How Trade in Services Varies Conditional on Different Determinants: Evidence from UK Firm-level Data using Quantile Regressions[*†]

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Abstract

The main purpose of this study is to analyse service export and import in the UK taking into account both country- and firm-level factors throughout the conditional distribution of trade values in the gravity framework. To detect possible parameter heterogeneity across the distribution of firm-level export and import, quantile regression has been used. The results show that the magnitude and significance level of each coefficient are different in each quantile and they are different from OLS estimations. The positive effect of GDP and the negative effect of distance on firm-level service export and import become stronger in higher quantiles, showing that firms with higher level of export and import are affected more by changes in GDP and distance.

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[†] This work was based on data from the International Trade in Services Survey and Annual Respondents Database, produced by the Office for National Statistics (ONS) and supplied by the Secure Data Service at the UK Data Archive. The data are Crown Copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the data in this work does not imply the endorsement of ONS or the Secure Data Service at the UK Data Archive in relation to the interpretation or analysis of the data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

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1. Introduction

In last two decades, the number of firm-level studies has increased in international trade literature starting from pioneer study by Bernard and Jensen (1994). Those studies show that exporting firms are larger and more productive, use more capital intensive production processes and employ more highly skilled workforce (see Bernard et al, 2007 and Wagner, 2007 for firm-level good trade and Breinlich and Criscuolo, 2011 and Federico and Tosti, 2011 for firm-level service trade). Melitz (2003) combines heterogeneous firm models with international trade theories to explain why international trade induces reallocations of resources among firms in an industry. Expanding Melitz's theoretical model, Chaney (2008) proposes that exporting firms have different characteristics to export with different foreign markets and extensive and intensive margins of bilateral trade flows between countries are affected differently by changing trade costs.

However, the effects of different variables explaining the trade values by firms alter through the distribution of trade since each firm possesses different characteristics. In other words, if firms with higher trade values are different from firms with lower trade values, then different variables would have different impacts on different firms. Point estimates such as OLS estimate assume that the conditional distribution of a dependent variable is homogeneous for a given set of explanatory variables. In this case, it is not possible to observe firm heterogeneity. Therefore, in this paper we employ Quantile Regression approach which enables us to examine the impacts of different country- and firm-level variables at different points of conditional distribution of UK's firm-level service export and import. In the existing micro-level literature, there are studies which consider the effect of trading (mostly exporting) on different firm characteristics such as productivity, wage and size by using quantile regression approach (Dimelis and Louri, 2002; Serti and Tomasi, 2009; Shevtsova, 2010; Velucchi and Viviani, 2011; Hijzen et al, 2011; Powell and Wagner, 2011; Haller, 2012) However, the number of studies which employ quantile regression to analyze the effects of different firm/country level characteristics on firm or country-level trade values is more limited. Moreover these studies generally focus on goods trade (see Wagner, 2004 and Molder, 2011). Especially in service trade literature, there is no study which investigates the effects of different determinants of service trade at different points of conditional distribution of trade values.

However, the increasing importance of international services trade should be considered. It has depicted faster growth than goods trade. According to World Trade Organization (WTO) statistics, world export in commercial services (services excluding governmental services) stood at 3.7 billion USD in 2010 with an average annually growth rate over 15% over the past 20 years. Moreover, it is of significance not only in international trade but also in all economic activities. Nearly 71% of global value added in 2010 was generated in the services sector with 3% average annual growth rate from 1990 to 2010, and around 45% of total employment is hired by service sectors (World Development Indicators, 2011). On the other hand, the UK is one of the leader countries in trade in services. According to WTO (2011), the UK is the third largest exporter and fourth largest importer in commercial services. Besides, the UK Office for National Statistics provides a very well established, unique database in firm-level service trade. Therefore, the UK has been chosen for the analyses.

The main purpose of this study is to analyze service export and import in the UK taking into account both country and firm-level factors throughout the conditional distribution of trade values in the gravity framework. To this end, the gravity model is used as an empirical tool in this study. To estimate gravity equation, quantile regression and OLS have been employed. Possible parameter heterogeneity across the distribution of firm-level export and import is investigated by means of quantile regression for five quantiles (10th, 25th, 50th, 75th, and 90th quantiles) while OLS is used as benchmark estimation. In order to avoid correlated residuals across countries, country clusters are used to obtain cluster corrected standard errors in all firm-level analyses. As an additional descriptive analysis, we provide OLS estimations with the interaction terms. This enables us to examine how the effects of different trade determinants alter across firm size and productivity level.

Results from firm-level analyses show that the magnitude and significance level of each coefficient are different in each quantile as well as in OLS estimations. The positive effect of GDP and the negative effect of distance on firm-level service export and import become stronger in higher quantiles, showing that firms with higher level of export and import are affected more by changes in GDP and distance. Additional to GDP and distance variables, GDP per capita and colonial relationship, regional trade agreements, EU and WTO membership dummies are also significant in export analyses. The effect of GDP per capita is not varying over different quantiles, however it has an insignificant effect in the 10th quantile

showing that firms with low export level are not affected by development level of the trading partners. Regional trade agreements, EU and WTO membership dummies have significantly negative effects on firm-level export for all quantiles except 10th quantile. Negative effects of these variables are increasing for higher quantiles.

According to results from OLS estimations with interaction terms, the effect of GDP on firm-level export and import grows as firms become larger and more productive while the effect of the distance variable shrinks across firm size and productivity. These results are compatible with the existing literature. If it is true that firms with higher productivity and employment level have higher export and import level since they are able to handle trade costs, it is expected to have increasing positive coefficient for GDP and negative but decreasing coefficient for the distance variable as firm size and productivity increase.

The rest of the paper is organized as follows. Section 2 provides literature review on gravity equation and quantile regressions as well as their implications on international trade. Information on databases, description of variables and methodology used are presented in Section 3. Section 4 gives the analysis results from empirical models. Section 5 concludes.

2. Literature Review

After the pioneer studies by Tinbergen (1962) and Pöyhönen (1963), the gravity framework has become one of the mostly used models in the international trade literature due to the simplicity of the model. Its high explanatory power and sound theoretical background make it to fit the available data well and to provide econometric estimations for the determinants of trade flows. The most basic form of the gravity equation explains bilateral trade flows between any two countries as a function of their economic size and the distance between them. Many studies have improved the model both theoretically and emprically (Anderson, 1979; Helpman and Krugman, 1985; Bergstrand, 1989; Deardorff, 1995; Anderson and van Wincoop, 2003; Feenstra, 2004). Although there are numerous studies that apply gravity

framework on country-level and firm-level goods trade data, there are a limited but growing number of studies on county- and industry-level services trade as well[4].

However, the mounting of heterogeneous firm models into the trade models leaded researchers to focus on firm-level data in both goods and services trade. Accordingly firms have different characteristics which determine their trade decision. Melitz (2003) explains that international trade induces reallocations of resources among firms because of the existence of heterogeneous firms in an industry. In his analyses for 169 countries over the period 1980-1997, Chaney (2005) concludes that market structure differences and firm heterogeneity decrease the effect of trade barriers on export flows. Bernard et al (2007) and Wagner (2007) are the examples of the empirical analyses which support theory showing that exporting firms are larger and more productive, use more capital intensive production processes and employ more highly skilled workforce. These analyses have been applied for trade in services as well and similar results have been obtained (Kelle and Kleinert, 2010; McCann and Toubal, 2011; Ariu, 2010; Federico and Tosti, 2011; Breinlich and Criscuolo, 2011). Last three of these studies also apply gravity equation to estimate the determinants of services trade in Belgium, Italy and the UK respectively.

Nevertheless, most of the existing studies employ point estimators such as OLS, TOBIT or PPML to estimate trade determinants in the gravity framework. However, if firms are heterogeneous, the effects of different variables explaining the trade values by firms alter through the distribution of trade. Point estimates assume that the conditional distribution of a dependent variable is homogeneous for a given set of explanatory variables. In this case, it is not possible to observe firm heterogeneity. Therefore, in this paper we employ Quantile Regression approach which enables us to examine the impacts of different country- and firm-level variables at different points of conditional distribution of UK's firm-level service export and import. In the existing micro-level literature, there are studies which consider the effect of trading (mostly exporting) on different firm characteristics such as productivity, wage and size by using quantile regression approach (Dimelis and Louri, 2002; Yasar et al, 2006; Yasar and Morrison Paul, 2007; Trofimenko, 2008; Serti and Tomasi, 2009; Shevtsova, 2010; Velucchi and Viviani, 2011; Hijzen et al, 2011; Powell and Wagner, 2011; Haller, 2012).

