR data, the model is only estimated for trading pairs of EU15 member countries. They find significant impacts on trade from the level of PMR and the level of heterogeneity. Distance between countries negatively effects trade whilst GDP and similar language increase the level of trade.

The literature analysing the determinants of services trade using gravity-based approaches shows a lack of consensus on many of the key findings. The aim of this paper is improve upon these results. In the next section, the gravity model is applied to services trade and a variety of estimation techniques are tested to find the most appropriate. The standard gravity equation is augmented with new variables to further develop the model. In the following section, a measure of the level of barriers to trade is included in the model to assess their role in services trade and to estimate a set of non-tariff equivalents.

4. Model Estimation and Results

4.1 Model

The initial gravity model estimated in this paper is (1), in which all continuous variables are expressed in logarithms. Data sources for each variable are fully documented in the appendix.

$$\ln M_{ijt} = \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \theta_t + \varepsilon_{ijt} \quad (1)$$

The dependent variable M_{ijt} is imports of services from country i into country j at time t. The OECD (2003) data used covers imports between 27 OECD countries and up to fifty of their trading partners over a three year period (1999-2001). The gravity model is estimated five times, with total services, government services, transport services, travel and other commercial services as dependent variables. Whilst the OECD (2003) database on services trade has been employed in gravity based studies before as discussed in section 3.2, previous research has focussed on the total services category.[14]

As explanatory variables, five continuous variables and three dummies are included. In the literature on gravity models, three variables are considered for use as measures of the size of a country: Gross Domestic Product (GDP), GDP per capita and population. Clearly all three can not be included due to multicollinearity. In this paper the latter two are included. As countries tend to consume more service commodities as they become richer, GDP per capita is of more relevance than GDP itself. The choice of population over GDP also facilitates the interpretation of the model results (Fitzsimons *et al.*, 1999).

The first two continuous variables are the real GDP per capita of the exporting and importing countries at time t ($\beta_1 \ln GDPpc_{it}$ and $\beta_2 \ln GDPpc_{jt}$ respectively). The coefficients β_1 and β_2 are expected to be positive. A higher level of income in the importing country should indicate a higher level of demand for services (produced domestically or imported), whilst a higher income level in the exporting country should be positively related to that country's ability to produce more services for export. Mirza and Nicoletti (2006) show that the supply of services to foreign markets is strongly linked to the availability of inputs in both the domestic and foreign markets.

The coefficients on $\ln Pop_{it}$ and $\ln Pop_{jt}$, the population in the importing and exporting countries at time t, may be expected to take either a negative or positive sign. As Martinez-Zarzosa and Nowak-Lehmann (2002) show, population size may have a negative effect on exports if countries export less as they become larger (as they rely more on internal trade) or a positive effect if they export more as they become larger as they are able to achieve economies of scale. Population size will have a similar effect on imports.

Although distance between the importer and exporter ($\beta_5 \ln Distance_{ij}$) is typically expected to have a negative impact on trade in goods, it is not clear from the review of the existing literature that this is necessarily the case for services. Service products do not have to be physically transported from location to location. Depending on the nature of the service, in some cases it will require movement of physical persons but in others it

[14] Kox and Lejour (2005) consider the other commercial services sector, but not the other three.

may be communicated electronically. Consequently, the importance of distance in services trade may be low or even insignificant.

The standard measure of distance, also employed in this paper, is to measure the distance between the countries' capitals as the distance between them. This has several problems associated with it: (i) it assumes no difference between air, sea and land transportation costs; and (ii) the capital city may not be the economic centre of the country or some countries may have several economic centres.[15] To overcome some of these problems, different measures of distance have been developed (such as trade-weighted distances and distance measured relative all other trading partners). However, given the possibility that distance is not particularly relevant for services trade as discussed above, the standard measure is used in this paper.

The final three regressors are dummy variables indicating whether the importing country and exporting country are adjacent ($\beta_6 \text{Adjacency}_{ij}$), share a common language ($\beta_7 \text{Language}_{ij}$), and whether both are members of the European Union ($\beta_8 \text{EU}_{ij}$). All three are expected to be positively related to the level of trade. Finally, θ_t are year dummies to control for any time trends in the data.

Language has been found to be significant in gravity model assessments of goods trade flows and this effect could be expected to be particularly strong in services, as common language should greatly facilitate many transactions. There is evidence to suggest that a common language variable may also capture other effects such as cultural or institutional similarities between countries. This should be borne in mind when interpreting the results of the model.

The final dummy variable is used to capture the effects of European Union membership on services trade flows. It is common in the literature applying the gravity model to goods trade to include a variable measuring the impact of Free Trade Areas (FTAs) but is not clear that this is appropriate for services trade as the majority of such agreements focus on the free movement of goods rather than services. The only agreement considered in this paper is the EU. Whilst trade in services within the EU is not fully liberalised, there are elements of EU policy that promote or facilitate trade in services and foreign direct investment, as opposed to EFTA for example, which provides only for free trade in goods.[16]

4.2 Specification Testing

A number of estimation techniques are applied to the model. The results for total services imports using these estimators are shown in table 3. Initially, the observations are pooled over the three years in the dataset and the model is estimated with Ordinary Least Squares (OLS). However, it has been shown that OLS suffers from heterogeneity bias in the gravity model context (Cheng and Wall, 2005). Trade between any pair of countries is likely to be influenced by certain unobserved individual effects. If these effects are correlated with the explanatory variables, which an examination of the OLS residuals supports, this will lead to pooled OLS estimates being biased.

[15] Consider the case of the US-Japanese trade for example: measuring the distance from Washington DC to Tokyo fails to consider the economic importance of numerous major cities on the Pacific coast of the US.
[16] The EU is taken to be the fifteen member states as of 1999-2001 (the period covered by the dataset).

