Charles University in Prague

Faculty of Social Sciences
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MASTER'S THESIS

The Elasticity of Trade with Respect to Trade Costs: A Meta-Analysis

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, May 18, 2017

Signature

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Abstract

The goal of this thesis is to present a meta-analysis of studies that are focused on the relation between the international trade flow and the trade costs. The effect of trade costs has become one of the key elements to resolve the six major puzzles in the bilateral trade flow. I examine 1,090 estimates of the trade cost effect reported in 58 studies, codify 51 aspects of study design that may influence the estimates. I use meta-regression analysis to investigate why trade costs effects vary. The results suggest that different methods and mainly data characteristics systematically affect the estimated trade costs effects. I find evidence for publication selection bias by using the appropriate tests. The authors of primary studies tend to report preferentially large estimates of the elasticity of trade with respect to trade costs. The evidence for publication selection bias is stronger for studies reported in peer-reviewed journals than for unpublished studies.

JEL Classification C81, C83, F10, F15
Keywords meta-analysis, international trade, gravity equation, trade costs

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Abstrakt

Cílem této práce je představit meta-analýzu studií zabývajících se vztahem mezi mezinárodním obchodem a jeho náklady. Vliv těchto nákladů se stal jednou z nejdůležitějších součástí, které pomáhají vysvětlit základní proměnné ovlivňující objem mezinárodního obchodu. Celkově jsem nasbírala 1090 odhadů z 58 různých studií. Celý dataset jsem rozčlenila podle 51 aspektů metodologie a testovala případnou heterogenitu v rámci jednotlivých odhadů. V této práci ukazuji, že používání různých metod a především využívání různých databází ovlivňuje publikované efekty obchodních nákladů. Během testování jsem narazila na problém publikačního vychýlení. Autoři jednotlivých studií mají tendenci prezentovat přednostně větší odhady nákladů obchodu. Přítomnost publikační selektivity je výraznější v publikovaných studiích než v ostatních zdrojích.

Klasifikace JEL	C81, C83, F10, F15
Klíčová slova	metaanalýza, mezinárodní obchod, gravitační zákon, obchodní náklady

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Contents

List of Tables

List of Figures

Acronyms

ER Exchange rate

FAT Funnel asymmetry test

FTA Free trade agreement

GMM Generalized method of moments

MRA Meta-regression analysis

NTB Non-tariff barriers to trade

OLS Ordinary least squares

OECD Organisation for Economic Co-operation and Development

PPML Poisson pseudo-maximum likelihood

REStat The review of economics and statistics

TFP Total-factor productivity

2SLS Two-stage least squares

Master Thesis Proposal

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Proposed topic	The Elasticity of Trade with Respect to Trade Costs: A Meta-Analysis

Motivation

During the last years, the topic of international trade and its relation with the different variables has long been attracted for economists. As Head and Mayer (2013) noticed, for the estimation of those variables many economists used gravity equation of bilateral trade. The trade cost elasticity of trade does not stand aside. Trade costs play an important role in some specific models, for instance economic geography model (Krugman, 1991). He also presented that trade costs are also used for forming the optimal trade arrangements related to the size and natural trade barriers. Head and Mayer (2013) recognized that the elasticity of wage in the origin country is closely related to the elasticity with respect to trade costs in many studies taking into account a gravity equation. Number of studies that are focused on the topic of trade cost elasticity has been on the increase. Researchers have tried to find out the answer to the following question: How a change in the trade costs will change bilateral trade (Simonovska 2012). They compute the elasticity to identify how the international trade agreement will influence aggregate trade. Additionally, this elasticity also explain the trade discrepancy between two countries. The aim of this thesis is to collect the estimates from these studies and provide a quantitative analysis. For this purpose, I will use the meta-analysis. Searched economic studies might differ in various aspects, such as methodology, data sets, time periods, etc., and some of these can explain the uncertainties in results. Meta-analysis has attracted more economists, who applied meta-analytical tools in various kind of sphere, for instance Mayer et al. (2009) on the effect of foreign direct investments, Havranek (2010) on the trade effect of currency unions, or Havranek and Irsova (2015) on boarder effect on trade.

Hypothesis

1. Hypothesis #1: The methodology used (between, within heterogeneity, publication bias, etc.) can explain the diversity in results of particular studies.
2. Hypothesis #2: The literature estimating the elasticity of trade with respect to trade costs is affected by publication bias
3. Hypothesis #3: The magnitude of publication bias vary within different publication characteristics.

Methodology

In my diploma thesis, I will deal with various meta-analytical tools. The first application of meta-analysis was in medicine - by Karl Pearson in 1904, the procedure was created as a way how to deal with small sample sizes. Later on meta-analysis was used in another scientific disciplines to summarize and evaluate empirical results from various studies in the same topic. Stanley and Jarrel (1989) firstly applied this method in economics. Meta-analysis is and approach which possess an advantage over classical literature review as it is more detailed quantitative review, it provides more systematic procedure in data and literature analysis, because it combines empirical results from many different studies and thus increases the explanatory power. Additionally it can provide information about publication bias (Stanley, 2001). The first step of this method is the collection of data from primary studies. I will use Google Scholar and RePEc database to find these studies. Since meta-analysis of this topic has not been made yet, I will start to create a dataset that would be convenient for subsequent application of meta-analytical tools. Apart from testing of between and within heterogeneity among studies, I will focus my diploma thesis to test the possible occurrence of publication bias. Publication bias is a situation when researchers prefer for either publishing result to go with the same direction as a theory or if they publish only statistically significant results. This issue might occur in different areas of research. For testing publication bias, we need estimates that should be selected on the basis of standard errors (precisions) and not on the ground of particular sign of the effect or its statistical significance (Stanley et al. (2010). As Goldfarb (1995) or Stanley et al. (2008) presented, I assume that relevance of publication bias decrease in time.

Outline

1. Introduction
2. Theoretical Overview - Elasticity of trade with respect to trade costs
3. Methodology Used
4. Empirical Analysis (MRA, Publication bias)
5. Results (Discussion of the results)
6. Conclusion (Summary of my findings an their implications for future research)

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Author Supervisor

Chapter 1

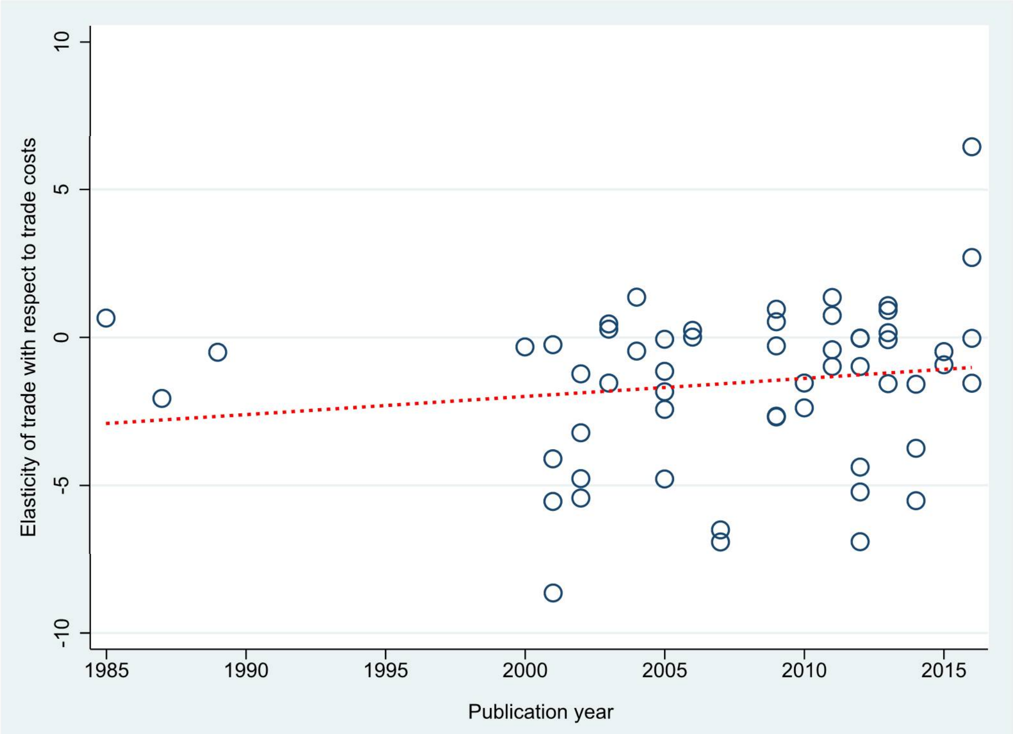
Introduction

The effect of trade costs has become one of the key elements explaining the bilateral trade flows. Obstfeld & Rogoff (2001) noticed that the trade cost effect helps to resolve the six major puzzles in international macroeconomics, for instance the border effect that was already investigated by Havranek & Irsova (2015). An importer or exporter encounter trade costs during the whole process of trade starting from collecting information about market conditions and ending with final payment (De 2006). The trade flow process contains certain number of related trade costs: policy barriers (tariff and non-tariff barriers), transport costs (freight and transit costs), costs related to different language or different currency, information costs, or retail and wholesale distribution costs (Anderson & Van Wincoop 2004). Recent researchers have reported the negative impact of the trade costs on the international trade flow.

The most commonly used model to estimate the effect of trade costs on the international trade represents the gravity equation. Figure 1.1 shows the trade cost effects reported in the studies applying the gravity model. The trade cost effects do not converge only to a single value. The dispersion of the estimates around the average number, represented by the red line, might be caused mainly by including different explanatory variables within the gravity model. The authors of a particular study have tried to explore the most economic significance of these trade costs that might vary according to various aspects - applying of different methods, adding different explanatory variables into the model, using data from different database and many others. A growing number of resources has also provided the results that are rather more specific.