[4] Freund and Weinhold, 2002; Grunfeld and Moxnes, 2003; Mirza and Nicoletti, 2003; Tharakan et al, 2005; Kimura and Lee, 2006; Walsh, 2006; Head et al, 2009; Francois and Hoekman, 2009; Kandilov and Grennes, 2010 and 2012.

However, there are only one country-level study and one plant-level study which employ the quantile regression to explain the determinants of trade flows. Wagner (2004) employs quantile regression to examine the impact of plant characteristics on export intensity of German manufacturing. Molder (2011) uses quantile regression in the gravity framework in order to show potential heterogeneous effects along the trade volume levels. However, the main aim of the study is to reveal the high level of heterogeneity of the trade-creating effect of trade agreements along the trade volume and per-capita income distributions. To this end, this study analyzes service export and import in the UK taking into account both country and firm-level factors throughout the conditional distribution of trade values in the gravity framework.

In particular, in service trade literature, there is no study (to the best of our knowledge) which investigates the effects of different determinants of service trade at different points of conditional distribution of trade values. Taking into account this deficiency in the existing literature, this study contributes to the literature by applying quantile regression approach to detect possible parameter heterogeneity across the distribution of firm-level export and import. Given that the UK is among the largest service traders in world trade and the UK Office for National Statistics provides a very well established database in firm-level, the UK has been chosen for the analyses.

3. Data and Methodology[5]

This section provides information on databases, detailed description of the variables and methodology used in the analyses.

3.1. Data

In this part of the study, we provide information of the databases, followed by the data management process. Then, we present detailed description of the variables that are used in the analyses

[5] This section of the study mostly benefits from the first chapter of my dissertation: "Determinants of Trade in Services: Evidence from UK Firm-Level Data using a Gravity Equation Approach".

3.1.1. Data Sources

This study considers both country- and firm-level factors in order to evaluate the validity of the gravity model for trade in services and analyze the importance of different determinants within this framework. To this end, several data sources are used. The main data sources are surveys on the UK private sector companies conducted by the Office for National Statistics (ONS). Each survey contains Inter-Departmental Business Register (IDBR) reference numbers which are anonymous but unique reference numbers assigned to the business organizations. This allows us to combine different surveys.

The main data source that is used in this study is the UK's International Trade in Services Inquiry (ITIS). ITIS data are collected from a number of different surveys and administrative sources. It provides import and export of 46 different types of services by country of origin and destination for roughly 20,000 firms (from 2001, previously approximately 10,000) over the period 1996-2005. The companies with over 10 employees have been included in the inquiry. ITIS provides information on producer services and excludes travel and transport, some banking, financial and legal services, higher education and film and television companies. Since the firms included in surveys change every year and the highest number of the firms covered in 2005, this study focuses on the data from 2005.

Firm specific variables are obtained from The Annual Respondent Database (ARD) and the Business Structure Database (BSD). The ARD provides structural variables for firms. It is constructed from a compulsory business survey which is based on the Annual Business Inquiry (ABI) from 1998 onwards. This dataset is created for the Economic Analysis and Satellite Accounts Division for research purposes. To create the ARD, the other surveys are converted into a single consistent format linked by the IDBR reference over time. The data encompass many variables such as employment, turnover/output, capital expenditure, intermediate consumption, gross value added (derived), postcodes, industrial classification, owner nationality, acquisitions and disposals of capital goods for both smaller and larger businesses (firms with more than 100 or 250 employees depending on the year). To control for firm specific characteristics, variables for firm size, productivity and research and development (R&D) engagement have been used in the analyses from the ARD. On the other hand, other firm characteristics such as firm age and legal status are obtained from the BSD. The BSD contains a small number of variables for almost all business organisations in the UK

for the period of 1997-2010. The purpose of the BSD is to create a version of the IDBR for research use, reflecting a wide variet of firm demographics. Specifically, the BSD aims to embody the following characteristics: record life span of enterprises; takeovers and mergers; account for restructuring/changes in enterprises; identify accurately birth and death and improve demography statistics and allow historical analysis. As other firm characteristics, firm age variable has been generated from birth and death variables and being a Limited Liability Company (LLC) dummy is generated from legal status variable provided by the BSD.

The last data source that is used in this study is CEPII Gravity Database. This is a freely available dataset generated by Head et al (2010). In order to analyze the country- and firm-level determinants of trade in services for the UK using the gravity equation, data sources providing country-level data are combined with the firm-level datasets given above. All country-level variables except dummy for European Union (EU) membership (GDP and GDP per capita of the trading partner, distance and time differences between the countries, dummies for colonial relationship, common language, common legislation, regional trade agreement and GATT (WTO) membership) are obtained from the CEPII Gravity database.

3.1.2. Data Management Process

The ITIS reports observation with positive transaction values. It covers 83014 observations reported for 5428 firms trading with 214 countries in 46 service types for 2005. For the same year, the ARD reports variables for firm characteristics for 1860045 observations. However, if we consider only the contributors who were selected and returned data, there are only 52171 observations in question. These firms are operating under 8 different sectors classified according to the UK Standard Industrial Classification of Economic Activities 1992 (SIC(92)): catering, construction, motor trades, production, property, retail, other services and wholesale. After merging these two database as well as gravity dataset, we obtained export and import datasets: 1754 firms exporting to 181 countries in 46 service types and 1909 firms importing from 177 countries in 46 service types.

In order to estimate firm-level service trade determinants throughout its distribution, we combine country-level data with firm-level data. In other words, we investigate the effects of

country characteristics on firm-level export and import. With such data, the true inference is obtained if and only if the random disturbances in the regression are independent within the groups. If the disturbances are correlated within the groups (countries in our case) that is used to merge firm-level data with country-level data, then even small levels of correlation can cause poor inference because of the downward biased standard errors (Moulton, 1990). In the case of within-group correlation, cluster corrected standard errors can be used to improve the inference (Angrist and Pischke, 2009). In our case, the dependent variables are firm-level export and import while the main explanatory variables of interest vary only at country level. It is expected that firms trading with a certain country might share some unobservable characteristics which would lead the regression disturbances to be correlated. Therefore country-cluster corrected standard errors are used in all models.

3.1.3. Variable Descriptions

To examine determinants of firm-level service export and import in UK, transaction values (£'000) of export and import have been used as dependent variables. To explain variations in firm-level export and import, GDP and GDP per capita of trading partner, distance and time differences between the countries, dummies for colonial relationship, common language, common legislation, regional trade agreement and GATT membership, firm size, firm age, productivity of firms, legal status indicator and a dummy for R&D engagement variables have been employed as explanatory variables[6].

GDP and GDP per capita of trading partners are the proxies of economic size and development level respectively. GDP of partners is expected to have positive impact on UK firm-level export and import because it refers to the potential demand and production in a country. A positive sign is also expected for GDP per capita of the partner country. Helpman and Krugman (1985) suggests that higher GDP per capita corresponds to higher capital intensity in a country showing that the country is a developed country. Thus, it is expected that a country with higher GDP per capita has higher import and export. Bergstrand (1990) investigates the effect of GDP per capita on export and import separately. According to Bergstrand (1990), GDP per capita of exporter is a proxy for capital-labour ratio but it represents per capita income for importer country. Therefore, if a trading partner of UK has higher GDP per capita income, then import in UK would be higher due to higher capital-

[6] A brief explanation of variables used in the analyses is given in Table A 1 in the Appendix.

labour ratio in the exporting country and export in UK would be higher due to demand for greater variety in the importing country.