Using panel data techniques captures the relationships between variables over the period of the sample and can control for the possibility that the unobserved effects may be correlated with the regressors.[17] The two most commonly employed panel models are the fixed effects model (FEM) and the random effects model (REM). In the FEM, the intercept terms are allowed to vary over the individual units (in this case the importing and exporting country pairs) but are held constant over time. REM assumes that the intercepts of individual units are randomly distributed and independent of the explanatory variables. *A priori*, the FEM would be expected to fit better in the gravity model context as the panel tracks pairs of countries over time and it is not realistic to consider them to be randomly drawn. If this is the case and the unobserved effects are correlated with regressors, the REM estimates will be biased.[18]

A shortcoming of the FEM is that variables that do not vary over time (distance or common language for example) cannot be estimated as they are dropped in the fixed effects transformation. Cheng and Wall (2005) solve this problem by estimating an auxiliary equation in the FEM in which the time invariant explanatory variables are regressed on the estimated country pair intercepts α_{ij} from the FEM regression using OLS:

$$\hat{\alpha}_{ij} = \beta_1 + \beta_2 \ln\text{Distance}_{ij} + \beta_3 \text{Adjacency}_{ij} + \beta_4 \text{Language}_{ij} + \beta_5 \text{EU}_{ij} + \nu_{ij} \qquad (2)$$

Both FEM and REM are estimated and their efficiency compared. First, the Breusch-Pagan test is applied to the REM, comparing it to the pooled OLS estimator. The null hypothesis is rejected, indicating that REM is a better estimator than OLS.[19] Second, as noted above it likely that OLS and REM suffer from heterogeneity bias and endogenous explanatory variables respectively. It can be seen in table 3 that the estimated coefficients using OLS and REM are very close. The Hausman test is applied to REM and FEM. The test statistic of 14.61 is greater than the chi-squared critical value at six degrees of freedom at the 5 percent significance level (12.59), therefore the null hypothesis that the REM is consistent is rejected, the REM is shown to suffer from correlation and generate biased estimates.

As an alternative to both the fixed effects and random effects models, Egger (2002, 2005) proposes the use of the Hausman and Taylor model (HTM).[20] The HTM employs an instrumental variable approach that uses information solely from within the dataset to eliminate the correlation between the explanatory variables and the unobserved individual effects that undermines the appropriateness of the REM in the gravity model context. The HTM is increasingly applied in gravity models of trade in goods, but this is the first time it has been applied to services trade.[21]

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[17] Baier and Bergstrand (2005b) provide a detailed discussion of the potential sources of bias in gravity model estimation and the techniques that may be used to overcome this problem.

[18] In the gravity model relationship it is more likely than not that the REM will be biased. Egger (2005, p883) cites the example of an observed variable such as GDP being correlated with unobservable determinants of trade such as human capital stock or trade barriers in the importing and exporting countries. The explanatory variables are considered to be endogenous as they are correlated with the error term. See Cheng and Wall (2005) for a more detailed discussion.

[19] A test statistic of 2597 is greater than the critical chi-squared value at one degree of freedom at 1% significance level (6.63).

[20] See Hausman and Taylor (1981).

[21] Egger and Pfaffermayr (2004) apply a HTM to FDI flows.

The variables chosen as exogenous (the same variables are used in the model for total services and four disaggregated service categories) are the year dummies, which are the only time variant exogenous variables, distance, common language and adjacency. These variables are used to instrument for the remaining variables, which are assumed to be endogenous. In addition, time invariant variables can be estimated using the HTM, giving it an advantage over the FEM.

To test the appropriateness of the HTM, the Hausman-Taylor over-identification test is applied to the FEM and HTM specifications. The test statistic of 1.39 is less than the critical chi-squared value with six degrees of freedom at 1 percent significance, so the null hypothesis that the unobserved effects are correlated with other regressors is not rejected: HTM is more efficient. Testing of the different specifications appears to confirm that the findings of Egger (2002, 2005), that the HTM is the most appropriate estimator for the gravity equation of trade in goods, also holds for trade in services. This result holds for total services and the four sub-sectors. Consequently, the discussion of the results for these sectors in the next section will focus on those obtained using the HTM estimator.

Prior to the interpretation of the results, it is useful to examine the changes in estimated coefficients between the pooled OLS and HTM. The differences are due to the bias in the OLS estimator (Egger, 2005). The OLS estimate of importer GDP per capita is likely to be biased downward by unobserved effects, such as restrictions on trade, that have been omitted from the model but are negatively correlated with imports. The OLS estimator overstates the importance of exporter GDP per capita due the correlation of this variable with omitted variables such as the technology and capital stock of the country. Similarly, the significance of the EU membership in the OLS model is likely due to the high levels of factor endowments in EU members. While distance is negatively correlated with imports in the OLS model, using the HTM to control for unobserved characteristics shows it to be statistically insignificant. Egger (2005) suggests poor institutional standards of many peripheral economies as a possible source of the negative correlation.

4.3 Results

Total Service Imports

As shown in table 3, when the gravity model is estimated using pooled OLS, all variables are significant and their coefficients take the signs that would expected from the standard gravity literature. GDP per capita of the importer and exporter, common language, adjacency and EU membership all positively influence trade, as do the populations of the respective countries indicating that larger countries produce more services commodities for export and demand more services imports. Distance is the only variable that has a negative influence on trade.

In the HTM estimation (IV in table 3), the only variables that remain statistically significant are GDP per capita of both importing and exporting countries and the common language dummy. As discussed above, the HTM is the most appropriate choice for estimating this gravity model. The results from this estimator produce several interesting conclusions regarding trade in services.