I apply the framework of meta-analysis to investigate the effect of trade cost on the bilateral trade flows. The meta-analysis represents the quantitative

Figure 1.1: The reported trade cost effects



Notes: The figure presents median estimates of the distance coefficient reported in each primary study. The horizontal axis depicts the year, when study appeared in Google Scholar. The red line presents the time trend.

method of literature synthesis (Stanley & Jarrell 1989). This statistical method has been initially used in medicine. In recent years the application of the meta-analysis has been spread to other fields, especially to the economics. The importance of the meta-analysis has been rising with increasing number of studies related to a particular research.

The only other quantitative research on the same topic was explored by Head & Mayer (2013), who revealed the mean and the median of the estimates of the whole sample. They also detect the potential heterogeneity within primary studies on the basis of the model and identifying the diversity in values of variable. They constructed a database of 750 estimates from 32 studies, which indeed contains the studies that for example do not report the standard error that I need for further investigation.

The intention of my thesis is the widening of the dataset and using other methods of meta-analysis to detect potential heterogeneity within studies. For the reason that Head & Mayer (2013) present only basic summary statistics, I have included the appropriate tests for revelation of the publication bias. My dataset consists of 1090 estimates taken from 58 studies. I have collected 51 aspects of the studies such as characteristics of the data in particular studies, characteristics of the applied methods, controlling variables, information from the publication outlet, number of citations and many others. I explore the impact of individual variables on the estimates of the trade cost effect.

The remainder of the thesis is ordered as follows. Chapter 2 describes the importance of trade costs in the international trade and discusses the potential discrepancies among different kinds of trade costs. In Chapter 3 I explain the theoretical approach and the commonly used methodology that investigate the elasticity of trade with respect to trade costs. Chapter 4 describes the rationalization of applying the meta-analysis and draws the attention to frequently repeated criticism. Chapter 5 shows the collected data from studies and discusses the different characteristics of the dataset. In Chapter 6 I test the presence of publication bias within studies. Chapter 7 explains why trade cost effects vary and investigates particular sources of the heterogeneity. Chapter 8 concludes the thesis. Appendix A provides a list of primary studies included in the meta-analysis. In Appendix B I include the additional results.

Chapter 2

Why trade costs matter

Recently, the researchers have been searching for diverse variables that have an important impact on the international trade. There are several groups of these variables. One group of the variables represents trade costs. Their enlargement is indeed highly significant. As Anderson & Van Wincoop (2004) argue, trade costs find many economically efficient magnitudes and patterns across countries or regions and also across various goods. We can simply define the trade costs such as all costs that arise before the goods arrive to the final customers. We do not include the marginal costs to the total amount of the costs, since they are related to the production of the goods. Anderson & Van Wincoop (2004) highlight the importance of trade cost.

2.1 Importance of trade costs

1. The main importance of trade costs arises from their above mentioned enlargement. Anderson & Van Wincoop (2004) estimated ad-valorem tax equivalent of trade costs for rich countries is approximately 170% total trade barrier, including local distribution costs (55%) and international trade costs (74%).

2. Obstfeld & Rogoff (2001) apprised another importance. If we include trade costs into the most standard international macroeconomics models, we can resolve many of empirical puzzles such as the home bias in trade puzzle, the home bias inequities puzzle, or the low consumption correlations puzzles.

3. Anderson & Van Wincoop (2001) explored third importance that is the effect of estimated total trade costs on trade and welfare among different organisations (for example among OECD countries or NAFTA). They refer the large influence of the trade costs on the national income.

4. The following importance represents the relationship between trade costs and policy barriers. Anderson & Van Wincoop (2004) argued that economic policy, such as regulations, languages, transport infrastructure investments, property rights institutions, etc. have a greater significance than direct policy instruments (tariffs, quotas, trade costs related to the exchange rate system).

5. Many researchers (for example Krugman (1990); Davis (1997); and Limao & Venables (2001)) inform about the link between trade costs and economic geography.

We can find other characteristics to determine why the trade costs influence the international trade. Most of them are specifically linked to various types of trade costs. In the subsequent part of this chapter, I am going to distinguish trade costs with their further importance to the international trade.

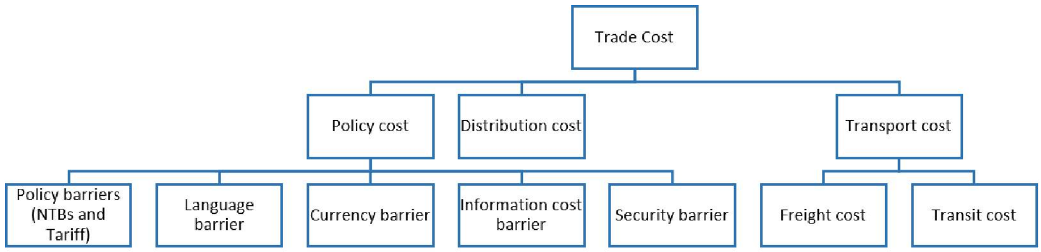
2.2 Different types of trade costs

Trade costs can be separated in different ways. O'Rourke & Williamson (2001) in the review of their historical evidence separate trade costs into two major groups, costs incurred by the transport (insurance, time costs, or transport cost itself), and the costs incurred by trade barriers (tariffs and quotas). Anderson & Van Wincoop (2004) follow O'Rourke & Williamson (2001) and describe the direct evidence of trade costs on transport costs, policy barriers, and distribution costs with their limitations that appear during their measurement. They warn about trade costs, mainly those linked to the information costs and contract enforcement that are not possible to measure. Figure 2.1 describes their division in detail.

2.2.1 Policy cost

Policy costs include tariffs, quotas, import license fees, foreign exchange taxes, stamps, etc. This group brings many difficulties in the measurement, because of

Figure 2.1: The division of trade costs.



Notes: The figure presents the division of trade costs according to Anderson & Van Wincoop (2004).

the inaccuracy that appears during collecting of dataset. Anderson & Van Wincoop (2004) describe in their study about trade cost the limitations of United Nations Conference on Trade and Developments Trade Analysis & Information System (TRAINS) that gather panel data on policy to trade. TRAINS does not currently record the specific tariffs in the form of the ad-valorem tax equivalent. The other measurement issue appears within the classification of the tariffs that usually differ from the classification of goods or commodities. Importance of policy barriers arises due to the existence of deviations of tariffs across goods in all countries. Many researchers report these variation in their study, for example Anderson & Neary (1994), Harrigan (1993), or Haveman & Hummels (1999).

2.2.2 Transport cost

Costs related to transportations include primarily freight rates (influenced by the type of transport- ships, trains, trucks, and aircrafts). Subsequently, among the transport costs belong insurance, inventory costs, or travel time costs. Limao & Venables (2001) find their dependence on geography, administrative barriers, infrastructure, and the organization of the shipping industry. They also inform about the importance of trading countries and the countries through which the trade passes. Unlike the policy cost, the measurement of transportation costs does not cause common occurrence of errors, even though its variation across countries. Anderson & Van Wincoop (2004) argue that although transport costs have a tendency to be higher in large agriculture products, they are comparable in average magnitude and in variability across countries and commodities.

2.2.3 Distribution cost

Among distribution costs belong wholesale and retail costs that affected prices of goods in each region, or country. Even though many researchers were convinced about its small effect, Burstein *et al.* (2003) prove the opposite. In their study about the distribution cost and real exchange rate (Burstein *et al.* 2003), they report that distribution services are focused on labour and land, thus they constitute the link between prices of the same good in different countries. They also pay an attention how the distribution cost can explain puzzles in the international macroeconomics. It highlights the other importance of the trade costs, since these puzzles profit from informations gained on the variation of distribution margins within different countries.

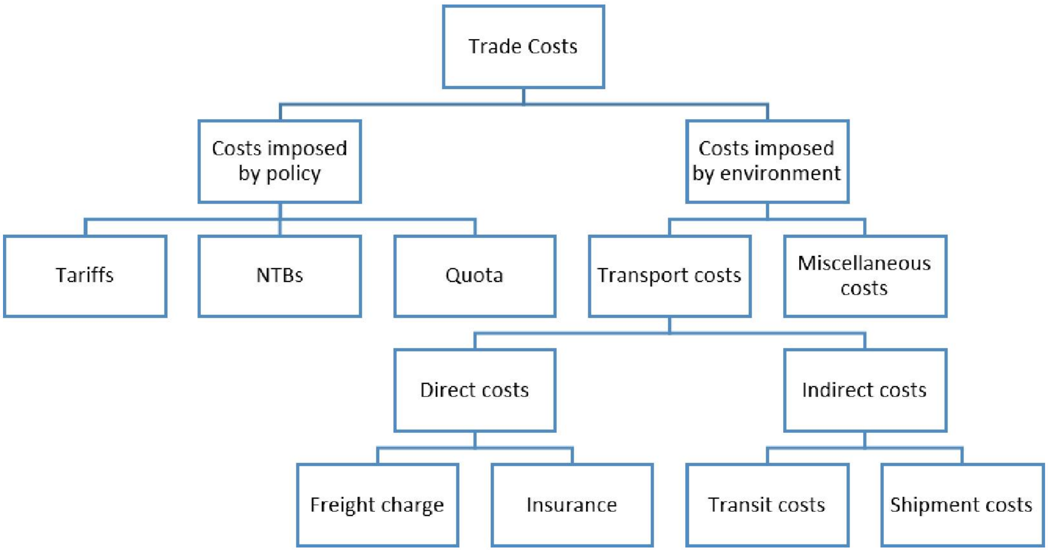
2.3 Distribution according to the literature

In recent years researchers have been more interested in how to measure trade cost relating to the international trade. The growing number of studies, however, has taken into consideration different kinds of trade costs. De (2006) customized the division of trade cost described in Figure 2.2. This distribution has governed greater part of the literature. As shown in Figure 2.2, De (2006) divided the trade cost by their nature only into two components. First, trade costs imposed by policy include tariffs, NTBs and quota. The next component contains the trade cost imposed by the environment (transport and others).

Tariffs represent extra revenues for governments and domestic producers and so an expense of consumers and foreign producers. Governments thus impose tariffs to protect domestic producer from the competition in the international trade. In general, consumers purchase the good which is cheaper. Bown & Crowley (2016) noticed that high income countries tend to have lower number of trade barriers than low income countries. It implies that small countries have lower trade barriers than large countries (Rodrik 1998). Bown & Crowley (2016) also described distribution of trade costs. The most common impositions of trade barriers are on agriculture goods. The other important sector are manufactured goods such as textiles, apparel and footwear which governments protect by the above mentioned trade barriers.