As in good trade literature, distance variable is expected to have negative impact on service trade as well. However, we expect to obtain stronger negative relationship between distance and service export and import than the relationship with good export and import because of the non-storability property of services which required physical proximity between service producer and consumer. The population-weighted great circle distance between large cities of the UK and her trading partners has been used as a proxy of transportation cost for trade following Head et al (2010). To see the net effect of geographical distance, we eliminate the effects of other factors that affect firm-level service trade. To this end, we include dummies for common language, common legislation, regional trade agreement and GATT membership, and colonial relationship. We also add time differences between the UK and her trading partner as a proxy for trade cost. Although trading in the same time-zone might increase coordination between countries, its effects on service trade might depend on types of services. A positive impact can be expected if the service type does not require office hours synchronization but a negative effect can be expected if the service type requires time coordination between producer and consumer (Kandilov and Grennes, 2010). Christen (2012) finds positive effect on US foreign affiliate sales in services for time zone differences of 5 hours and 9 or more hours while she finds negative impact for time zone differences 1 hour and 2 hours.

To control for the firm size and productivity of firms employment and gross value added per employee variables have been used in the analyses. Firm age variable is calculated by using birth and active variables provided by the BSD. First we considered active firms in 2005 then we subtracted year of birth from 2005. R&D variable is an indicator variable showing that whether a firm engaged in research and development work on a regular basis during the year. Depending on this indicator we create a dummy variable which takes value of one if a firm is engaged in R&D work. Lastly, we create an LLC dummy using the legal status of a firm variable provided by the BSD as a measure of financing business operations by external sources. Althoug there are 7 different legal status (LLC, sole proprietor, partnership, public corporation, central government body, local authority and non-profit making body) that a British firm can possess, the service trading firms possess only 3 of them (LLC, partnership

and non-profit making body). The company dummy takes value of 1 if a trading firm is an LLC and 0 otherwise.

All firm-level variables except firm age are expected to have positive impact on firm-level export and import. Love and Mansury (2009) confirms the positive impact of firm size and productivity for US business services firms in the year 2004. They find that larger and more productive firms are more export oriented showing the self-selection effects of more successful firms into exporting. They also analyze the effect of exporting on productivity of firms to investigate the endogeneity between these two variables and find weak relationship. In his literature survey on 45 microeconometric goods trade studies with data from 33 countries that were published between 1995 and 2004, Wagner (2007) also confirms that exporting does not necessarily increase productivity of firms. However, Yasar et al (2003) shows that the effect of exporting on productivity depends on several factors such as life duration and size of firms and type of goods that is exported. Eickelpasch and Vogel (2009) analyzed the impact of various firm-specific characteristics such as size, productivity, human capital and experience on firm's exporting performance in the national market in Germany and others by using a panel dataset of firms from the business services sector for the years from 2003 to 2005. They find that when the unobserved heterogeneity is controlled by firm fixed effects, the positive effects of productivity on export performance disappear conversely to the previous studies on manufacturing firms. Size still remains to have a positive and significant effect.

The effect of firm age on trade is unclear. Although mature firms may have knowledge accumulation, more experience in the market and wide networks, younger firms are more flexible and aggressive to adapt changing international conditions and recent technology. The existing firm-level studies generally focus on the effect of firm age on good export. Duenas-Caparas (2007) finds positive impact of firm age on export performance of firms in three main manufacturing sectors in the Philippines. Roberts and Tybout (1997), Niringiye and Tuyiragize (2010), Majocchi, Bacchiocchi, and Mayrhofer (2005) are the other studies which find a positive relationship between age and internationalisation for exporting firms in Colombia, Italy and Uganda respectively. In contrast with these studies, Roper et al. (2006) finds positive relationship between export propensity and younger Irish manufacturing plants

while Iyer (2010) does not determine any significat effect of firm age on export intensity of firms in New Zealand Agriculture and Forestry industries.

In the literature, it is common to employ R&D expenditure as a measure of level of technology that is used in firms and its effect on export mainly differs across countries and industries (Willmore (1992), Wagner (2001), Lefebvre and Bourgault (1998), Duenas-Caparas (2007)). However, the datasets that are used in the current study does not provide such variable. Therefore R&D engagement variable has been used as a measure for improved technology and skills in a firm. It is expected to obtain positive relationship between R&D engagement and trade since firms with R&D engagement would have more knowledge and skill to adapt increasing international competition.

A positive sign is expected for LLC dummy because companies can export more since they can easily find external sources to finance the additional costs due to exporting. Eickelpasch and Vogel (2009) use 3 dummies for legal status and find that *private companies* and *public limited companies* have a higher probability of being an exporter and choose a higher volume of exports than *sole proprietors*.

3.2. Methodology

In this study, an augmented version of the gravity equation has been used and it has been adapted to the firm-level data. The augmented gravity equation is given below:

$$T_{ids} = A_d^{\alpha} B_i^{\beta} \exp(Z'\gamma + \varepsilon_{ids}) \quad (1)$$

where T_{ids} denotes export (import) flows by firm i to (from) the destination (the origin) country d in service type s. There are two sets of explanatory variables on the right-hand side. A_d contains country-level variables such as GDP of trading partner, bilateral distance and time differences where variables related to the firm characteristics such as firm size and productivity are included in the set B_i[7]. Z denotes the vector of other control variables including firm and/or service type fixed effects and dummies such as common language and R&D engagement. ε_{ids} is the error term from this multiplicative form.

[7] The logarithm of all variables except dummies and time differences between countries are taken in line with gravity framework.

If firms are heterogeneous, the effects of different variables explaining the trade values by firms alter through the distribution of trade. Point estimates assume that the conditional distribution of a dependent variable is homogeneous for a given set of explanatory variables. In this case, it is not possible to observe firm heterogeneity. Therefore, in this paper we employ Quantile Regression approach which enables us to examine the impacts of different country- and firm-level variables at different points of conditional distribution of UK's firm-level service export and import.

In the first part of the analyses, equation (1) has been estimated by quantile regression in order to detect possible parameter heterogeneity across the distribution of firm-level export and import. Quantile estimations have been repeated for 5 quantiles (10th, 25th, 50th, 75th, and 90th quantiles) and OLS is used as benchmark estimation. In order to avoid correlated residuals across countries, country clusters are used to obtain cluster corrected standard errors in all firm-level analyses. In the last part of the analyses, to support results obtained from quantile regressions, OLS estimations with the interaction terms are provided. This enables us to control for size and productivity level of the firms.

3.2.1. Quantile Regression

Most of the empirical studies focus on average causal effects. However, the mean cannot explain the entire distribution of a dependent variable unless it is a dummy variable. In order to model the entire distribution, quantile regression is a powerful tool.

Suppose we are interested in the distribution of a continuous random variable, y_i, which is explained by a vector of regressors, X_i:

$$y_i = X_i'\beta_\tau + u_{\tau i} \quad (2)$$

where β is the vector of parameters to be estimated, and u is a vector of residuals. Equation (2) is defined as a quantile regression model by Koenker and Basset (1978) as follows:

$$Q_\tau(y_i|X_i) = X_i'\beta_\tau \quad (3)$$

In equation (3), $Q_\tau(y_i|X_i)$ is the τth conditional quantile of y given X. For the τth quantile and for $0 < \tau < 1$, the quantile regression solves the following problem:

$$Q_\tau(y_i|X_i) = \underset{q(X)}{\arg min} E[\rho_\tau(y_i - q(X_i))], \quad (4)$$

where $\rho_\tau(u) = (\tau - 1(u \leq 0))u$ is called the "check function". It asymmetrically weights positive and negative terms to generate minimization process that picks out conditional quantiles: $\rho_\tau(u) = 1(u > 0).\tau|u| + 1(u \leq 0).(1-\tau)|u|$ (Angrist and Pischke, 2009).

The quantile regression parameter, β_τ, gives the change in a certain quantile of dependent variable by a one unit change in the explanatory variable. This allows us to see how some of the percentiles of the dependent variable might be more affected by the determinants than the other percentiles. Quantile regression explains the entire conditional distribution of the dependent variable. With quantile regression, normality assumption is not needed for robust estimators. It provides robust estimators with outliers and heavy-tailed distribution. The estimator is invariant to outliers of the dependent variable that tend to $\pm\infty$ (Buchinsky, 1994). Moreover, quantile regression relaxes identically distributed error terms assumption. Error terms can be different at different points of the conditional distribution. This allows us to control for individual heterogeneity since we obtain different parameters for different quantiles of the conditional distribution (Velucchi and Viviani, 2011).