First, GDP per capita rather than the population of the country (i.e., wealth of country rather than size) determines the importer's demand for service commodities. A 1 percent increase in GDP per head increases imports of services by 1.3%. Intuitively, this would be expected as individuals and countries tend to consume more services as they become richer. A similar effect appears to hold in the exporting country: a richer country (rather than a larger country) will be able to produce more service commodities and will export more services.

Second, a common language is the only other explanatory variable that is significant. A shared language will increase trade between two countries. As discussed in section 4.1, it is reasonable to expect a common language to have a positive impact on trade services (perhaps even more so than in trade in goods). Many service transactions rely on the movement of physical persons and person to person communication, both of which will be greatly facilitated by a common language.

Distance has no significant influence on trade flows using the HTM. Similar to adjacency, this may reflect the fact physical distances have little or no relevance for the movement of service commodities. The lack of a statistically significant coefficient on the distance variable is particularly interesting because it confirms an earlier finding of Egger (2002) in relation to the application of the HTM gravity model to goods trade.[22]

Finally, the insignificance of both countries being members of the EU is likely due to the fact that service trade is not fully liberalised within the EU. This finding differs from the majority of research on goods trade that finds free trade areas and customs unions to be positively related to trade in those commodities. Perhaps surprisingly, adjacency has no impact on trade levels. This may reflect the fact that physical borders have little relevance to trade in services.

The effects of distance and borders are likely to vary between different types of services. In the following sections, the results for the four disaggregated services sectors (travel, transport, government and commercial services) are examined. A description of the composition of each of these sectors and the data sources for additional variables are contained in the appendix.

Travel Services

The results of the standard gravity model estimated for imports of travel services are shown in panel I of table 4. As noted in section 4.2, the Hausman and Hausman-Taylor over-identification tests indicate that the HTM is most appropriate in this case. Imports of travel services are found to be positively influenced by a common language, GDP per capita and population in the importing country, but the population of the exporting country is also statistically significant and exerts a strong negative effect on trade.[23] The significance of GDP per capita variable indicates that countries with higher incomes will attract the most travellers (this confirms earlier results by Hamilton *et al.*, 2005).

For total services, population was found to be insignificant, however intuitively it seems reasonable that absolute size of population will have a direct impact on the traveller

[22] McPherson and Trumbell (2003) also find evidence in support of this argument.

[23] In the case of travel, care must be taken in the interpretation of the variables. For travel services, the importing country is the "home" of traveller. The country visited, where the service is purchased, is the exporter.

numbers and consequently also on travel services (this is calculated as the sum of the expenditure of travellers on goods and services in the destination country). As discussed in section 4.1, the coefficient on population can be expected to be positive or negative. The positive coefficient on population of the importing country implies that larger countries produce more travellers and so import higher values of travel services. The negative coefficient on exporter population is counter-intuitive, it suggests that countries with larger home populations attract less travellers. It may reflect the importance of several small, high profile destinations (e.g., Cyprus or Malta).

To further examine the flows of travel services between countries, the standard gravity equation is augmented and (3) is estimated. The additional variables $\beta_9 \text{Temp}_i$ and $\beta_{10} \text{Temp}_j$ are the average annual temperatures of the exporting and importing countries (see the appendix for more details on the temperature variables).

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln Temp_i + \beta_{10} \ln Temp_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (3)$$

Previous research (Lise and Tol, 2002) suggests that travellers, in particular tourist travellers, are attracted to warm countries and this is supported by the results of model (3), shown in panel II of table 4. Warmer average temperatures in the exporting country (i.e., the destination country of the traveller) have a statistically significant, positive effect on imports of travel services. The impact of temperature in the home country (the importer) is insignificant.

Transport Services

In the case of transport services (panel I in table 5), the HTM is again found to be the most efficient specification. GDP per capita and population size of both the importer and the exporter are found to be positively related to the level of imports, as is distance, adjacency and EU membership.

The positive coefficient on distance is counter-intuitive in the gravity context, but perhaps in the case of transport services it may be more reasonable. A positive coefficient implies that, as distance increases, the value of transport services (air, land and sea transport) increases. It costs more to transport something as the distance increases. The significance of the EU variable is a change from the case of total services. This may be because the value of transport services is closely related to the value of trade in physical goods. If EU membership has a positive impact of the goods trade (as previous studies have found), this may have a knock-on effect on the demand for transport services to transport those goods within the Union. A similar effect may explain the importance of adjacency in this model.

Population (of both the importer and exporter) has a negative impact on imports. Again, this reflects that larger countries may be less likely to import or export certain types of services, they may rely more on internal trade flows.

Government Services

The first panel in table 6 shows the results of the standard gravity model applied to imports of government services. The estimated coefficients using the HTM are quite different than for the other service sectors and don't correspond to the standard gravity model findings. The only statistically significant variable is the GDP per capita of the exporting country. The reason for this is unclear. It suggests that a country needs a sufficiently high level of income before it may begin to export government services.

In an attempt to augment the standard gravity equation for imports of government services, equation (4) is estimated. The additional variables measure the perceived effectiveness of the provision of public (government services) in the importing and exporting countries (see appendix for further discussion of this variable). The results of equation (4) are shown in the second panel of table 6, the new variables have no statistically significant effect on the import of government services.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln GovtEff_i + \beta_{10} \ln GovtEff_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (4)$$

Commercial Services

For other commercial (not included elsewhere), the HTM is found to be best specification. The results of estimating equation (1) are shown in the first panel of table 7. Only GDP per capita (of both countries) and language are found to be significant and all three have positive coefficients. It is reasonable to assume that commercial services rely even more on wealth than the other service categories and this is shown in the relatively large coefficients on GDP per capita. This type of service is also likely to depend heavily on person to person communication and a common language promotes higher levels of trade.