Currently, tariffs have been declined but countries have increased their interest in imposing non-tariff barriers (NTBs). NTBs are policy barriers that restrict trade flows of goods or services through different mechanism than tariff

Figure 2.2: Trade costs and its components



Notes: The figure presents the division of trade costs according to De (2006) who considers he combination of direct observation and inferred costs in Figure 2.1 as an extremely rough breakdown.

barriers. By including the NTBs countries regulate international trade, support weak industries and compensate industries that have been negatively influenced by reduction of tariff barriers. NTBs gain the popularity due to the ability of interest parties to affect the process with lack of opportunities to gain government support to impose the tariffs. With the increasing consumer demand for environmentally friendly products, the applying of technical barriers to trade (one kind of NTBs) has also recorded certain growth. The United Nations Conference on Trade and Development (UNCTAD) nevertheless alerts to the fact that there are many kinds of NTBs. Thus, even if one kind of NTBs detects its growth in recent years (such as already mentioned TBT), use of other NTBs has contrarily decreased.

NTBs can be divided into different subgroups and researchers mostly customize its division. I follow the division outlined by De (2006), who separated a quota as an individual subgroup of policy barriers. They explained that even if quotas often belong among NTBs, there are discrepancies in its measurement. Quotas as tariffs, and NTBs are imposed due to the need to control the bilateral trade flow. Tariffs are imposed primarily due to their usability in the international trade. Foreign organizations enable countries to monitor and examine the tariffs applied for a particular item. Currently, NTBs are replacing tariffs and we can regard NTBs as a new form of protection. As I mentioned previously NTBs serve to protect people and natural resources in the country. In addition, by applying quotas countries can effectively reduce the quantity of goods to be imported. Deardorff & Stern (1997) clarified the statement and explained that some trade flow regression measures get better with quotas, since these measures tend to depend on the quantities rather than prices. The only difficulty is that quotas are not steadily binding and it is not always possible to specify appropriate functional forms for regression models.

Even though the trade costs are broadly defined, the growing literature has been emerged in structural modelling of trade costs (Anderson & Van Wincoop 2004). In the following chapter I am going to explain similar models used for exploring of the impact of trade costs on the international trade.

Chapter 3

Theoretical background

3.1 Elasticity of trade with respect to trade costs

'*Quantitative results from a large class of structural gravity models of international trade depend critically on a single parameter that governs the elasticity of trade with respect to trade frictions,'* (Simonovska & Waugh 2014).

The elasticity of trade with respect to trade costs is the parameter that many authors have already considered important (Anderson & Van Wincoop (2004); Arkolakis *et al.* (2012); or Yi (2003)). Additionally, it is one of the key concept to explain trade behaviour during the changes in tariffs, welfare gains or losses, or the magnitude of the barriers to trade (language barriers, information asymmetry, or for example exchange rate deviations). Simonovska & Waugh (2014) argue that the estimation of the parameter is not so simple due to the fact that the international trade models can rationalize small trade flows with small trade frictions and large elasticities or vice versa. A gravity equation offers the usual way to estimate the elasticity of trade across diverse quantitative trade models, and thus, it provides the common method to calculate welfare gains from the international trade (Arkolakis *et al.* 2012). Actually, the welfare prediction can be affected only by two statistics when their macro level limitations hold. The first statistic is observable (the share of expenditure on local goods, which is measured using the import ratio), and the second that measures the elasticity of trade with respect to the trade costs, can be estimated using the gravity equation for international trade (Head & Mayer 2013).

3.2 Gravity equation in economy

In 1962 Jan Tinbergen applied the functional form of Newton's Law of Universal Gravitation into the trade flows (Head 2006). The gravity equation have the same interpretation as in physics:

$$F_{ij} = G\frac{Y_i^{\alpha}Y_j^{\beta}}{D_{ij}^{\theta}} \tag{3.1}$$

where

- F_{ij} is the trade flow from the region or country i to destination j.
- Y_i and Y_j are the economic size of the regions or countries
- D_{ij} is the distance between the regions or countries
- G replaces the gravity constant; represents all other bilateral indicators
- α,β and θ stand for the elasticities to be estimated

Head & Mayer (2013) describe that if the F_{ij} measures the export values (or other monetary flows), then Y signifies the gross domestic product or the gross nominal income of each country. He further informs about the multiplicative nature of the gravity equations that enable to take natural log forms and obtain the linear relationship between the international trade flows, the economy sizes and distances. The transformed form of gravity equation can be rewritten as follows:

$$\ln F_{ij} = \alpha \ln Y_i + \beta \ln Y_j - \theta \ln D_{ij} + \ln G + \varepsilon_{ij} \tag{3.2}$$

where the error term ε_{ij} enable the equation to be estimated by ordinary least square regression (Head & Mayer 2013). The gravity equation, either the simple version, or its deriving form has been plentifully used in various spheres of the international trade. Thanks to the application of gravity equation the researchers are able to explain the relationship between trade flows and other variables. Most of them were focused to answer the question how the distance effect influences the international trade (Leamer & Levinsohn (1995) and Wei & Frankel (1998)). In the following part of Chapter 3 I am going to explain different models how the gravity equation is linked to the elasticity of trade with respect to trade costs.

3.3 Gravity equation in international trade

Indeed, the gravity equation has been widely used across various studies related to the international trade. The fundamental approach to the equations is the 'gravity-based' estimates. The researchers focused their study on trade elasticities, involved regressing bilateral trade on measures of bilateral trade costs or on exporter wages and productivity (Head & Mayer 2013). The regression they used can be expressed as follows:

$$\ln X_{ni} = \ln E_i + \ln M_n + \varepsilon \ln \tau_{ni} + \varepsilon_{in} \quad (3.3)$$

where

- E_i captures all abilities of the exporter i as a supplier to final destinations
- M_n represents all characteristics of destination market that support imports from all origins
- τ_{ni} measures the overall impact of trade flows, measured in terms of ad-valorem tariff rate
- ε is the partial elasticity of bilateral imports with respect to trade costs
- ε_{in} is the disturbance term (country-pair specific parameters that differ from trade costs).

Head and Mayer (2013) provide broad definition of the gravity-based method, which is sufficient to cover estimates derived from international trade on proxies of exporter wages, prices, and exchange rates. Besides the gravity-based estimates, there are two other important approaches. One of the methods describes how to estimate the Armington[1] elasticity (σ) by using GMM (the generalized method of moments) via heteroscedasticity. The Armington theory implies that goods produced in different location basically represent imperfect substitute by virtue of their origins. The elasticity of trade with respect to trade cost (ε) can be estimated by the expression 1-σ. This method was applied by Feenstra (1994) and Broda & Weinstein (2004).

The second method shows how to estimate the trade elasticity (ε) using the deviations of price gaps. Meaning that various trade models have different impact on the distribution of price gaps, implying different elasticity of

[1] An Armington elasticity represents the elasticity of substitutions between products of two locations assumed that products within the international trade are differentiated by country of origin (Armington 1969).

trade. The second method, devised by Eaton & Kortum (2002), influences many studies, primarily Simonovska & Waugh (2014). In contrast to the first method, the authors reflect the heterogeneity of goods in production rather than in consumption. They focus on the dependency of the trade cost and geographic barriers on the technology. I will describe their model of estimating the elasticity in further detail.

3.4 Estimating the elasticity of trade

To estimate the elasticity, the authors need to find a convenient way, where the trade frictions are independent on trade flows. Eaton & Kortum (2002) developed a Ricardian model of international trade encompassed to the attitude of geography. The model accounts all benefits arising from the comparative advantage, which supports the bilateral trade, and from geographic barriers, which contrarily delimit it. The geographic barriers incorporate transport cost and even policy barriers. The model provides the link between bilateral trade flows and both the deviation from the purchasing power parity and technology or geographic barriers. From these two relations the authors, Eaton & Kortum (2002), estimated the parameters required to get the international trade equilibrium.

Simonovska & Waugh (2014), following the model developed by Eaton & Kortum (2002), refined the idea that the maximum price deviation across goods between regions or countries can be used as a proxy for bilateral trade frictions. The price diversity among countries is an important parameter, as it is bounded by the bilateral trade frictions through no-arbitrage arguments. Simonovska & Waugh (2014) used a new simulated method of moment's estimator for the trade elasticity, which against the method of Eaton & Kortum (2002) presents the result formally and quantitatively measures the bias, found in finite samples of price data, by using Monte Carlo simulations. The bias results from the underestimation of the trade cost with positive probability and the overestimation of the trade cost with zero probability. The presence of the bias caused that the trade elasticity is located above the true parameter. If the sample size acquire large size, it is difficult to recognize this distortion, as the Eaton & Kortum (2002) model will estimate an elasticity of trade lying closely to the true effect. Thus, the presence of the bias can be eliminated, when the sample size is sufficiently large.

Simonovska & Waugh (2014) devise a method of moment's estimator that can be applied when the sample size is small. Their model, which like previous model is based on the Ricardian theory, is formed by the following equation:

$$\ln \frac{\frac{X_{ni}}{X_n}}{\frac{X_{ii}}{X_i}} = -\varepsilon \ln(\tau_{ni}) - \varepsilon \ln(P_i)\varepsilon \ln(P_n) \tag{3.4}$$

where X_{ni}/X_n stands for the fraction of income that country n spent on imports from the location i, or generally the trade shares. Similarly, an expression X_{ii}/X_i reflects the home trade share. τ_{ni} is the trade costs, assuming τ_{ni} is less than 1 for ni with τ_{ii}. P_i and P_n are the prices of goods in the origin country i and the destination n, respectively. Equation (3.4) contains the crucial parameter determining the trade flow, ε. It measures the sensitivity of the bilateral trade of two countries to a change of the trade cost (τ_{ni}). This parameter standing for the elasticity of trade is important, as it describes how a bilateral trade agreement will influence the international trade.