Considering the above mentioned superiorities of quantile regression, in the current study quantile regression approach has been used. But, OLS is used as benchmark estimation. In order to consider firm heterogeneity and to examine how the effects of different determinants of firm-level export and import may vary throughout the distribution, we estimate log-linearized form of equation (1) by quantile regression.

3.2.2. Interaction Terms

Although most of the studies in firm-level trade literature analyse the impact of exporting/importing on firm size and productivity, there are some studies which considers the reverse relation. These studies confirm that firm size and productivity level of firms has significant and positive impact on firm-level trade (Love and Mansury, 2009; Eickelpasch and Vogel, 2009). Accordingly, larger and more productive firms are more export oriented showing the self-selection effects of more successful firms into exporting. As found by Bernard et al (2007) and Wagner (2007), if the exporting firms are larger and more productive, it is important to examine how firm size and productivity affect the impact of

other variables on trade values. To this end, interaction terms have been added to the OLS estimations. Main explanatory variables of the gravity equation (GDP and distance) are interacted with number of employment variable and labour productivity variable in order to control for firm size and firm productivity respectively. It is expected that the positive effect of GDP becomes larger as firm size and productivity increases since those firms are able to provide more varieties. On the other hand, the negative effect of distance is expected to shrink for larger and more productive firms because of being able to handle increasing trade cost as they access more distant destinations. The main purpose of these analyses is to support results obtained from quantile regressions. Therefore, Table A2 provides employment and productivity level of each quantile of export and import. According to Table A2, from lower to upper quantiles of export and import, labour productivity increases. Although the employment level changes in each quantile, we observe that average employment in 90^{th} quantile is four times larger than 10^{th} quantile for export and it is two times larger for import.

4. Analyses

In order to examine the effects of different determinants of services trade at different points of conditional distribution of trade values, we employ quantile regression. All analyses have been reported for the UK firm-level service export and import in 2005. Quantile estimations have been repeated for 5 quantiles (10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles) and OLS is used as benchmark estimation. In order to avoid correlated residuals across countries, country clusters are used to obtain cluster corrected standard errors in all firm-level analyses. In the last part of the analyses, to control for size and productivity level of the firms, interaction terms are added into the models.

4.1. Firm-level Export and Import Analyses

Table 1 and Table 2 report quantile regression results from export and import respectively. In both tables, column 1 and column 2 provide OLS estimations without and with firm-level variables. According to the Table 1, the positive effect of GDP and the negative effect of distance on firm-level service export vary over the quantiles. Both impacts become stronger in higher quantiles, showing that firms with higher level of export are more affected by changes

in GDP and distance. Higher level of GDP indicates higher level of demand in importing countries. Demand for more varieties is also increasing as GDP increases. Therefore, firms with higher export values are able to export more varieties as GDPs of partner countries increase. On the other hand, firms with high level of export are harmed from increasing distance between countries. This prediction contradicts with the heterogeneous firm theory which claims that firms with high export values are mostly larger and more productive firms and they are able to handle increasing trade cost as they access more distant destinations. However these firms also face a coordination problem while exporting because, firms with higher export value export to many countries including distant destinations. Other trade cost variables such as time differences between countries, common language and common legislation are insignificant in all quantiles as found in OLS estimations. Common legislation and common language variables are significant only in 25^{th} quantile regression with additional firm-level variables although common language variable has an unexpected sign. The effect of GDP per capita is not varying over different quantiles, however it has an insignificant effect in the 10^{th} quantile showing that firms with low export level are not affected by development level of the trading partners because they trade with fewer countries which are already high-income economies. Regional trade agreements, EU and WTO membership dummies have significantly negative effects on firm-level export for all quantiles except 10^{th} quantile. Negative effects of these variables are increasing for higher quantiles. Models extended with additional firm-level variables have similar pattern as in models without firm-level variables. The effects of all firm-level variables except R&D engagement and LLC dummy are higher for higher quantiles. Firms with high export level are not affected by R&D engagement and its impact is stronger for lower quantiles. This is an expected result if the firms with higher export value have already had R&D engagement. Finally, the effect of being an LLC is changing over different quantiles, and the effect is significantly positive.

Quantile estimations for firm-level import are presented in Table 2. First two columns give OLS estimations without and with firm-level variables. According to the Table 2, among country-level variables only GDP and distance variables have significant effects on firm-level import. The effect of GDP becomes stronger for higher quantiles, showing that economic size of the partner country becomes prominent as import value increases. Since higher GDP in exporting countries shows the countries' ability of producing more varieties, these countries have possibility of having connection with many firms in the UK. The negative effect of

distance is around 2% for the import levels below the median. This effect increases by nearly 60% for the 75th and 90th quantiles, implying that firms with higher import level are affected more by increasing trade cost than firms with lower import. As mentioned in the export analysis, one possible explanation of this result is the increasing coordination costs as firms with high import level trade with many destinations. The development level of exporting countries does not have impact on lower quantiles as found in OLS estimation. However its effect turns into significant for the 75th and 90th quantiles, only firms with high level import are influenced by the development level of the trading partners. Models extended with additional firm-level variables have similar pattern for country-level variables as in models without firm-level variables. The effects of all firm-level variables except firm age and R&D engagement are significantly positive and become stronger as import values of firms increase. Especially the effects of firm size and productivity come into prominence for the firms with high import values. Firm age variable is insignificant in both OLS and quantile estimations. As found in OLS estimation, R&D engagement has negative impact on firm-level import, however it has significant effects for only 25th and 50th quantiles. Negative sign is an expected result if the firms prefer investing in services which require higher technology instead of importing it from other countries. On the other hand, its insignificancy at quantiles above the median can be explained by using the assumption that firms with higher import levels are already big and productive firms and they do not invest in R&D anymore to decrease the import.

4.2. OLS with Interaction Terms

As a complementary for the quantile analyses, in this part of the study, we control for size and productivity level of each firm with interaction terms in order to detect how the effects of GDP and distance on firm-level service export and import depends on firm size and productivity. Table 3 and Table 4 present regressions with interaction terms for export and import respectively. These analyses are repeated with additional firm characteristics and shown in Table 5 and Table 6. Each table consists of seven columns. First column presents OLS results without interaction terms. In columns 2-4, distance variable is interacted with size and productivity while in last three columns, GDP variable is interacted with size and productivity. According to Table 3, all interaction terms have significant effects showing that the effects of GDP and distance on firm-level service export depend on value of firm size and

labour productivity. The negative impact of distance shrinks across levels of firm size and productivity (columns 2-4) while the positive impact of GDP grows across levels of firm size and labour productivity (columns 5-7). This implies that as firms become larger and more productive, distance matters less but importance of economic size of the trading partner increases. However, in the model where GDP is interacted with both variables, it has an unexpected sign Column 7). In Table 5, additional firm characteristics have been added to the models. Accordingly, when we control for the firm characteristics, the effect of distance becomes stronger as firm size increases (column 2) but becomes weaker as firm becomes more productive (column 3). But, in the model where distance is interacted with both variables (column 4), the interaction term between distance and productivity turns into insignificant. Models where GDP is interacted with size and productivity variables show that effect of GDP on service export increases as firm size increases (column 5) but productivity level of firm does not affect the impact of economic size on export values (column 6).

Results from import analyses are given in Table 4 and Table 6. According to Table 4, all interaction terms have significant effects showing that the effects of GDP and distance on firm-level import depend on value of firm size and productivity as well. The negative impact of distance shrinks across levels of firm size and labour productivity (columns 2-4) and the positive impact of GDP grows across levels of firm size and labour productivity (columns 5-7). This implies that as firms becomes larger and more productive, cost of import matters less but the importance of economic size of the trading partners increases. The result related to the economic size of the countries supports the result obtained by quantile regression for firm-level import. However, coefficient shrink for the distance variable contradicts with quantile regression for firm-level import. Again, in the model where GDP is interacted with both variables, it has unexpected sign. In Table 6, additional firm characteristics have been added to the models. Accordingly, when distance and GDP are interacted with only firm size variable (column 2 and 5), both become insignificant. These variables have opposite signs with interaction terms when interacted with productivity (column 3 and 6). This shows that the negative effect of distance and the positive impact of GDP shrink as productivity level of the firm rises. This result is valid for the models which include both interaction terms; however, in model 4, the interaction term between distance and firm size turns into insignificant.