To explore the possibility that trade in commercial services may be sensitive to the investment climate in countries, even more so than the other services categories, equation (5) incorporates a broad measure of economic freedom in the importing and exporting countries ($\beta_9 EcoFree_i$ and $\beta_{10} EcoFree_j$ are described in detail in the appendix). The results, in the second panel of table 7, indicate that only the level of economic freedom in the exporting country significantly influence commercial services flows. However, the positive sign of the coefficient is counter-intuitive. A lower value of the variable ($\beta_9 EcoFree_i$) indicates greater economic freedom, therefore a positive coefficient suggests lower economic freedom in the exporting country encourages exports of services.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln EcoFree_i + \beta_{10} \ln EcoFree_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (5)$$

Overall, the results from the application of the standard gravity model approach to services are similar to those found in studies of trade in physical goods and are quite

robust.[24] The explanatory variables that are consistently the most influential are the GDP per capita of the importer and exporter and the presence of a common language. Unlike trade in goods, adjacency, distance between countries and EU membership are not found to significantly influence the level of services trade.

5. Estimating Tariff Equivalents

5.1 Non-Tariff Barriers in the Gravity Equation

A key objective of this paper is to estimate tariff equivalents of the barriers to services trade using the gravity framework. This is accomplished by adding a new variable ($\beta_9 \ln NTBTotal_j$) that measures the total level of non-tariff barriers (NTBs) of the importing country j to the gravity equation. This variable is primarily based on a trade restrictiveness index (TRI - an augmented frequency index) produced by the Australian Productivity Commission (as with other variables, full details of the data source are provided in the appendix). A higher level of protection in the importer should reduce the level of services trade between countries. The model estimated for total services imports becomes (6).

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} \\ & + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_9 \ln NTBTotal_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (6)$$

The results are shown in V of table 3. The new variable is statistically significant at the 15 per cent level and the coefficient has the expected sign. GDP per capita of the importer and common language remain positive determinants of imports of total services, however GDP per capita of the exporter is no longer statistically significant.

For travel services, the same variable measuring the total levels of NTBs in the exporting country (the destination of the traveller) is added to (3) to give (7). The results are shown in table 4, in the final panel. In this case, the NTB variable is not found to be statistically significant.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln Temp_i + \beta_{10} \ln Temp_j + \beta_{10} \ln NTBTotal_i + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (7)$$

In the case of transport services, rather than using a measure of the total barriers to services trade, a measure of NTBs specific to the transport sector ($\beta_9 \ln NTBTSP_j$) is added to equation (1) to give (8). This variable is not found to be statistically significant (table 5, second panel).[25]

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[24] For example, alternating the combinations of GDP per capita, GDP and population used in the gravity equation does not significantly alter the estimated coefficients. Nor does the adoption of varying measures of language or the replacement of the EU dummy with dummies for EU and NAFTA.

[25] Replacing the transport specific NTB variable with the total services NTB measure used in earlier equations does not change the results for transport services.

$$\ln M_{ijt} = \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_9 \ln NTBTSP_j + \theta_t + \varepsilon_{ijt} \quad (8)$$

No specific variable measuring barriers to the import of government services is provided by the Australian Productivity Commission, therefore the total services NTB variable is included in the model to give (9). As with transport and travel services, the NTB variable is not found to be statistically significant.

$$\ln M_{ijt} = \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_{10} \ln NTBTotal_j + \theta_t + \varepsilon_{ijt} \quad (9)$$

Similarly, a variable measuring barriers to trade in commercial services ($\beta_{11} \ln NTBComm_j$) is added to equation (5) to give (10). Once again, the results show that the variable does not significantly influence trade flows (table 7, third panel).

$$\ln M_{ijt} = \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_9 \ln EcoFree_i + \beta_{10} \ln EcoFree_j + \beta_{11} NTBComm_j + \theta_t + \varepsilon_{ijt} \quad (10)$$

The results from the inclusion of the NTB variable are not satisfactory. Only in the case of total services is this variable found to significantly influence trade flows (at the 15 per cent level) and even this result is not particularly robust to changes in the specification of the gravity equation.

Earlier research by Grunfeld and Moxnes (2003) employed the same OECD services trade database and a similar NTB variable (also based on the same TRI). The NTB variable is found to be significant at the 1 per cent level in most of their models. They use pooled OLS with exporting country fixed effects (the authors do not state how they specify their fixed effects model). Applying this approach to the dataset used in this paper, similar results to Grunfeld and Moxnes (2003) are found, with the NTB variable significant at the 5 per cent level for total services imports. However, as discussed above, the HTM has been found to be the most appropriate estimator in this case and use of the pooled OLS does not allow for the richness of the panel data database to be fully exploited.

5.2 Tariff Equivalents

The model predictions from the previous section are used to calculate tariff equivalents of the impact of NTBs on services trade. As the inclusion of the various NTB variables was only found to be statistically significant in the case of total services, this methodology cannot be applied to the four disaggregated service sectors.

Several approaches to estimating tariff equivalents using gravity models exist. This paper follows the approach of Park (2002). Tariff equivalents are calculated using equation (11).

$$T = \left[M_P / M_{FT} - B_P / B_{FT} \right]^{1/-e} \qquad (11)$$

T is the power of the tariff equivalent (1+t). M_P and M_{FT} are the predicted and free trade levels of imports of services respectively. The former is based on the gravity model prediction of imports and the latter is calculated as the predicted level of trade if all barriers to services trade were abolished. As is standard in the literature (e.g., Francois, 2001), the import ratio is measured relative to a free trade benchmark ratio (B_P and B_{FT}). The benchmark is taken to be the country with the lowest level of restrictions, reflected in the closeness of predicted and free trade levels of imports, which is the Netherlands in this case.