Simonovska & Waugh (2014) present the meaning of the elasticity of trade for welfare. They define that the parameter ε constitutes the inverse of welfare elasticity with respect to local expenditure shares:

$$\ln(P_n) = -\frac{1}{\varepsilon} \ln \frac{X_{nn}}{X_n} \tag{3.5}$$

The authors by equation (3.5) express how to measure the effect of international trade on welfare. It is enough to gather data on realized local expenditures and an estimate of the trade elasticity. The elasticity ε is the key parameter in any quantitative study related to the world trade.

3.5 Naive and structural gravity equations

In prior sections I showed how the gravity equation could vary across particular studies. This diversity was properly defined in Cookbook of the gravity equation introduced by Head & Mayer (2013). They define three forms of the gravity equation whose distinction can be useful in the following meta-analysis. The first definition is closely related to the physical interpretation of equation (3.2), termed as 'general gravity'.

The general gravity includes the set of models that consider bilateral trade equation expressed as

$$x_{ni} = GE_i M_n \varepsilon_{ni} \tag{3.6}$$

The meaning of variables that are used in equation (3.6) are already known from the previous chapters, as well the expression ε_{ni} represents a bilateral accessibility of n to exporter i, $0 \leq \varepsilon_{ni} \leq 1$. It considers trade costs with their respective elasticity to detect the overall impact on trade flows.

The next crucial definition explains the term of the 'structural gravity' that includes the subset of the general gravity models in which the bilateral trade is expressed as

$$x_{ni} = \frac{Y_i}{\omega_i} \frac{X_n}{\vartheta_n} \varepsilon_{ni} \tag{3.7}$$

The proportion Y_i/ω_i stands for the variable E_i, where $Y_i = \Sigma_i Y_{ni}$ is the value of production and ω_i is the multilateral resistance term. The proportion X_n/ϑ_n contrarily deputizes the variable M_n, where $X_n = \Sigma_i X_{ni}$ is the value of the importer's expenditure on all origin countries. The variable ϑ_n represents the multilateral resistance term as well. Head & Mayer (2013) defined the structural gravity in more detail and explained all its modifications used in different studies. They notice researchers apply specified form[1] of trade costs, described in Chapter 2. They show how the variables vary when the authors estimates the structural gravity by using different methods, such as fixed effects, GMM or 2SLS. The structural gravity varies also by disaggregation within different sectors or different countries.

By the cognition, Head & Mayer (2013) divide the structural gravity into two groups. The first group represents 'demand-side' models where the exogenous wage compounded with constant returns to scalper constant trade margins neutralizes the supply side of the model. Among demand-side derivations they classified the models based on the following assumptions: CES National product differentiation (Anderson-Armington), CES Monopolistic competition (Dirit-Stiglitz-Krugman), CES demand with CET production and Heterogeneous consumers. The second group of models is called 'supply-side' due to the fact that distributional assumptions used in these models (Pareto or Frechet) demand-side terms are in the last step eliminated from the formulation. Among supply-side derivations they categorized models assumed Heterogeneous Indus-

[1]The iceberg model is a simple economic model of trade costs. The model defined by Samuelson (1954) and further employed by Krugman (1991) adopt the idea that costs of transporting goods should be paid with a share of the transported goods, more likely than any other sources.

tries (Ricardian Comparative Advantage) and Heterogeneous firms. The last definition introduces the term 'naive gravity' that considers the bilateral trade as

$$X_{ni} = GY_i^{\alpha}Y_n^{\beta}\varepsilon_{ni} \tag{3.8}$$

The naive gravity is more restrictive than definitions derived from theory and includes the fact that bilateral trade should be roughly proportional to the product of country size. Krugman (1991) noted that theoretical foundation for the definition of the naive gravity insert the unlikely restrictions that ε_{ni} is constant. This restriction excludes the requirement of the multilateral resistance terms but cannot be reconciled with convincing evidence that trade cost differ across bilateral pairs. The omission of the control for the multilateral resistance term called as gold medal mistake[2] appears mainly before Anderson & Van Wincoop (2004).

So far, I have presented a number of trade costs and diversity of models used to define the elasticity of trade with respect to trade costs. For the reason that a growing literature have provided mixed results, I apply the framework of meta-analysis.

[2]The term 'gold medal mistake' is introduced by Baldwin & Taglioni (2007) and represents the problem that arises as the omitted terms are correlated with the trade-cost term. The correlation biases the estimate of trade costs and all its factors.

Chapter 4

Meta-analysis Methodology

4.1 Meta-analysis and publication bias

Meta-analysis is a statistical method that is used to combine results from a number of different studies and attempts to integrate and explain the resources about some specific important parameter (Stanley & Jarrell 1989). The method has long been applied in various scientific areas (from health to social sciences) for summary and quantification of results (Nelson & Kennedy 2009).

Glass (1976) was the first to devise the concept of meta-analysis through a study related to psychotherapy, where he gathered analysis results from primary studies for the purpose of integrating the findings. Even though he became the first who used the term meta-analysis, the first attempts of making quantitative research had been done long before. Simpson & Pearson (1904) were the first who collected data from different clinical studies. They collected data for soldiers who were and were not vaccinated against typhoid fever and analysed them (O'Rourke 2007). Glass (1976) is widely recognized as the first modern pioneer of meta-analysis, however, the methodology they used pre-dates their work by decades in studies such as Cochran (1937).

The aim of this method is to explore the factors that affect results of studies addressing the same issue. It solves the deviation of research results using econometric methods. It is based on data gathering from number of studies that share certain statistics. At the beginning it is necessary to show the right statistics that would fit and explain the issue of interest. This statistics should be frequently used in published studies focused on the topic and included its standard errors or another statistics from which standard error can be calculated (Stanley 2005). In many cases this is the most important step in a process of meta-analysis. Meta-analysis is an analytical interpretation of results of single studies with various or even opposite methods of examination (Hunt 1997). The method can explain, why different studies vary, however it is not easy to figure out what factors and study characteristics influence the results the most. It primarily attempts to eliminate a subjectivity of inference within particular studies.

The researchers also widely applied meta-analysis in economic sphere because it is closely related to detection and quantification of publication bias. They analyse the relationship between estimates from studies and their standard errors. In case of the absence of publication bias these two should not be correlated. For a scientist it is very important to have published as many studies as possible in different reviewed scientific journals. The statistical significant results are for the researchers so important that they tend to distort the data to get the required outcomes. Publication bias occurs in case, when editors, reviewers or scientists prefer statistically significant results, successful experiments or confirmation of their own proposed or preferred theories (Stanley 2005).

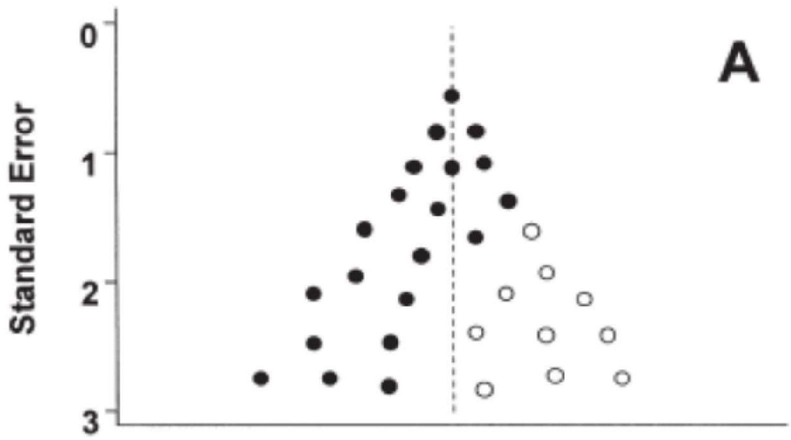
4.2 Funnel plots

The presence of publication bias can be detected by several methods. One of the preferred and common used method represents the funnel plot. Funnel plots are basic scatter plots for visualising publication and other bias in meta-analysis. They treat effects estimated from individual studies against a measure of study size. Effects of individual studies are on horizontal axis, while the vertical axis measures the estimates precision, the inverse of the standard error (Nelson & Kennedy 2009). It is used primarily as a visual aid for detecting bias or systematic heterogeneity.

The name of the chart comes from its ideal shape that should adopt a funnel shape in the optimal case. The chart without any bias is supposed to look like an inverse funnel, what is shown in Figure 4.1. The results from studies with smaller amount of samples scatter widely at the lower part of the graph, while the more important studies with larger impact lie in narrower part of the plot at the top of the graph. An absence of the funnel shape notifies a presence of publication bias.

In ideal case the results are randomly and symmetrically (normal distribu-

Figure 4.1: A hypothetical funnel plot



Notes: A hypothetical funnel plot without any publication bias. Absence of open circles points to an absence of publication bias (Sterne *et al.* (2000)).

tion) arranged around the true value of the studied effect (shown as a dashed line in Figure 4.2). Various shapes of the funnel plot can be used for description of heterogeneity. For example, if there is the second type of publication bias is present, the graph will be very wide and hollow - thus with no studies in the middle. Additionally, if the funnel plot has several peaks, it implies the heterogeneity of estimated effect (Havranek *et al.* 2015). The theory of funnel plot comes from the assumption that there is only one true effect value. Thus, if the assumption is not met, the deviation of the funnel shape does not necessarily mean publication bias.

4.3 Funnel asymmetry test

Because of the possible shortcomings, it is needed to enhance the graphical approach by the explicit regression test. The funnel asymmetry test (FAT) can be described as an inverse version of the funnel plot. The horizontal axis of the FAT indicates the standard errors instead of precision (the inverse of the standard errors). Thus, the FAT arises combining of the econometric models devised by Stanley & Jarrell (1989) with publication bias investigation. This combination can be rewritten into the following model

$$b_j = \beta + \beta_0 se_j + \sum_{k=1}^{K} \alpha_k Z_{jk} + \varepsilon_j \qquad (4.1)$$

where β stands for the population value, β_0 measures the level of publication bias, and se_j is the standard error. The variables Z_{jk} stand for various factors, such as information about model, number of observations, or for example the output of the publication.