5. Conclusion

During the last two decades, the trade in services becomes prominent in the wolrd economy as well as in the UK economy. The UK is one of the leader countries in trade in services. Therefore it is of great importance to analyse the determinants of service trade flows in this country. On the other hand, an analysis on aggregate trade values might be misleading from the policy perspective since firms engaged in international trade are different from not only non-trading firms bot also the other trading firms. Hence, in this study we analyse the determinants of *firm-level* service trade in the UK. However, if the firms are heterogeneous, the effects of different variables explaining the trade values by firms vary through the distribution of trade. To to observe firm heterogeneity, in this paper, we employ Quantile Regression approach which enables us to examine the impacts of different country- and firm-level variables at different points of conditional distribution of UK's firm-level service export and import.

To detect possible parameter heterogeneity across the distribution of firm-level export and import, quantile regression has been used. Quantile estimations have been repeated for 5 quantiles (10th, 25th, 50th, 75th, and 90th quantiles) and OLS is used as benchmark estimation. Results from firm-level analyses show that the magnitude and significance level of each coefficient are different in each quantile as well as in OLS estimations. The positive effect of GDP and the negative effect of distance on firm-level service export and import become stronger in higher quantiles, showing that firms with higher level of export and import are affected more by changes in GDP and distance. Additional to GDP and distance variables, GDP per capita and colonial relationship, regional trade agreements, EU and WTO membership dummies are also significant in export analyses. The effect of GDP per capita is not varying over different quantiles, however it has an insignificant effect in the 10th quantile showing that firms with low export level are not affected by development level of the trading partners. Regional trade agreements, EU and WTO membership dummies have significantly negative effects on firm-level export for all quantiles except 10th quantile. Negative effects of these variables are increasing for higher quantiles.

Quantile regression results have not been confirmed in OLS estimations with interaction terms. In these analyses, we control for size and productivity level of each firm with

interaction terms in order to detect how the effects of GDP and distance on firm-level service export and import depend of firm size and productivity. If it is true that firms with higher productivity and employment level have higher export and import level since they are able to handle trade costs, it is expected to have increasing positive coefficient for GDP and negative but decreasing coefficient for the distance variable as firm size and productivity increase. These results have been observed in models without firm-level variables with different interaction terms although they contradict with quantile regression results. However, when we control for additional firm characteristics, results become similar to what we obtain in quantile estimations.

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Table 1. Firm-level Export - Quantile Estimations

	(1) OLS	(2) OLS	(3) q10	(4) q10	(5) q25	(6) q25	(7) q50	(8) q50	(9) q75	(10) q75	(11) q90	(12) q90
Log of GDP partner	0.262***	0.281***	0.164***	0.172***	0.274***	0.276***	0.299***	0.320***	0.286***	0.317***	0.321***	0.323***
	(9.42)	(10.40)	(8.91)	(9.41)	(13.04)	(12.34)	(10.46)	(10.11)	(7.73)	(8.62)	(8.72)	(8.66)
Log of GDPPC partner	0.0978***	0.108***	0.0148	0.0352	0.0730**	0.0745**	0.109***	0.112**	0.124**	0.117**	0.122**	0.137***
	(2.68)	(2.81)	(0.50)	(1.45)	(2.24)	(2.31)	(2.89)	(2.24)	(2.38)	(2.53)	(2.25)	(2.71)
Log of distance	-0.375***	-0.413***	-0.354***	-0.266***	-0.393***	-0.352***	-0.411***	-0.446***	-0.409***	-0.497***	-0.389***	-0.494***
	(-5.61)	(-5.85)	(-4.49)	(-6.68)	(-7.31)	(-6.28)	(-4.84)	(-5.52)	(-4.16)	(-4.73)	(-3.88)	(-4.83)
Colonial relationship	0.294**	0.366***	0.318	0.366***	0.278**	0.480***	0.435***	0.517***	0.313	0.321***	0.213	0.161
	(2.59)	(3.39)	(1.63)	(3.29)	(2.39)	(4.28)	(3.39)	(3.66)	(1.60)	(2.75)	(0.85)	(0.63)
Common legislation	0.0237	0.0638	0.0134	0.0658	0.128	0.170**	0.0294	-0.00198	-0.118	0.0283	-0.175	0.0833
	(0.25)	(0.67)	(0.09)	(0.88)	(1.34)	(1.99)	(0.24)	(-0.01)	(-0.75)	(0.30)	(-0.84)	(0.38)
Common language	0.0428	0.0178	0.0465	-0.00515	-0.0213	-0.150*	-0.128	-0.0587	0.133	0.0763	0.218	0.153
	(0.50)	(0.22)	(0.36)	(-0.06)	(-0.22)	(-1.70)	(-1.25)	(-0.61)	(1.23)	(0.74)	(1.49)	(1.17)
Time difference	-0.0214	-0.0220	0.0140	0.0000395	-0.00718	-0.0131	-0.0150	-0.0129	-0.0408	-0.0303	-0.0706*	-0.0618
	(-0.71)	(-0.74)	(0.63)	(0.00)	(-0.28)	(-0.62)	(-0.44)	(-0.32)	(-0.95)	(-0.78)	(-1.73)	(-1.41)
Regional trade agreement	-0.383**	-0.368**	-0.150	-0.157**	-0.301**	-0.202*	-0.433**	-0.393	-0.560**	-0.436**	-0.684***	-0.666***
	(-2.29)	(-2.18)	(-1.20)	(-1.97)	(-2.23)	(-1.77)	(-2.09)	(-1.59)	(-2.35)	(-2.15)	(-3.12)	(-2.78)
GATT membership	-0.380*	-0.402**	-0.175	-0.181	-0.267*	-0.378**	-0.346*	-0.416*	-0.496*	-0.402	-0.478*	-0.525*
	(-1.89)	(-1.99)	(-1.14)	(-1.41)	(-1.85)	(-2.37)	(-1.65)	(-1.87)	(-1.68)	(-1.43)	(-1.90)	(-1.93)
European Union membership	-0.258*	-0.311**	-0.140	-0.0130	-0.183**	-0.161	-0.245*	-0.249*	-0.357*	-0.521***	-0.483*	-0.620***
	(-1.82)	(-2.11)	(-1.58)	(-0.22)	(-2.03)	(-1.55)	(-1.75)	(-1.66)	(-1.87)	(-2.82)	(-1.81)	(-2.81)
Log of # of employees		0.379***		0.238***		0.339***		0.398***		0.464***		0.455***
		(24.84)		(13.33)		(18.10)		(20.90)		(26.97)		(19.68)
Log of labor productivity		0.490***		0.289***		0.420***		0.519***		0.599***		0.555***
		(32.77)		(11.39)		(15.57)		(28.15)		(44.70)		(25.11)
Log of age of the firm		-0.327***		-0.205***		-0.279***		-0.292***		-0.380***		-0.501***
		(-10.76)		(-6.25)		(-6.62)		(-7.29)		(-8.65)		(-8.82)
Dummy for being an LLC		0.741***		0.579***		0.826***		0.795***		0.806***		0.682***
		(13.85)		(12.47)		(12.44)		(9.76)		(10.61)		(7.85)
R&D engagement		0.150***		0.267***		0.258***		0.133***		0.0115		0.0524
		(4.07)		(4.68)		(5.40)		(2.74)		(0.22)		(0.88)
Constant	4.717***	0.982	2.590***	-0.684	3.185***	-0.588	4.553***	0.510	6.377***	2.143**	7.668***	4.238***
	(6.96)	(1.37)	(3.58)	(-1.36)	(5.69)	(-1.04)	(5.31)	(0.60)	(6.46)	(2.03)	(7.71)	(3.94)
N	16252	15726	16252	15726	16252	15726	16252	15726	16252	15726	16252	15726
r2	0.0722	0.173	0.0692	0.165	0.0714	0.169	0.0717	0.172	0.0715	0.171	0.0695	0.168