The elasticity of substitution e is assumed to be 1.95. A wide range of estimates for e exist in the literature, the figure used here is from the Global Trade Analysis Project (GTAP). It is a trade weighted elasticity of substitution for the services sector as a whole. The elasticities in the current version of the GTAP database are based on estimates by Hertel *et al.* (2004). The resulting tariff equivalents are sensitive to the elasticity used. Park (2002) uses a figure of 5.6 for all sectors, Francois *et al.* (2003) use elasticities between 1.26 and 1.68 for different service sectors. Earlier research by Francois (2001) used an elasticity of 4 for overall services trade.

From equation (11), the tariff equivalents of the barriers to trade flows between each bilateral trading pair of countries are calculated. As it is not feasible to report the full set of tariff equivalents between each country and all of its trading partners, the average import tariff equivalents for each country are shown in table 8.

The average tariff equivalents range from 0 to 125 per cent, with a mean of 72 per cent. For a number of countries no figure is reported, these are countries that appear in the services trade database but for which no measure of NTBs is available.

In general, the highest tariff equivalents are found in developing countries (such as Brazil, Morocco or Indonesia). Barriers to trade in Asian countries appear to be particularly large, with the exception of Japan and Hong Kong. Even countries that are traditionally open to trade (e.g., Singapore) are found to have high tariff equivalents.

The average for the EU15 countries is 48 per cent (this rises to 57 per cent with the inclusion of the ten new member states). Amongst the EU members, the figures vary widely. The Netherlands, Belgium-Luxembourg and the UK have low or zero tariff equivalents, while Austria, Italy and Greece have relatively high barriers (74, 75 and 84 per cent respectively).

Direct comparisons with earlier research by Hoekman (1995), Francois *et al.* (2003) and Park (2002) are difficult. Hoekman's tariff equivalents are relative to a "guess-estimate" of the tariff in the most protectionist country. Francois *et al.* and Park employ similar methodologies to this paper, but both use different elasticity parameters. In addition, all three provide tariff equivalents at the sectoral level, rather than for total services trade and the country coverage differs. However, some similarities and differences in the relative levels of protection between countries are notable.

Francois *et al.* (2003) calculate the tariff equivalent of the Netherlands to be zero across all sectors, as found for total services in this paper (Park, 2002, also finds relatively low barriers for the Netherlands). Similarly low levels of protection are also found for other EU countries such as Germany and Belgium in all three studies. In contrast to the results in this paper, the UK is found to have relatively higher levels of protection in many sectors in Park. For the United States and Canada, Park also finds relatively high levels of protection but Francois *et al.* calculate low tariff equivalents for North America. Similar patterns exist for Asian countries in the results in this paper and Park, in that both find them to be relatively protectionist. Francois *et al.* estimate very low tariff equivalents for their aggregate high-income and other Asia regions.

6. Conclusions

This paper employs a gravity model approach to analyse the determinants of services trade and to measure the importance of non-tariff barriers on trade in services. Using an OECD database providing total services imports as well as imports for four sub-sectors (travel, transport, government and other commercial) a variety of panel data estimators are applied and tested.

The Hausman-Taylor model is used to estimate the gravity equation for services for the first time. It is found to be superior to the random effects model, which typically suffers from heterogeneity bias in the gravity model, and avoids the problems associated with trying to account for time-invariant variables using a fixed-effects model.

The standard gravity framework explains the determinants of services well. The GDP per capita of the importing and exporting countries and a common language are found to be most important determinants of trade between two countries. Unlike trade in goods, adjacency and membership of the European Union are not found to increase services trade. The results also confirm some earlier research suggesting that distance is not a significant determinant of services trade flows.

A variable measuring the non-tariff barriers (NTB) to trade in each importing country, primarily based on trade restrictiveness indexes of the Australian Productivity Commission, is added to the gravity equation to calculate a set of tariff equivalents of the restrictions to services trade. The NTB variable is only found to be weakly significant (at the 15 per cent level) in the case of total services and not at all for the four sub-sectors.

Rather than contradicting the established view that barriers to services trade are important, this highlights the problem of collecting accurate data on such barriers. Data on services flows have only recently become available but they are still limited. Barriers to services trade are wide ranging and reflect the heterogeneous nature of services products. Compiling and categorising restrictions is difficult and their quantification even more so, but progress needs to be made in this area for the effects of restrictions to be properly understood. This issue has wider implications. With the share of services in world trade increasing, it becomes ever more important to be able to accurately model services trade and estimate the impact of changes in restrictions on trade flows.

7. Tables

Table 1: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Distance	5,512	4,586	57	19,564
GDP pc – importer [a]	17,198	11,131	326	37,992
Population – importer	66,700,000	180,000,000	266,080	1,270,000,000
GDP pc – exporter [a]	16,970	11,229	326	37,992
Population – exporter	69,300,000	185,000,000	266,080	1,270,000,000
Adjacency	0.057	0.233	0	1
Language	0.080	0.271	0	1
EU	0.128	0.334	0	1

[a] In US dollars.