Stanley (2005) informs about the occurrence of error-in-variable bias that arises by measurement of the standard error, se_j, with an error term. The issue can be eliminated by using a method of instrumental variables (IV), with an instrument of the square root of the sample size, or number of degrees of freedom. The method enables consistent estimation under assumptions that the explanatory variables are correlated with the error terms and exogenous in the model. Ordinary least square regression cannot be longer used since results biased and inconsistent estimates. Nevertheless, Stanley (2005) notes that it is important to realize the level of correlation between se_j and $\sqrt{n}$, IV regression may not always return unbiased estimates.

While collecting the data, one can notice that primary studies mostly use different data sets, different models, and different explanatory variables. Thus, the disturbance term ε_j is unlikely to be homoscedastic. Stanley & Jarrell (1989) determine that even though the estimates remain by using OLS unbiased and consistent in any case, the standard error estimates will be biased. Thus, the occurrence of heteroscedasticity influence the researchers who will focus on the reported t-statistics. For the correction of heteroscedasticity Stanley (2008) suggests to apply WLS method.

$$t_j = \beta \frac{1}{se_j} + \beta_0 + \sum_{k=1}^{K} \alpha_k Z_{jk} \frac{1}{se_j} + \vartheta_j \tag{4.2}$$

The dependent variable in this model represents t-statistics, such as a standardized measurement of the parameter of interest. Nevertheless, Doucouliagos *et al.* (2006) argue that equation (4.2) is not sufficient for the socio-economic phenomenon, the economic research, which is more complex than publication selection. They define a general model to detect publication bias using additional moderator variables.

$$t_j = \beta \frac{1}{se_j} + \beta_0 + \sum_{i=1}^{I} \gamma_i S_{ji} + \sum_{k=1}^{K} \alpha_k Z_{jk} \frac{1}{se_j} + \vartheta_j \tag{4.3}$$

Equation (4.3), using to estimate and test the publication bias, becomes the successful MRA framework. A vector S_{ji} stands for moderator variable that influence the magnitude of the selection bias. In addition, an expression Z_{jk}/se_j represents the moderator variables having an impact on the magnitude of the published results.

Stanley *et al.* (2007) present the simple version of equation (4.3) that is not related to Heckman model. The model likewise test the presence of publication bias, however against the Heckman meta-regression, it is much simpler. The authors claim quadratic form of standard errors implies the asymmetry as follows

$$t_j = \beta \frac{1}{se_j} + \beta_0 + \vartheta_j \tag{4.4}$$

This modified version of the FAT helps the researchers to estimate the true effect via the whole sample size.

4.4 Criticism of meta-analysis

The criticism of meta-analysis has raised within the increasing number of studies. It is mainly related to the data gathering, where some mistakes might have appeared. Nelson & Kennedy (2009) present that even though the whole process of meta-analysis seems simple, its quality is often neglected.

The criticism in general may have negative impact on meta-analysis. One of the weaknesses of meta-analysis is derived from the quality of the primary studies. Meta-analysts aspire to be as objective as possible, they collect data from all available studies without examining their quality (Glass 1976). They calculate the average from a large number of low quality studies and small number of high quality studies. As their meta-analysis has the same quality as the estimates they used, the 'polluted' data set might make the outcome controversial. To moderate the criticism there is an sollution suggested by Slavin (1986). It is the alternative method, called best-evidence synthesis. His method combines all studies that use the highest the internal and external validity and meta-analytic review by not being too distant but still involving tools that are objective.

The other source of criticism arises from merging different kinds of studies in the same analysis (Wolf 1986). The meta-analysts focusing on a summary effect may ignore the fact that a true effect can vary across particular studies. The total effect might disregard differences emerging from diverse outcomes or explanatory variables across primary studies. Another shortcoming can arise in differences of used unit. The aim of meta-analysis lies in examining certain number of effects in the study, thus, the researchers engaged are particularly focused on the summary of effects and ignore the heterogeneity that makes their results meaningless.

The last and simultaneously one of the most discussed criticism represent the presence of publication bias. Publication selection bias arises when researchers of primary studies prefer statistically significant results (Stanley 2005). In addition, the meta-analysts should measure the publication bias within all primary studies, since the publication bias may occur within all studies no matter what is the level of their treatment effect. A situation, when researchers often omit some studies is called the file drawer problem of meta-analysis. This mistake that the publication bias is not related to the narrative review might be easier to ignore (Borenstein *et al.* 2009).

Chapter 5

The dataset of the trade cost effects

5.1 The estimates of trade cost effects

The collection of data ranks among the initial and particularly crucial part of every meta-analysis. In recent years an interest in the variables that influence the international trade has been rising. In my Bachelor thesis (Tlusta 2015) I was focused on meta-analysis concerning the effect of distance on the international trade. During the collection of dataset I detected that researchers also explore what impact have trade costs on the bilateral trade. Arkolakis *et al.* (2012) state that the gravity equation is a simple way how to calculate welfare gains from trade. Head & Mayer (2013) then emphasize that the elasticity of trade is one of the sufficient statistics required (when their macro restrictions hold). It can be estimated applying the gravity equation on the international trade. The second statistics is the import ratio, vice versa directly observable.

Until now, the meta-analysis that properly investigates the studies that are related to the elasticity of trade with respect to trade cost has not been made yet. Head and Mayer (2013), nevertheless, in their Cookbook about the gravity equation devote inter allia to exploring gravity estimates of policy impacts. The authors collected a dataset of estimates of important trade effects other than distance by using the dataset of meta-analysis developed by Disdier & Head (2008) that served also as the starting point for my bachelor thesis. Their final dataset consists 159 studies and more than 2500 estimates, but relatively few of the papers estimate trade cost elasticities, exactly 32 of them. Except for the gravity based estimates there are two other relevant approaches that I have already described in Chapter 3, that are also included in dataset. One of the approach, developed by Feenstra (1994), represent the estimation of the 'Armington' elasticity by using GMM method via heteroscedasticity. The second approach, devised by Eaton & Kortum (2002), estimates the elasticity by relating trade flows to price gaps.

The major part of the gravity based estimates is derived from the regressions of equation (3.1). The authors of collected studies, within meta-analysis known as primary studies, use different method to estimate the trade elasticity with respect to trade costs or the exporter 'competitiveness' such as wage, exchange rate, prices and productivity. The definition of the equation is broad enough to additionally include the estimates derived from regression of the international trade on that proxies for exporter competitiveness.

Head & Mayer (2013) explain further the implementation of the competitiveness based estimates in two different ways. One of the approaches at first estimates the exporter and then put the certain regression on wages. The method was used in a very precise form by Eaton & Kortum (2002). As I have already described in Chapter 3, the wage expresses the elasticity that is the same or similar to the elasticity of trade with respect to trade cost in most forms of the gravity equation. The second approach stands for the idea to directly estimate equation (3.1) applying the determinants of E_{ij}, including wages. This method among other employed by Costinot *et al.* (2011) and regresses log of exports on log of productivity that they expressed by producer prices data (based on perfect Ricardian theory).

5.2 The collection of dataset

Trade cost effect represents the shortened term for the elasticity of trade with respect to bilateral trade cost and is focused in more than 32 papers. Since the original dataset consists only data from 2005 and from dataset of Disdier & Head (2008) I decided to extend it on other gravity-estimates from missing studies related to the elasticity of trade with respect to trade cost. Even if Head & Mayer (2013) used Econlit for the collecting of data my data source was a RePEc database. The RePEc is one of the largest bibliographic databases of economics research and it closely collaborates with the American Economic Association's EconLit database.

I use 'gravity and trade cost' as search query for titles, or keywords of papers listed in the database. I proceed the division of trade cost described in Figure

2.2 and I also use the following search query constantly for titles, or keywords of studies: 'gravity and trade and tariff', 'gravity and trade and quota', 'gravity and trade and non-tariff (or NTB)', 'gravity and trade and freight charge (or freight cost)', 'gravity and trade and transit cost', 'gravity and trade and shipment cost'. The search yields 282 studies since 1985. The total quantity of primary studies was reduced since some of the studies, mainly related to NTB, include only theoretical part of the research. I read the abstracts of the all studies and downloaded only those that might contain empirical estimates of the trade cost effect on the international trade. I stopped the search of primary studies on December 15, 2016.

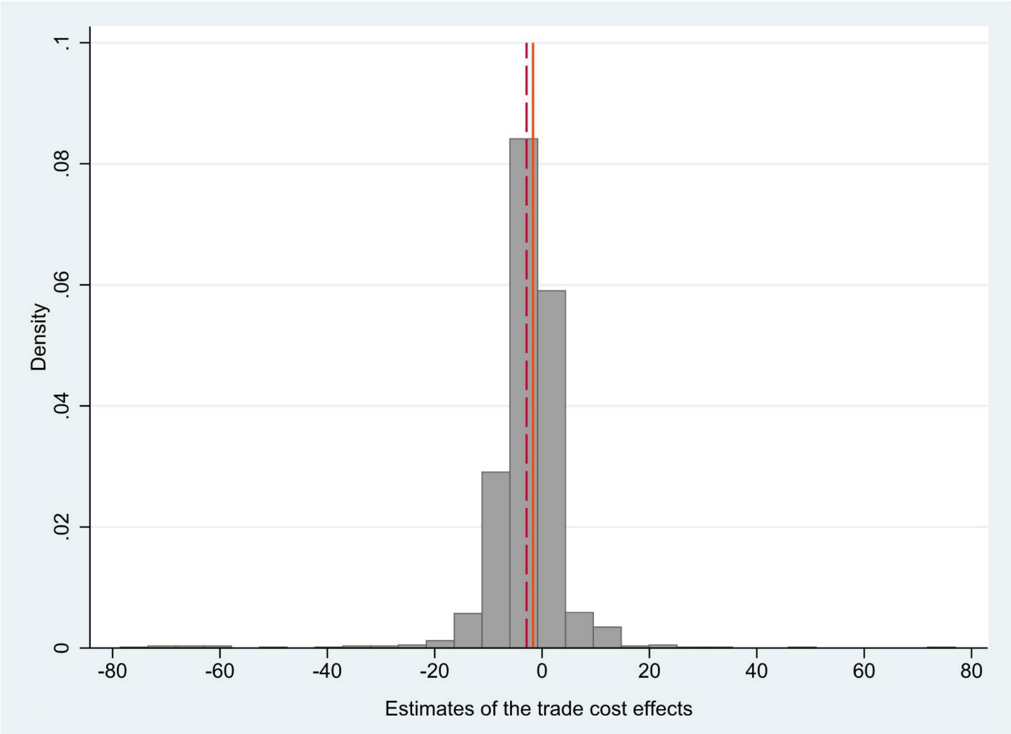
Creating a good sample size is needed for keeping the objectivity of the meta-analysis unbiased. I applied a few inclusion criteria to keep an appropriate dataset. Since half of primary studies are collected by Head & Mayer (2013), who partly use the dataset from Disdier & Head (2008), in addition to other I adopted the inclusion criteria that were used in their meta-analysis. Firstly, I exclude all studies relating to the bilateral trade between large countries and its small territories. These studies contain only the elasticity of trade with respect to trade costs within the framework of a particular country, whereas my thesis focused on the international trade. Some studies, such as Thursby & Thursby (1987), disaggregate the empirical results due to individual countries. However, the study still does not explore the trade cost within that country but between the country and rest of the world.