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table 2. Firm Level Import – Quantile Estimations

	(1) OLS	(2) OLS	(3) q10	(4) q10	(5) q25	(6) q25	(7) q50	(8) q50	(9) q75	(10) q75	(11) q90	(12) q90
Log of GDP partner	0.209***	0.225***	0.106**	0.117***	0.203***	0.197***	0.241***	0.243***	0.243***	0.269***	0.249***	0.281***
	(14.49)	(15.08)	(2.44)	(9.42)	(13.47)	(12.47)	(14.60)	(13.37)	(10.22)	(11.34)	(9.01)	(11.75)
Log of GDPPC partner	0.0411	0.0353	-0.0148	-0.00377	-0.0363	-0.0209	0.0387	0.0383	0.0864*	0.0713	0.0967*	0.0569
	(1.31)	(1.03)	(-0.41)	(-0.15)	(-0.77)	(-0.51)	(0.90)	(0.88)	(1.84)	(1.27)	(1.81)	(0.96)
Log of distance	-0.240***	-0.247***	-0.200**	-0.105**	-0.199***	-0.204***	-0.208***	-0.212***	-0.347***	-0.380***	-0.340***	-0.443***
	(-4.98)	(-5.07)	(-2.52)	(-1.97)	(-4.18)	(-4.04)	(-3.47)	(-3.00)	(-5.39)	(-4.55)	(-3.82)	(-4.22)
Colonial relationship	0.125	0.163	0.130	0.00830	0.0990	0.233*	0.246	0.422*	0.0240	0.147	-0.0970	0.0663
	(0.73)	(0.90)	(0.97)	(0.08)	(0.63)	(1.83)	(1.17)	(1.93)	(0.07)	(0.60)	(-0.21)	(0.12)
Common legislation	0.0347	-0.0292	-0.00216	0.0219	0.0631	-0.100	-0.0956	-0.165	0.0392	-0.0337	0.349	0.0769
	(0.22)	(-0.18)	(-0.03)	(0.28)	(0.45)	(-0.84)	(-0.53)	(-0.78)	(0.12)	(-0.15)	(0.93)	(0.14)
Common language	-0.00300	-0.00677	0.0286	0.120	0.0629	0.00242	-0.00109	-0.144	0.0658	-0.0626	-0.0428	0.0724
	(-0.03)	(-0.07)	(0.29)	(1.43)	(0.57)	(0.03)	(-0.01)	(-1.17)	(0.42)	(-0.43)	(-0.19)	(0.41)
Time difference	-0.00417	-0.0109	0.000612	-0.00693	0.0166	0.00673	0.00180	-0.00791	-0.0140	0.000585	-0.0555	-0.0292
	(-0.17)	(-0.44)	(0.03)	(-0.43)	(0.76)	(0.30)	(0.06)	(-0.27)	(-0.40)	(0.02)	(-1.10)	(-0.65)
Regional trade agreement	-0.144	-0.219	-0.167*	-0.0701	0.0328	-0.0936	-0.123	-0.200	-0.295	-0.321	-0.253	-0.439
	(-1.00)	(-1.57)	(-1.74)	(-0.89)	(0.26)	(-0.69)	(-0.72)	(-1.25)	(-1.38)	(-1.47)	(-0.83)	(-1.41)
GATT membership	-0.0285	0.00939	-0.107	0.0228	-0.0850	-0.0128	-0.123	-0.0415	0.176	0.0462	-0.0246	0.198
	(-0.14)	(0.05)	(-0.84)	(0.26)	(-0.73)	(-0.08)	(-0.52)	(-0.23)	(0.49)	(0.16)	(-0.04)	(0.66)
European Union membership	-0.229	-0.203	0.0546	0.0125	-0.112	-0.166	-0.174	-0.195	-0.380	-0.255	-0.545***	-0.265
	(-1.59)	(-1.23)	(0.24)	(0.11)	(-0.73)	(-1.43)	(-1.05)	(-0.93)	(-1.61)	(-0.72)	(-2.66)	(-1.09)
Log of # of employees		0.179***		0.0321**		0.0935***		0.154***		0.262***		0.360***
		(11.08)		(2.23)		(4.36)		(6.41)		(10.94)		(13.58)
Log of labor productivity		0.271***		0.0576***		0.116***		0.247***		0.423***		0.473***
		(14.89)		(2.84)		(3.60)		(8.94)		(14.03)		(20.91)
Log of age of the firm		-0.0230		0.0751		0.0222		0.00631		-0.0573		-0.123
		(-0.34)		(1.15)		(0.37)		(0.10)		(-0.72)		(-1.42)
Dummy for being an LLC		0.883***		0.435***		0.788***		0.931***		0.997***		0.968***
		(11.87)		(5.81)		(7.34)		(8.53)		(8.69)		(6.24)
R&D engagement		-0.126**		-0.0643		-0.204***		-0.204***		-0.121		-0.0922
		(-2.50)		(-1.17)		(-3.92)		(-2.97)		(-1.46)		(-1.10)
Constant	3.414***	0.583	1.565**	-0.468	2.069***	0.384	2.831***	0.166	4.991***	1.341*	6.649***	2.672**
	(6.57)	(1.00)	(2.39)	(-0.76)	(3.85)	(0.57)	(4.26)	(0.21)	(6.80)	(1.67)	(5.56)	(2.43)
N	13988	13012	13988	13012	13988	13012	13988	13012	13988	13012	13988	13012
r2	0.0389	0.0781	0.0325	0.0657	0.0376	0.0713	0.0385	0.0768	0.0384	0.0765	0.0370	0.0738

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table 3. Firm Level Export: The Effects of Firm Size and Productivity

		Distance interacted with…			GDP interacted with…		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of GDP partner	0.262***	0.262***	0.276***	0.293***	0.141***	0.101***	-0.322***
	(9.42)	(8.98)	(10.24)	(9.99)	(4.55)	(3.13)	(-7.05)
Log of GDPPC partner	0.0978***	0.0969**	0.109***	0.109***	0.0988***	0.109***	0.113***
	(2.68)	(2.60)	(2.99)	(2.82)	(2.65)	(2.94)	(2.88)
Log of distance	-0.375***	-0.461***	-0.519***	-0.896***	-0.384***	-0.389***	-0.417***
	(-5.61)	(-6.52)	(-7.35)	(-11.40)	(-5.68)	(-5.58)	(-5.84)
Colonial relationship	0.294**	0.314***	0.308***	0.367***	0.319***	0.312***	0.374***
	(2.59)	(2.65)	(3.04)	(3.38)	(2.72)	(3.01)	(3.39)
Common legislation	0.0237	0.0151	0.0330	0.0251	0.0178	0.0216	0.0154
	(0.25)	(0.15)	(0.40)	(0.26)	(0.18)	(0.25)	(0.16)
Common language	0.0428	0.0373	0.0334	0.0264	0.0349	0.0388	0.0313
	(0.50)	(0.43)	(0.40)	(0.31)	(0.40)	(0.46)	(0.36)
Time difference	-0.0214	-0.0257	-0.0131	-0.0210	-0.0248	-0.0162	-0.0225
	(-0.71)	(-0.84)	(-0.43)	(-0.68)	(-0.81)	(-0.53)	(-0.71)
Regional trade agreement	-0.383**	-0.408**	-0.334**	-0.372**	-0.398**	-0.370**	-0.400**
	(-2.29)	(-2.38)	(-2.01)	(-2.13)	(-2.32)	(-2.19)	(-2.26)
GATT membership	-0.380*	-0.388*	-0.390*	-0.386*	-0.398**	-0.389*	-0.409*
	(-1.89)	(-1.92)	(-1.88)	(-1.84)	(-1.98)	(-1.85)	(-1.90)
European Union membership	-0.258*	-0.271*	-0.258*	-0.284**	-0.276*	-0.251*	-0.275*
	(-1.82)	(-1.92)	(-1.83)	(-2.03)	(-1.95)	(-1.78)	(-1.96)
Size*Distance		0.0151***		0.0423***			
		(6.69)		(18.49)			
LP*Distance			0.0301***	0.0591***			
			(18.07)	(29.56)			
Size*GDP					0.0238***		0.0543***
					(10.10)		(22.69)
LP*GDP						0.0392***	0.0750***
						(13.97)	(22.31)
Constant	4.717***	4.816***	4.566***	4.739***	4.790***	4.648***	4.781***
	(6.96)	(7.00)	(6.58)	(6.57)	(6.95)	(6.64)	(6.50)
N	16252	16252	15726	15726	16252	15726	15726
r2	0.0722	0.0814	0.0953	0.145	0.0853	0.0924	0.143
F	45.04	38.56	67.00	93.35	42.67	78.90	143.9