Table 2: Spearman Rank Correlations Coefficients

	Distance	GDP pc – importer	Pop – importer	GDP pc – exporter	Pop – exporter	Adjacency	Language	EU
Distance	1.00							
GDP pc – importer	-0.05	1.00						
	(0.00)							
Population – importer	0.21	-0.19	1.00					
	(0.00)	(0.00)						
GDP pc - exporter	-0.06	-0.23	-0.01	1.00				
	(0.00)	(0.00)	(0.41)					
Population – exporter	0.22	-0.04	0.03	-0.21	1.00			
	(0.00)	(0.02)	(0.11)	(0.00)				
Adjacency	-0.35	0.03	-0.03	0.04	-0.03	1.00		
	(0.00)	(0.07)	(0.12)	(0.03)	(0.07)			
Language	0.06	0.06	0.02	0.07	0.02	0.22	1.00	
	(0.00)	(0.00)	(0.15)	(0.00)	(0.35)	(0.00)		
EU	-0.37	0.17	-0.06	0.17	-0.07	0.17	0.02	1.00
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.56)	

Significance levels in brackets

Table 3: Total Services

	I	II	III	IV	V
Estimator	Pooled OLS	REM	FEM[a]	HTM	HTM
Dependent Variable	Total Services Imports				
GDP per capita – importer	1.110***	1.113***	1.111**	1.257***	1.114***
	[0.019]	[0.030]	[0.459]	[0.412]	[0.418]
GDP per capita – exporter	1.037***	1.044***	0.722	0.841**	0.037
	[0.019]	[0.029]	[0.452]	[0.411]	[0.456]
Population – importer	0.826***	0.829***	0.117	1.058	0.649
	[0.014]	[0.022]	[1.178]	[0.809]	[0.804]
Population – exporter	0.789***	0.790***	-1.146	-0.371	1.23
	[0.014]	[0.023]	[1.154]	[0.885]	[0.944]
Distance	-0.694***	-0.710***	0.339***	0.386	-0.525
	[0.022]	[0.035]	[0.052]	[1.191]	[0.873]
Adjacency	0.427***	0.442***	2.080***	-0.06	0.281
	[0.091]	[0.147]	[0.232]	[2.326]	[0.740]
Language	1.311***	1.317***	1.199***	1.135***	1.424***
	[0.069]	[0.111]	[0.179]	[0.435]	[0.255]
EU	0.238***	0.226**	0.820***	10.654	2.182
	[0.065]	[0.107]	[0.155]	[17.211]	[4.383]
NTB - Total					-1.136
					[0.790]
Constant	-37.200***	-37.265***	4.925	-30.972***	-38.907***
	[0.508]	[0.794]	[32.348]	[10.521]	[12.148]
Observations	3820	3820	3820	3820	3312
Country pairs	1456	1456	1456	1456	1253
Adjusted R^2	0.7356	0.7359			
Hausman Test: χ^2 (6)			14.61**		
Over-Identification Test: χ^2 (6)				1.39	

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
a Time invariant variables estimated in second step: $R^2 = 0.05$; Observations = 3820

Table 4: Travel Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Travel Services Imports		
GDP per capita – importer	1.659***	1.489***	1.452***
	[0.356]	[0.369]	[0.387]
GDP per capita – exporter	0.111	0.206	0.316
	[0.331]	[0.348]	[0.334]
Population – importer	2.55***	2.453***	1.781*
	[0.965]	[0.838]	[0.928]
Population – exporter	-2.796***	-2.682***	-2.907***
	[0.871]	[0.876]	[0.822]
Distance	0.96	0.577	2.573*
	[1.156]	[0.909]	[1.398]
Adjacency	1.917	1.071	2.756
	[1.445]	[1.583]	[2.238]
Language	1.099*	1.195	1.324
	[0.657]	[0.779]	[1.066]
EU	6.464	7.6	15.408
	[4.561]	[7.238]	[11.784]
Temperature – importer		-0.511	-0.043
		[0.655]	[0.879]
Temperature – exporter		2.078***	2.581***
		[0.599]	[0.685]
NTB - Total			3.787
			[3.796]
Constant	-17.625	-17.82	-15.693
	[15.482]	[13.54]	[16.494]
Observations	3044	2726	2446
Country pairs	1167	1029	907

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Transport Services

	I	III
Estimator	HTM	HTM
Dependent Variable	Transport Services Imports	
GDP per capita – importer	1.008***	0.863*
	[0.391]	[0.513]
GDP per capita – exporter	0.985***	0.739*
	[0.376]	[0.394]
Population – importer	-1.611	-0.301
	[0.985]	[1.073]
Population – exporter	-1.916**	-1.713*
	[0.969]	[1.023]
Distance	3.763***	3.670**
	[1.318]	[1.737]
Adjacency	4.537***	3.782**
	[1.478]	[1.685]
Language	0.524	1.12
	[0.797]	[0.708]
EU	14.944***	14.075**
	[5.003]	[6.306]
NTB - Transport		2.326
		[1.961]
Constant	11.918	-5.987
	[16.93]	[22.070]
Observations	3055	2399
Country pairs	1198	903

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%;
*** significant at 1%

Table 6: Government Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Government Services Imports		
GDP per capita – importer	0.988	1.147	0.344
	[0.769]	[0.944]	[1.057]
GDP per capita – exporter	1.936***	1.69**	1.765**
	[0.732]	[0.837]	[0.765]
Population – importer	0.033	1.731	0.849
	[1.621]	[2.297]	[2.268]
Population – exporter	0.971	-0.493	0.525
	[1.114]	[1.406]	[0.823]
Distance	-0.613	-0.405	-1.837
	[1.182]	[2.932]	[2.680]
Adjacency	-1.361	-0.222	-0.563
	[1.130]	[2.841]	[0.893]
Language	0.446	0.842	0.263
	[0.558]	[0.973]	[0.691]
EU	-1.281	-1.092	-9.009
	[5.377]	[10.576]	[12.222]
Economic Freedom – importer		-0.633	
		[0.436]	
Economic Freedom – exporter		-0.345	
		[0.411]	
Government Effectiveness – importer		-0.014	
		[1.507]	
Government Effectiveness – exporter		0.944	
		[1.138]	
NTB - Total			-3.842
			[4.454]
Constant	-37.727***	-42.764*	-33.581*
	[14.241]	[23.918]	[19.955]
Observations	1496	1106	1374
Country pairs	596	432	544