Secondly, my dataset includes only English studies. While the search queries are composed of the English world, I did not have to omit any studies due to language barriers that would defend me. Since Head & Mayer (2013) or Disdier & Head (2008) did not investigate a publication bias within primary studies, they include into the dataset also studies without estimates of standard errors.

Finally, I remove all studies that do not report the estimates of standard errors or statistics from which standard errors can be derived. The standard errors represent a key component for investigation of publication bias as main part of the meta-analysis. The dataset contains 1114 estimates with a large range from -78.6 to 76.97.

Figure 5.1 depicts the histogram of the estimated elasticity of trade with respect to trade costs. Most of the estimates are negative. The positive estimates represent about 21% of all elasticities, but only 5% has higher elasticity than 2. The median estimate is a bit different from the overall mean and is equal to -1.6. The median estimate of the median elasticities reported in primary studies

Figure 5.1: Trade cost effects differ across studies.

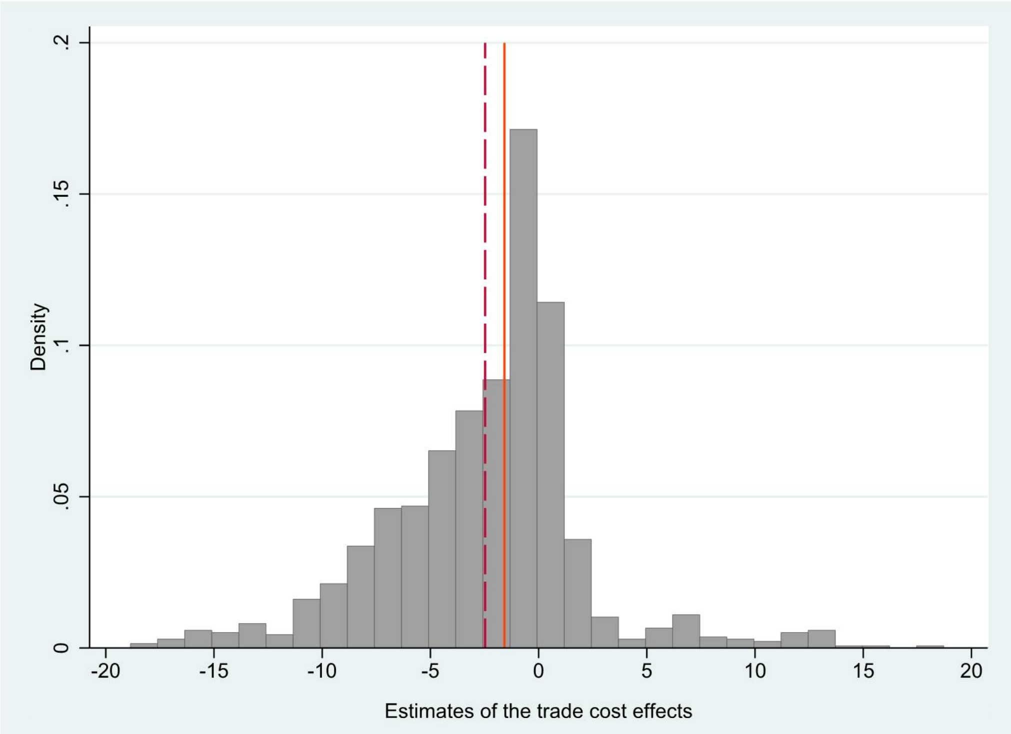


Notes: The figure represents a histogram of the estimates of the trade cost coefficient reported in the individual studies. The solid vertical line indicates the median of all the estimates. The long-dashed line indicates the median of median estimates from individual studies. The histogram contains the outliers that will be further eliminated.

is equal to -2.1, which is closely similar to the mean of the estimates weighted by the inverse number of estimates reported in individual study (-1.83). Even if the mean and median estimate are relatively close, the shape of the histogram shows that there are some outliers in both side of my data set, so I exclude all estimates that exceed 30 in their absolute value. I eliminate 14 estimates included in the following studies: Caliendo & Parro (2014), Erkel-Rousse & Mirza (2002), Hertel *et al.* (2007), Hummels (1999) and Nahuis (2004). The histogram 5.2 shows the distribution of reported estimates without the above mentioned outliers.

The list of 58 primary studies that met all of the selection criteria is available in Appendix A. The updated dataset contains 1090 estimates collected from 18 working papers and 40 refereed journals. The first study that has explored the effect of trade cost on the international trade was published in 1985 and measured the effect of trade cost in the form of the exchange rate. The fact that the research for the effect of trade cost on the international trade has become more popular in recent years confirm the number of citations of particular

Figure 5.2: Distribution of trade cost effects

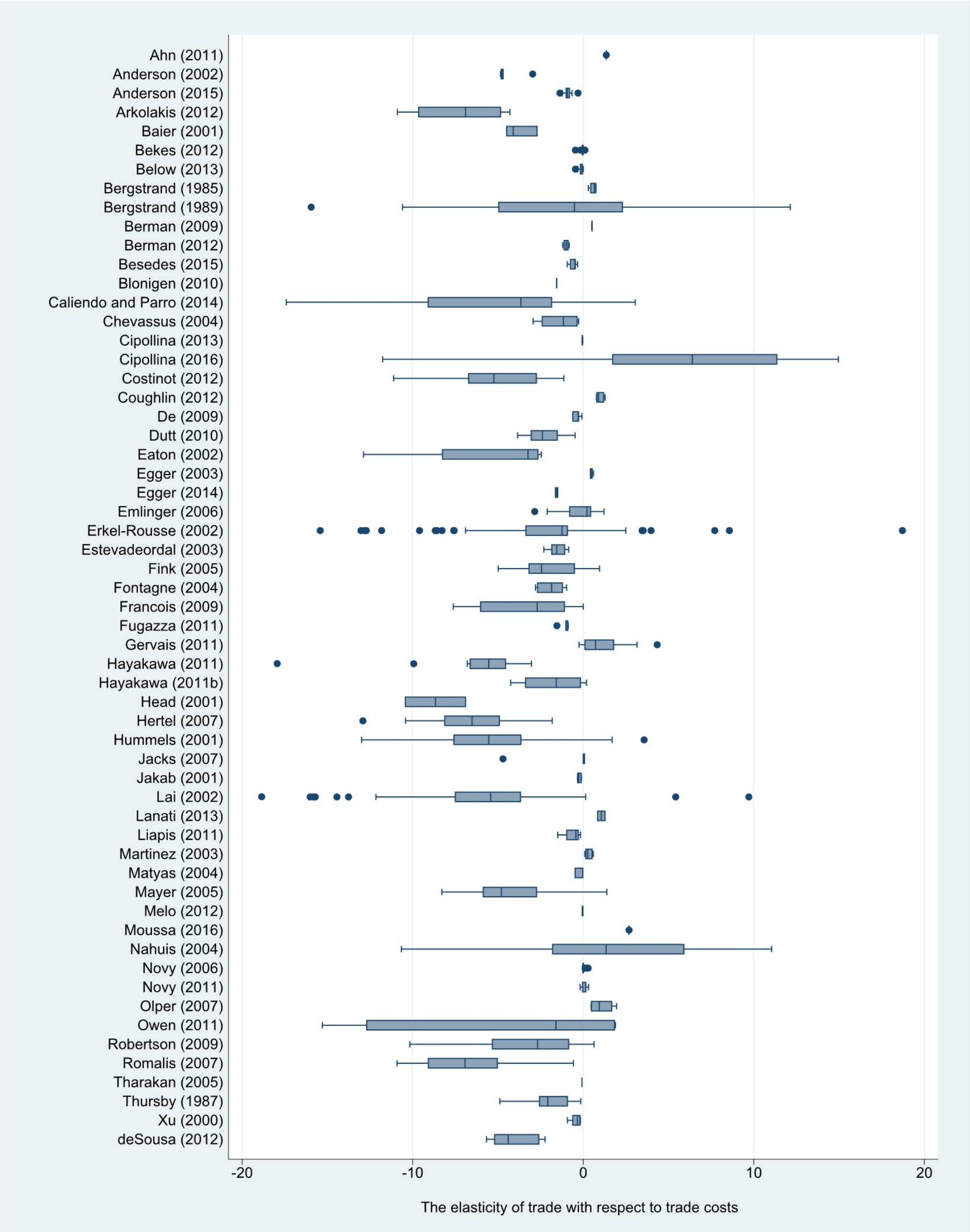


Notes: The figure represents a histogram of the estimates of the trade cost coefficient reported in the individual studies without outliers reported the estimates above 20 (in their absolute value). The solid vertical line indicates the median of all the estimates. The long-dashed line indicates the mean of estimates from individual studies.

studies. Together the primary studies have counted almost 3 000 citations in Google Scholar. The number of citations is not so significant since the recent studies have not frequently been cited yet.