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table 4. Firm Level Import: The Effects of Firm Size and Productivity

		Distance interacted with…			GDP interacted with…		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of GDP partner	0.209***	0.213***	0.226***	0.237***	0.133***	0.109***	-0.0788***
	(14.49)	(14.19)	(15.98)	(16.38)	(7.85)	(5.06)	(-2.88)
Log of GDPPC partner	0.0411	0.0404	0.0529*	0.0479	0.0399	0.0565*	0.0530
	(1.31)	(1.27)	(1.66)	(1.47)	(1.25)	(1.77)	(1.61)
Log of distance	-0.240***	-0.287***	-0.371***	-0.529***	-0.234***	-0.258***	-0.248***
	(-4.98)	(-5.55)	(-7.93)	(-9.93)	(-4.87)	(-5.57)	(-5.30)
Colonial relationship	0.125	0.129	0.204	0.193	0.133	0.228	0.232
	(0.73)	(0.77)	(1.12)	(1.09)	(0.80)	(1.26)	(1.32)
Common legislation	0.0347	0.0269	-0.0391	-0.0510	0.0243	-0.0588	-0.0754
	(0.22)	(0.18)	(-0.23)	(-0.31)	(0.16)	(-0.35)	(-0.46)
Common language	-0.00300	-0.00619	-0.0236	-0.0112	-0.00965	-0.0340	-0.0331
	(-0.03)	(-0.06)	(-0.25)	(-0.12)	(-0.10)	(-0.36)	(-0.34)
Time difference	-0.00417	-0.00831	-0.00278	-0.0125	-0.00815	-0.00487	-0.0119
	(-0.17)	(-0.34)	(-0.11)	(-0.51)	(-0.33)	(-0.19)	(-0.47)
Regional trade agreement	-0.144	-0.163	-0.170	-0.201	-0.159	-0.195	-0.213
	(-1.00)	(-1.12)	(-1.24)	(-1.44)	(-1.10)	(-1.40)	(-1.50)
GATT membership	-0.0285	-0.0515	0.0142	-0.0111	-0.0529	-0.00520	-0.0319
	(-0.14)	(-0.26)	(0.07)	(-0.06)	(-0.27)	(-0.02)	(-0.16)
European Union membership	-0.229	-0.232	-0.205	-0.205	-0.229	-0.206	-0.199
	(-1.59)	(-1.63)	(-1.25)	(-1.27)	(-1.61)	(-1.28)	(-1.24)
Size*Distance		0.00915***		0.0217***			
		(3.88)		(9.87)			
LP*Distance			0.0258***	0.0365***			
			(12.75)	(18.97)			
Size*GDP					0.0149***		0.0265***
					(8.75)		(15.00)
LP*GDP						0.0253***	0.0375***
						(8.05)	(11.14)
Constant	3.414***	3.423***	3.304***	3.302***	3.395***	3.349***	3.304***
	(6.57)	(6.51)	(6.64)	(6.47)	(6.48)	(6.59)	(6.40)
N	13988	13988	13012	13012	13988	13012	13012
r2	0.0389	0.0416	0.0565	0.0682	0.0442	0.0511	0.0646
F	50.93	46.71	79.54	86.25	49.12	71.02	94.62

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table 5. Firm-Level Export: The Effects of Firm Size and Productivity, with additional firm-level variables

		Distance interacted with…			GDP interacted with…		
	(1)	(2)	(3)		(1)	(2)	(3)
Log of GDP partner	0.281***	0.281***	0.281***	0.281***	0.210***	0.291***	0.138**
	(10.40)	(10.51)	(10.40)	(10.46)	(6.67)	(8.76)	(2.60)
Log of GDPPC partner	0.108***	0.108***	0.108***	0.108***	0.109***	0.108***	0.110***
	(2.81)	(2.83)	(2.84)	(2.83)	(2.85)	(2.81)	(2.87)
Log of distance	-0.413***	-0.304***	-0.490***	-0.338***	-0.412***	-0.413***	-0.412***
	(-5.85)	(-4.03)	(-5.37)	(-3.02)	(-5.85)	(-5.85)	(-5.84)
Colonial relationship	0.366***	0.363***	0.365***	0.364***	0.367***	0.365***	0.368***
	(3.39)	(3.38)	(3.39)	(3.38)	(3.42)	(3.39)	(3.41)
Common legislation	0.0638	0.0648	0.0642	0.0648	0.0654	0.0642	0.0642
	(0.67)	(0.68)	(0.67)	(0.68)	(0.69)	(0.67)	(0.68)
Common language	0.0178	0.0184	0.0171	0.0181	0.0160	0.0175	0.0165
	(0.22)	(0.22)	(0.21)	(0.22)	(0.19)	(0.21)	(0.20)
Time difference	-0.0220	-0.0209	-0.0217	-0.0209	-0.0216	-0.0219	-0.0220
	(-0.74)	(-0.70)	(-0.73)	(-0.70)	(-0.73)	(-0.74)	(-0.74)
Regional trade agreement	-0.368**	-0.365**	-0.364**	-0.364**	-0.361**	-0.367**	-0.365**
	(-2.18)	(-2.16)	(-2.16)	(-2.16)	(-2.15)	(-2.17)	(-2.16)
GATT membership	-0.402**	-0.401**	-0.403**	-0.402**	-0.409**	-0.402**	-0.411**
	(-1.99)	(-1.98)	(-2.00)	(-1.99)	(-2.03)	(-1.99)	(-2.04)
European Union membership	-0.311**	-0.312**	-0.313**	-0.313**	-0.312**	-0.312**	-0.311**
	(-2.11)	(-2.12)	(-2.12)	(-2.12)	(-2.12)	(-2.12)	(-2.11)
Log of # of employees	0.379***	0.543***	0.380***	0.527***	0.300***	0.380***	0.269***
	(24.84)	(6.84)	(24.75)	(5.99)	(8.27)	(24.82)	(5.83)
Log of labor productivity	0.490***	0.488***	0.346***	0.444***	0.485***	0.503***	0.427***
	(32.77)	(31.30)	(4.26)	(4.90)	(32.02)	(17.59)	(10.78)
Log of age of the firm	-0.327***	-0.328***	-0.328***	-0.328***	-0.328***	-0.327***	-0.327***
	(-10.76)	(-10.80)	(-10.80)	(-10.80)	(-10.67)	(-10.77)	(-10.60)
Dummy for being an LLC	0.741***	0.737***	0.739***	0.737***	0.736***	0.740***	0.737***
	(13.85)	(13.85)	(13.82)	(13.84)	(13.84)	(13.90)	(13.84)
R&D engagement	0.150***	0.150***	0.150***	0.150***	0.147***	0.150***	0.148***
	(4.07)	(4.07)	(4.04)	(4.06)	(3.95)	(3.99)	(3.96)
Size*Distance		-0.0211**		-0.0190*			
		(-2.13)		(-1.68)			
LP*Distance			0.0182*	0.00556			
			(1.69)	(0.45)			
Size*GDP					0.0137**		0.0189***
					(2.53)		(2.74)
LP*GDP						-0.00234	0.0104
						(-0.43)	(1.47)
Constant	0.982	0.139	1.579*	0.407	1.402*	0.927	1.810**
	(1.37)	(0.19)	(1.95)	(0.45)	(1.86)	(1.30)	(2.24)
N	15726	15726	15726	15726	15726	15726	15726
r2	0.173	0.173	0.173	0.173	0.173	0.173	0.173
F	138.0	126.1	154.4	133.5	139.5	126.9	149.0