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Commercial Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Commercial Services Imports		
GDP per capita – importer	1.556**	1.702***	1.254*
	[0.62]	[0.602]	[0.739]
GDP per capita – exporter	1.119*	1.15*	1.203*
	[0.613]	[0.599]	[0.654]
Population – importer	0.57	0.713	0.385
	[0.794]	[0.793]	[0.608]
Population – exporter	0.718	0.504	0.322
	[1.424]	[1.418]	[1.667]
Distance	-0.306	-0.23	0.597
	[0.708]	[0.728]	[2.183]
Adjacency	0.487	0.541	1.142
	[0.709]	[0.735]	[1.999]
Language	0.928***	0.998***	0.970**
	[0.310]	[0.323]	[0.436]
EU	1.631	1.769	4.979
	[3.001]	[3.041]	[8.462]
Economic Freedom – importer		0.385	0.095
		[0.33]	[0.361]
Economic Freedom – exporter		0.579*	0.439
		[0.334]	[0.353]
NTB - Commercial			0.804
			[1.344]
Constant	-40.896	-42.819***	-35.733*
	[11.574]	[11.634]	[18.315]
Observations	3077	3065	2736
Country pairs	1209	1204	1062

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Average Import Tariff Equivalent by Country

Importer	Tariff Equivalent (%)	Importer	Tariff Equivalent (%)
Albania	-	Japan	0.0
Argentina	39.2	Latvia	-
Australia	56.3	Lithuania	-
Austria	74.3	Malaysia	119.6
Bahamas	-	Malta	-
Barbados	-	Mexico	108.0
Belarus	-	Morocco	120.2
Belgium-Luxembourg	0.0	Netherlands	0.0
Brazil	112.3	New Zealand	82.8
Bulgaria	-	Nicaragua	-
Canada	81.7	Nigeria	-
Chile	90.8	Norway	0.0
China	121.3	Pakistan	78.3
Colombia	92.3	Philippines	122.7
Costa Rica	-	Poland	109.5
Croatia	-	Portugal	69.1
Cyprus	-	Romania	-
Czech Republic	81.8	Russia	-
Denmark	60.2	Saudi Arabia	-
Egypt	75.5	Senegal	-
El Salvador	-	Singapore	83.5
Estonia	-	Slovak Republic	-
Finland	41.0	Slovenia	-
France	64.0	South Africa	89.2
Germany	26.0	South Korea	101.2
Greece	83.9	Spain	42.8
Guatemala	-	Sweden	70.1
Honduras	-	Switzerland	69.5
Hong Kong	18.3	Thailand	120.9
Hungary	100.1	Trinidad & Tobago	109.0
Iceland	-	Turkey	114.3
India	113.7	Ukraine	-
Indonesia	124.8	United Arab Emirates	-
Iran	-	United Kingdom	3.9
Ireland	63.9	United States	77.0
Israel	96.7	Uruguay	85.6
Italy	75.0	Venezuela	87.2
Ivory Coast	85.4	Vietnam	-
Jamaica	-	Yugoslavia	121.4

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Appendix: Data Sources

Imports of Services

The primary data source employed in this paper is the OECD's statistics on international trade in services (OECD, 2003), assembled by the OECD with assistance from Eurostat. The dataset provides data on exports and imports of services between twenty-seven OECD countries and up to fifty-five non-OECD partner countries for three years (1999-2001). The collection of the data is based on Manual on Statistics of International Trade in Services guidelines which provides for the extension of the International Monetary Fund's balance of payments methodology to account more fully for services transactions.

Total services trade flows are further disaggregated into transport services, travel services, other commercial services and government services. The use of FDI as a vehicle for the provision of services in foreign countries is not considered in this paper. In terms of the GATS modes of supply of services, the most relevant to services trade data in OECD (2003) are modes 1 and 2 (cross border supply and consumption abroad). The database provides little coverage of commercial presence and the presence of natural persons (modes 3 and 4).

Transport services cover air, sea, land, internal waterway and pipeline transport services. Trade in these services involves their provision by suppliers from one country to customers in another. The products transported include passengers, freight (goods) and some ancillary services provided in terminals and ports. Transport accounts for approximately 10 per cent of the total value of services imports in the OECD database.

Also accounting for 10 per cent of total services imports, travel services are goods and services purchased by travellers whilst abroad. The destination country is considered the exporter of the service, the home country of the traveller is the importer. The most common products purchased are accommodation, food, entertainment and transport within the country and any goods taken out of the country by the traveller. Business and personal travellers are both included, provided their visit last less than one year. For business travellers, purchases made on behalf of their companies are excluded.

Trade in government services is quite limited (less than 1 per cent of total services imports). This category covers government purchases not included elsewhere such as transactions by embassies or other government agencies based abroad and general purchases of services by government institutions.

The largest component of total services imports are commercial services (80 per cent in the OECD database). This cover a wide range of products not included in the above categories (communications, construction, insurance, intermediary and auxiliary financial, computer and IT, royalties, recreational and other business services) supplied to customers in another country. In particular, other business services is an extremely broad category that includes, amongst other items, advertising, R&D services, legal and other technical services. In some cases, the goods imported into a country for use on a specific project are also included in services rather than goods trade (e.g., materials for use in construction).