The trade cost effect sample is shown in Figure 5.3. The box plot is instrumental in the depicting of the heterogeneity both between and within primary studies through the quartiles of the estimates. The box plot determines minimum, first quartile, median, third quartile, and maximum of the estimate of the individual study. The vertical line stands for the second quartile, the median, which passes centrally through the box. Individual points then signifies outliers. Box plots help to determine different skewness patterns of the estimated data. The data that are concentrated on the high end of the scale can be skewed left, contrarily the data concentrated on the low end might signify their skewed right. The most of the primary studies presents negative estimates ranged between -5 and 0.

Figure 5.3: The division of trade costs.



Notes: The figure presents a box plot of the estimates of the trade cost coefficient reported in the individual studies. The box indicates interquartile range with median highlighted by the vertical line. The individual points signifies the outliers. Full reference of the primary studies are available in the Appendix A.

Table 5.1: Descriptive statistics of the elasticities of trade in gravity equations

Estimates:	Median	Mean	s.d.	No. of est.
Full sample	-1.58	-2.47	4.65	1090
Naive gravity	-4.86	-4.73	3.39	150
Structural gravity	-1.19	-2.11	4.72	940
Split structural estimates by:				
Estimation method				
FE	-1.21	-2.25	4.91	756
Ratios	-0.91	-1.54	3.81	184
Identifying variables				
Tariffs/Freight rates	-2.19	-2.56	5.21	630
Price/Wage/ER	-0.9	-1.22	3.95	310

Notes: The table represents the mean and median of reported estimates and shows the diversity that arises by application of different kind of the gravity model. This statistics is adopted by Head & Mayer (2013), who made the same investigation of their dataset.

5.3 Potential heterogeneity within primary studies

The estimates of the price elasticities that I have collected differ in many circumstances; for example in methods, models, or the different explanatory variables. Many authors report their prefer estimates within studies, however in many cases it is impossible to select those. In addition, by collecting all estimates I avoid one of the criticism of meta-analysis related to its objectivity. Havranek & Irsova (2015) noticed that using several estimates per study let the meta-analysts employ study-level fixed effects, which eliminate the number of characteristics that might be distinctive to a particular study.

Head & Mayer (2013) refer one of the approach that cause a diversity within primary studies and divide their dataset on the basis of a kind of gravity equation applied in a particular study. I have already described a different kinds of the gravity equation in Chapter 3. I follow the strategy of Head & Mayer (2013) and determine whether the authors of the primary study used naive or structural form of the gravity model. Table 5.1 shows the evidence of immense difference within the estimates, since the standard deviation is twice as large as the average. Thus, Table 5.1 reports also the median of the estimates to eliminate the impact of outliers and falls the elasticity from -2.47 to -1.58. In addition, results in Table 5.1 shows how the median and the mean of the estimates vary within different gravity models. The negative gravity represents more significant negative effect of trade costs on the international trade. Nevertheless, the structural gravity method brings a much greater response of trade flows to price shifter.

I divide the data applying the structural gravity by two different characteristics. Firstly, I distinguish whether the author of primary studies controls for the multilateral resistance. Most of the estimates deal with the multilateral resistance trough the fixed effects - either country fixed effects, or sector fixed effects or year fixed effects. Secondly, I divide the estimates according to the kind of the identifying variable. The structural gravity merges the coefficients estimated using bilateral tariffs and exchange rate changes. Beside bilateral tariffs I included the following identifying variables: applied tariffs, average tariffs, CES tariff index, duties, freight tariffs, and other tariff equivalents. On the contrary, among exchange rates changes I also classified for example ER volatility, price, productivity (based on output, prices or TFP), real exchange rates, spot exchange rates, or wages. Overall, the most valuable estimate of my dataset is -2.19, the median coefficient obtained from models using bilateral tariffs as the identifying variable and simultaneously controlling for MR term.

The other diversity might arise on the basis of the prestige of journals where primary studies are published. Some of the studies come from the top ranked journals with high interest among public. The other studies, on the contrary are published in local journals. The last group from the studies comes from working papers. To outline the potential discrepancies among individual journals I examined the mean and median estimate for studies published only in top ranked journals: the Quarterly Journal of Economics, Econometrica, the Review of Economics and Statistics, the American Economic Review, the Review of Economic Studies and the Journal of the International Economics. My dataset includes 18 studies that are published in above listed journals. The median estimate of the studies is equal to -2.8 that is very close to mean of the overall mean. Differences among high ranked journals and other outlets are not so significant compare to the range of the reported trade cost effect within primary studies. In addition, a potential reason for the difference may be explained by used methodology.

Table 5.2 shows the mean of the estimates for particular subsets divided according to the method and characteristics of individual estimates. The left-hand part of the table represents unweighted estimates, on the contrary the right hand part shows estimates weighted by the inverse number of observations reported in individual study. I adopt the weighting method by Havranek

Table 5.2: Trade cost effects vary across different methods and studies

		Unweighted			Weighted		
	No. of est.	Mean	95% conf. int.		Mean	95% conf. int.	
Panel data	584	-2.31	-3.29	-1.33	-1.70	-2.48	-0.93
Disaggregated	660	-2.86	-4.98	-0.75	-2.14	-3.61	-0.68
Head and Mayer	709	-3.82	-5.01	-2.62	2.79	-3.72	-1.74
New estimates	381	0.02	-1.91	1.95	-0.65	-1.49	0.19
Zeros omitted	191	0.58	-2.80	3.96	-0.99	-2.76	1.78
Zero plus one	123	-1.96	-3.60	-0.33	-1.76	-2.87	-0.65
Published	1023	-2.62	-4.07	-1.16	-1.86	-2.54	-1.06
ALL	1090	-2.47	-3.87	-1.08	-1.72	-2.43	-1.01

Notes: The table shows the mean estimates of the trade cost coefficient for the estimates reported in a particular study or using a particular methods. Head and Mayer = estimates obtained from the data set of Head & Mayer (2013), New estimates= estimates collected by author (the collection of data is explained in Section 5.2. The remaining variables are explained in detail in Table 7.1. The confidence intervals around the mean are made using standard errors clustered at study level. In the right-hand side are the estimates weighted by the inverse of the number of estimates reported per study (the implementation of clustering and weights method follows Havranek & Irsova (2015)).

& Irsova (2015) who argue that the weights assign each study the same importance. The 95% confidence intervals around the mean of the estimates are constructed using standard errors clustered in a study level. The method of clustering has been used by several authors, since the trade cost effect estimated in the same study might also use the same or similar dataset. Cameron *et al.* (2011) or Havranek & Irsova (2015) additionally follow the approach of two-level clustering; they use standard errors clustered at the study and data set level. Elasticities obtained using panel and disaggregated data is comparable to the overall mean, especially considering the weighted estimates. The data obtained from studies also used in dataset of Head & Mayer (2013) have tendency to indicate higher negative effect, while the new estimates record the mean of the estimate very close to zero. Table 5.2 also shows that omitting zero from data has caused positive mean of the estimates, on the contrary the adding one to the dependent variable of equation (3.3) cause that mean of the estimates is close to the overall mean, especially when the estimates are weighted.

Table 5.3 represents the countries and country groups that are the most frequently investigated within primary studies. Bergstrand (1985) who first

Table 5.3: Trade cost effects vary across countries

		Unweighted			Weighted		
	No. of estimates	Mean	95% conf. int.		Mean	95% conf. int.	
US	511	-3.27	-4.80	-1.74	-2.73	-4.07	1.38
Canada	327	-2.26	-3.58	-0.94	-2.83	-4.35	-1.31
Japan	488	-3.29	-4.86	-1.72	-2.51	-3.76	-1.28
EU	476	-1.05	-3.09	0.99	-1.49	-2.64	-0.36
OECD	99	-0.67	-2.08	0.73	-1.47	-2.83	-0.11
Emerging	278	-3.69	-5.75	-1.62	-1.34	-2.67	-0.01
ALL	1090	-2.47	-3.87	-1.08	-1.72	-2.43	-1.01

Notes: The table shows the mean estimates of the trade cost coefficient for a particular country or a country group that are explained in detail in Table 7.1. The confidence intervals around the mean are made using standard errors clustered at study level. In the right-hand side are the estimates weighted by the inverse of the number of estimates reported per study (the implementation of clustering and weights method follows Havranek & Irsova (2015)

examined exchange rate changes among 15 OECD countries. Head & Ries (2001) who first examined tariff rates as a variable identifying the elasticity in the regression between the US and Canada. Both Bergstrand (1985) and Head & Ries (2001) recognize that the other source of heterogeneity might different countries for which the trade cost effects are considered. Table 5.3 shows that the trade cost effect might vary among different countries. The left-hand part of Table 5.3 reports the substantially diverse average of the estimates within selected countries. The smallest negative effect is obtained for the OECD countries, whereas the largest negative effect responds to the emerging countries. The average of estimates for Canada is close to the overall mean. When I use the method of weighted estimates by the inverse of the number of observations within a particular study as I did in Table 5.3, the country diversity appears less scattered.

In addition, the dataset of a particular study originated from the different data source, what I have already described in Chapter 2. The elasticities reported in primary studies are measured in large time period from 1870 to 2010. The most of the dataset of primary studies falls to a period from 1980 to 2000. The further investigation of the heterogeneity within the dataset will be described in detail in Chapter 7.