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table 6. Firm-Level Import: The Effects of Firm Size and Productivity, with additional firm-level variables

		Distance interacted with…			GDP interacted with…		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of GDP partner	0.225***	0.225***	0.227***	0.227***	0.0144	0.364***	0.122***
	(15.08)	(15.27)	(15.53)	(15.52)	(0.32)	(10.50)	(2.91)
Log of GDPPC partner	0.0353	0.0358	0.0350	0.0354	0.0352	0.0324	0.0339
	(1.03)	(1.06)	(1.04)	(1.05)	(1.04)	(0.95)	(1.00)
Log of distance	-0.247***	-0.00915	-0.532***	-0.352***	-0.247***	-0.248***	-0.248***
	(-5.07)	(-0.10)	(-6.01)	(-3.02)	(-5.16)	(-5.10)	(-5.16)
Colonial relationship	0.163	0.169	0.157	0.162	0.171	0.146	0.161
	(0.90)	(0.94)	(0.87)	(0.89)	(0.94)	(0.81)	(0.89)
Common legislation	-0.0292	-0.0327	-0.0282	-0.0303	-0.0238	-0.0158	-0.0186
	(-0.18)	(-0.20)	(-0.17)	(-0.18)	(-0.14)	(-0.09)	(-0.11)
Common language	-0.00677	-0.0148	-0.00441	-0.00921	-0.0142	-0.00181	-0.0104
	(-0.07)	(-0.15)	(-0.04)	(-0.09)	(-0.14)	(-0.02)	(-0.11)
Time difference	-0.0109	-0.00875	-0.0112	-0.00997	-0.00697	-0.00920	-0.00698
	(-0.44)	(-0.36)	(-0.46)	(-0.41)	(-0.29)	(-0.38)	(-0.29)
Regional trade agreement	-0.219	-0.211	-0.209	-0.206	-0.191	-0.201	-0.188
	(-1.57)	(-1.52)	(-1.50)	(-1.49)	(-1.39)	(-1.46)	(-1.37)
GATT membership	0.00939	0.0117	0.0116	0.0125	0.0150	0.0201	0.0189
	(0.05)	(0.06)	(0.06)	(0.06)	(0.07)	(0.10)	(0.09)
European Union membership	-0.203	-0.198	-0.210	-0.206	-0.198	-0.205	-0.200
	(-1.23)	(-1.21)	(-1.28)	(-1.26)	(-1.20)	(-1.24)	(-1.21)
Log of # of employees	0.179***	0.503***	0.180***	0.358***	-0.0700	0.183***	-0.0175
	(11.08)	(4.57)	(11.39)	(3.46)	(-1.55)	(11.48)	(-0.45)
Log of labor productivity	0.271***	0.268***	-0.252**	-0.163	0.257***	0.460***	0.349***
	(14.89)	(14.56)	(-2.18)	(-1.47)	(15.02)	(9.73)	(7.57)
Log of age of the firm	-0.0230	-0.0256	-0.0321	-0.0319	-0.0271	-0.0316	-0.0303
	(-0.34)	(-0.38)	(-0.46)	(-0.46)	(-0.40)	(-0.46)	(-0.45)
Dummy for being an LLC	0.883***	0.885***	0.881***	0.882***	0.894***	0.879***	0.889***
	(11.87)	(11.98)	(11.70)	(11.79)	(12.21)	(11.59)	(12.02)
R&D engagement	-0.126**	-0.130**	-0.131**	-0.133***	-0.135***	-0.140***	-0.139***
	(-2.50)	(-2.58)	(-2.60)	(-2.62)	(-2.68)	(-2.76)	(-2.76)
Size*Distance		-0.0424***		-0.0233			
		(-2.74)		(-1.65)			
LP*Distance			0.0674***	0.0558***			
			(4.28)	(3.82)			
Size*GDP					0.0384***		0.0306***
					(5.39)		(5.90)
LP*GDP						-0.0312***	-0.0146**
						(-3.80)	(-2.01)
Constant	0.583	-1.239*	2.802***	1.418	1.973***	-0.247	1.303**
	(1.00)	(-1.92)	(3.16)	(1.52)	(2.89)	(-0.46)	(2.16)
N	13012	13012	13012	13012	13012	13012	13012
r2	0.0781	0.0793	0.0802	0.0805	0.0808	0.0798	0.0811
F	66.71	76.32	79.07	76.03	93.84	57.06	90.15

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; t-statistics are calculated based on cluster-robust standard errors.

Table A 1. Explanation of Variables Used in the Model

	Explanations	Variable	Sources	Expected Sign
Dependent Variables	UK firm level export to the trading partners	Export	ITIS	
	UK firm level import from the trading partners	Import	ITIS	
	UK firm total export/import to/from the trading partners	Total export/import		
	Number of firms exporting and importing	Number of firms		
	Average export/import value per firm	Average export/import		
Explanatory Variables	GDP of trading partner (current mn US$)	GDP partner	CEPII	+
	GDP per capita of trading partner (current mn US$)	GDPPC partner	CEPII	+
	Population-weighted great circle distance between large cities of the UK and her trading partners	Distance	CEPII	-
	Number of hours difference between the UK and her trading partner	Time difference	CEPII	+/-
	Dummy variable for colonial relationship; 1 if the UK and her trading partner ever in colonial relationship	Colonial relationship	CEPII	+
	Dummy variable for common legislation; 1 if the UK and her trading partner have common legal origin	Common legislation	CEPII	+
	Dummy variable for Common language; 1 if a language is spoken by at least 9% of the population in the UK and her trading partner	Common language	CEPII	+
	Dummy variable for regional trade agreement; 1 for regional trade agreement in force between the UK and her trading partner	Regional trade agreement	CEPII	+
	Dummy variable for GATT/WTO membership; 1 if the UK and her trading partner are members of GATT/WTO	GATT membership	CEPII	+
	Dummy variable for EU membership; 1 if the UK and her trading partner are members of EU			
	Total number of employees, point in time	# of employees	ARD	+
	Gross value added per employee	Labor productivity	ARD	+
	Research and development engagement dummy: 1 if the firm is engaged in R&D activities	R&D engagement	ARD	+
	Age of the firm	Age of the firm	BSD	+/-
	Dummy for legal status of the firm; 1 is the firm is an LLC	LLC	BSD	+

Table A 2. Size and productivity in different quantiles of trade_value variable

	Acc. to export quantiles				Acc. to import quantiles			
		obs	**mean**	**std.dev.**		**obs**	**mean**	**std.dev.**
employment	<q10	2034	1040.77	11981.08	<q10	2343	783.68	5717.69
	q10-q25	2197	825.84	6426.22	q10-q25	1205	866.53	7731.86
	q25-q50	3958	1222.11	12824.45	q25-q50	3453	744.61	4817.13
	q50-q75	4004	1973.37	18795.38	q50-q75	3506	704.65	4607.13
	q75-q90	2435	1042.04	8153.97	q75-q90	2084	718.52	1829.65
	>q90	1624	4084.87	29316.01	>q90	1397	1376.74	7603.65
LP	<q10	2034	430.82	1910.44	<q10	2343	378.38	7025.59
	q10-q25	2197	813.69	18573.7	q10-q25	1205	277.71	2194.71
	q25-q50	3958	1004.94	15313.68	q25-q50	3453	508.09	9773.61
	q50-q75	4004	2772.91	27171.39	q50-q75	3506	1248.71	17565.59
	q75-q90	2435	5849.59	41192.95	q75-q90	2084	3005.39	29374.37
	>q90	1624	15199.21	67106.25	>q90	1397	15527.81	68302.39
trade value	<q10	2034	1.413	0.492	<q10	2343	1.416	0.493
	q10-q25	2197	4.686	1.425	q10-q25	1205	3.428	0.495
	q25-q50	3958	18.338	7.945	q25-q50	3453	10.238	4.222
	q50-q75	4004	84.129	38.048	q50-q75	3506	47.677	22.932
	q75-q90	2435	361.248	151.179	q75-q90	2084	224.864	101.573
	>q90	1624	4539.695	13865.73	>q90	1397	2799.873	7880.028