In total there are over two thousand bilateral pairs of countries in the database, however many fail to report trade with some, or even all in some cases, of their partners. As some

of the bilateral pairs of countries report differing level for the trade between them, the approach of Kox and Lejour (2005) is followed to determine a ranking of countries in terms of their reporting reliability. After the duplicate bilateral pairs and missing data are removed, there remain approximately 1400 bilateral country pairs reporting imports of total services for at least one of the years in the sample (1999-2001). Pooled across the three years there are just over 3800 observations. The number of country pairs and observations for the disaggregated sector data are lower as countries are less likely to provide full information on the four sub-categories of services.

GDP, GDP per capita and Population

Data on GDP, GDP per capita (both in US dollars) and population variables are from the World Development Indicators database (World Bank, 2005).[26] Some regressions were implemented using GDP at purchasing power parity but this was not found to significantly change the results.

Distance

Distances are measured as the distance between capital cities of each country in kilometres and are from the Great Circle Distance programme.[27]

Dummy Variables

The dummy for adjacency takes the value of one if the two countries have a common border and zero otherwise. In the dataset there are 47 country pairs that share a common border. The EU dummy takes a value of one if the two countries are members of the European Union. The language dummy takes the value of one if the two countries share a common (official) language and zero otherwise. In total there are 174 pairs of countries that share a common language in the data.

Given the possible importance of a shared language to services trade, some simulations were implemented with an extended language variable that incorporated data on the prevalence of non-official languages and the degree to which they are spoken in countries (*Clair et al.*, 2004). It is continuous variable that ranks the degree of similarity of the languages of trading partners (or the linguistic distance between them). This had little influence on regression results compared to the use of the standard variable. This may reflect the fact the sample of countries covered in the model are primarily OECD countries, the majority of which have one dominant language in use. The extended language variable does not capture significant variation that is not already captured in the standard dummy variable method.

The summary statistics for each of the explanatory variables are shown in table 1. To examine the possibility of multicollinearity amongst the explanatory variables, the spearman rank correlation coefficients are shown in table 2. As there are no two variables with a correlation greater than 0.37, there is no evidence that multicollinearity is a major issue with these variables

[26] Belgium and Luxembourg are treated as single country in OECD (2003), so the sum is used for GDP per capita and population variables.
[27] Available at: http://www.wcrl.ars.usda.gov/cec/moregen.htm.

Temperature, Economic Freedom and Government Effectiveness

The temperature, economic freedom and government efficiency variables are sourced from the Sustainability and Global Change dataset assembled by Hamilton *et al.* (2002). This database brings together a wide range of other data sources available elsewhere on the web.[28]

The temperature variable, from New *et al.* (1999), measures the average annual temperature between 1961 and 1990 for each importing and exporting country. Although, the data does not correspond to the time period of the dataset used in this paper, global temperatures have not changed considerably despite global warming and it is unlikely that relative temperatures between countries have changed.

The economic freedom variable is based on the Heritage Foundation's Index of Economic Freedom (Miles *et al.*, 2006). Countries are scored on an annual basis on a number of headings related to their level of economic freedom. The variable is measured on a scale of 1 to 5, lower scores indicate higher levels of economic freedom and lower government intervention.

Government effectiveness measures the quality of public service prevision. Kaufman *et al.* (1999) base their variable on a database of three hundred governance indicators. A higher score implies more effectiveness government prevision of services.

Non-Tariff Barriers

The primary source of data on NTBs is the Australian Productivity Commission's (APC) trade restrictiveness index (TRI), an augmented frequency index as described in section 2.2. The TRI measures the level of protection imposed by each country on imports of services on a scale of 0 (liberal) to 1 (restrictive). The APC provides two sets of TRIs. The first measures the restrictions imposed on the operation of domestic firms (such barriers are considered to be non-discriminatory). The second measures all restrictions that hinder the establishment and operation of foreign service providers (discriminatory and non-discriminatory measures). The difference between the two indicates the level of discrimination against foreign firms and this measure is used in this paper.

TRIs are provided for a number of service sectors, some of which broadly match the four sectors covered in OECD (2003). For total services imports, the average of all the sectoral TRIs is used. As the TRI country coverage is not a perfect match for the OECD services database, a coverage ratio based on Hoekman (1995) is used to supplement the TRI database. The coverage ratio (CR) sums up the number of GATS commitments of each country. The more commitments signed up by a country, the more liberal it is considered. To equate this measure to the TRI, the ratio is subtracted from one (1-CR) to give a scale of 0 (liberal) to 1 (restrictive). The correlation between the TRI and (1-CR) is 0.62. Although this may seem quite low, the country coverage of the TRI and the OECD database are quite close, the coverage ratio is only used for a few countries. The *NTBTotal* variable is primarily based on the TRI.

[28] Available at http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/Models.htm.

As noted in above, for travel and government services the same *NTBTotal* variable is used to measure restrictions in those sectors as no TRI is provided for these service sectors.[29]

For transport services, a more specific TRI measuring restrictions in maritime transport is used to proxy for NTBs in the transport sector as a whole. To supplement this measure, several coverage ratios from Hoekman (1995) were considered (maritime, air, land and total transport are among the sectors for which coverage ratios are provided). However, these measures are found to be poorly correlated with the TRI for transport and were not used.

To measure NTBs in commercial services, a TRI measuring restrictions in the banking sector is the primary source for the *NTBComm* variable. This sector is broader than simply banking and financial services but this TRI provides the closest match and it is reasonable to assume that banking and financial services provide a large share of the total value of commercial services. For a small number of countries for which a TRI is not provided, a coverage ratio for business and financial services is used (correlation coefficient of 0.76).

[29] Hoekman (1995) provides a coverage ratio for education and health and social services but it is not clear from OECD (2003) that these sectors match the commodities included in the government services category.