Chapter 6

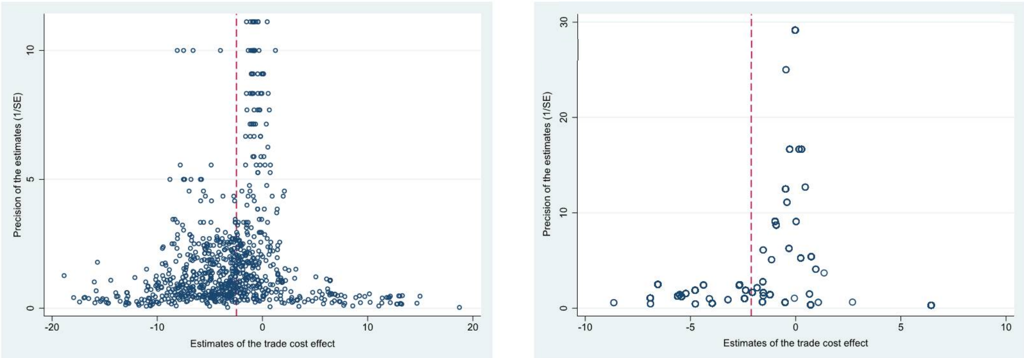
Testing for publication bias

Detecting for a presence of publication bias should be undertaken always at a first phase of a meta-analysis (Macaskill *et al.* 2001)). In Chapter 4.1 I have mentioned the most commonly used methods to determine the publication bias. The analysis is based on the assumption that the researcher knows the size of standard errors of the particular estimates to be able to apply the funnel asymmetry test. That is why I classify the occurrence of standard errors within primary studies as the key of the inclusion criteria.

6.1 Funnel plot

Creating a funnel plot of the precision (the inverse of the estimated standard error) against the estimated effects can visually detect a publication bias. As I have already described in Chapter 4.1 that in the absence of publication bias the plot is assumed to take a characteristic funnel shape. The funnel plot for my data set is reported in Figure 6.1. Figure 6.1 (a) shows the funnel for the trade cost effect of all estimates, while Figure 6.1 (b) shows the funnel plot for the median estimates reported in the primary studies. I make the several observations from the funnels.

Both funnel plots are not symmetrical, since the estimates are not entirely distributed around the axis of the funnel. Figure 6.1 (b) shows that almost one third of primary studies are distributed around zero. Studies that reported smaller negative effect of trade cost than the average number have some common characteristics. Most of them represent working papers and do not disaggregate data across countries or sectors. The authors of these studies also use the structural gravity model and control for multilateral resistance



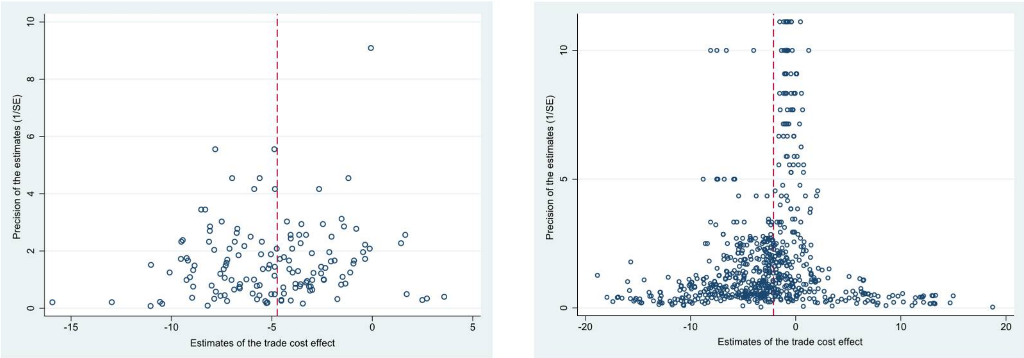
(a) All estimates (b) Median estimates reported in studies

Figure 6.1: Funnel plots

term through fixed effects. Additionally, the authors frequently reports several estimation taht differ by very specific characteristics, for instance they add different explanatory variables, such as time delays (Liapis (2011)), they explore the effect of fixed costs (Besedeš & Cole (2017), or they use probit model to estimate the gravity equation Chevassus-Lozza *et al.* (2005). Figure 6.1 (a) shows that even if the median of coefficient within some studies is close to converge to zero, the distribution of the estimates is around the axis of the funnel. The differ outputs of two funnels are caused various results reported within particular studies, mainly working papers. The diversity across a particular study caused that the median of the estimates within the study is close to zero. Therefore, more accurate output is shown in Figure 6.1 (a) on which I describe further observations.

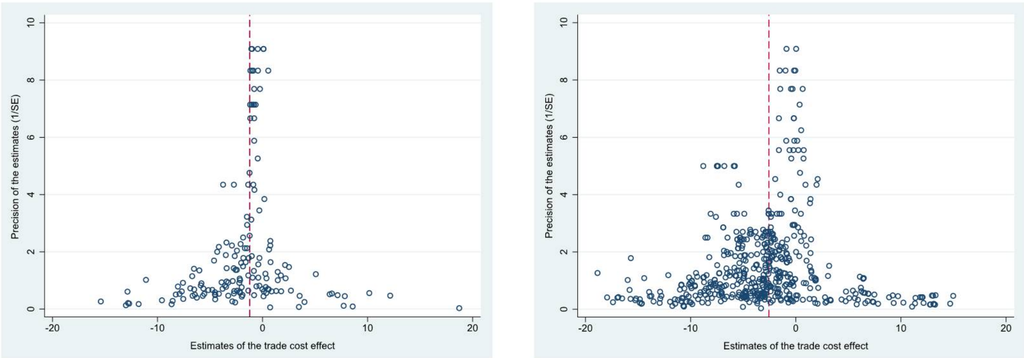
First, the distributions of the estimates are not uniform, the left-side is evidently much heavier. Second observation presents that the most of the estimates are close to the average reported elasticity. Third, the funnel plot is not hollow, even there is an evidence of the deviation in the size of elasticities. Last, the funnel has more peaks, which implies heterogeneity in the estimated trade cost effects. The evidence of heterogeneity is expected result in various estimates based on data from different countries or different characteristic of a study as I have described in Chapter 5.

Signs of heterogeneity can be also caused by different kinds of trade costs. I use the main characteristics already described in Figure 5.1 to divide the estimates based on the used models or methods for further investigation of the publication selection. Figure 6.2 shows the funnel plots for studies that applied different kind of the gravity equation. On the left-side, the funnel plot for



(a) Estimates in naive gravity (b) Estimates in structural gravity

Figure 6.2: Funnel plots within gravity models



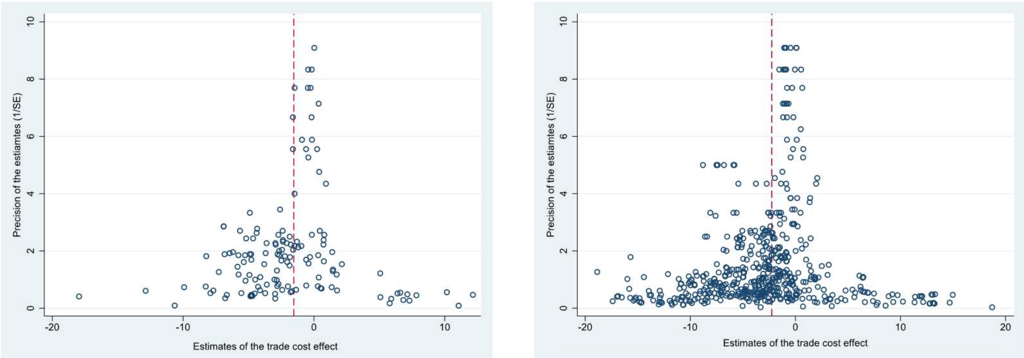
(a) Exchange rates/producer prices (b) Tariffs/freight rates

Figure 6.3: Funnel plots within identifying variables

estimates of naive model exposes the evidence of publication bias, mainly due to the obvious hollows. Contrarily, on the right side the funnel plot, represented by the estimates reported in studies applying structural gravity model, shows more accurate funnel shape.

In addition, Figure 6.3 describes the funnel plots that control the publication selection within studies used structural gravity model. As Head & Mayer (2015) described, the key characteristics is to realize whether the authors of primary studies used the tariffs/freight rates or exchange rates/producer prices/productivity as the variable identifying the price elasticity in the regression. Both funnel plots show the certain sign of the publication bias, as their left-hand sides are still heavier than right-hand sides.

Moreover, the other characteristics within primary studies is to detect how the authors control for the multilateral resistance. Figure 6.4 represents two funnel plots that show the difference, while the estimates are dealing with the



(a) Ratios (b) Fixed effects

Figure 6.4: Funnel plots within controls for MR

MR trough ratios and the fixed effect. In case of the controlling MR term trough ratios, the publication selection is more evident than in case of fixed effects. Nevertheless, both ratios method and fixed effects method indicate the publication selection bias due to a burdening of left-sides of the funnel plots.

6.2 Funnel assymetry test

I noted in Chapter 4 that the funnel plot is not the only method to determine the publication bias and as the other methods, it contains some shortcomings. The main shortcoming arises from the indistinct argument for shape deviation. For this reason I elevate the results from the previous section by the explicit funnel asymmetry test (FAT). The publication bias can be also revealed by the relation between the size of the elasticity of trade with respect to trade cost and its standard error. Thus, I customize equation (4.1) to get the following regression model:

$$Trade\ cost_{ij} = Trade\ cost_0 + \beta \cdot SE(Trade\ cost_{ij}) + \omega_{ij}, \tag{6.1}$$

where $Trade\ cost_{ij}$ signifies i-th estimates of the elasticity recorded in the j-th study, $SE(Trade\ cost_{ij})$ denotes the standard errors of the elasticity estimates, $Trade\ cost_0$ is the mean elasticity corrected for possible publication bias, β measures the magnitude of the publication bias and ω_{ij} stands for a normal disturbance term. Stanley (2005) noted that if the data are not affected by the publication bias, the estimation effects will vary around the true effect ($Trade\ cost_0$). If true elasticity was zero (signifying no trade cost effect) but all researchers determined 5% of estimates that are positive and statistically significant, the estimated β would be close to two: meaning that the researchers would require their t-statistics (*Trade cost/SE(Trade cost)*) to be equal at least two (Havranek *et al.* 2015).

In the determination of the publication bias it is common to expect that the selection criteria leading to the bias are on the basis of the sign and statistical significance of the elasticity questioned. In some meta-analysis (Havranek *et al.* 2015), researchers developed an idea that estimates can be adjusted due to results of previous meta-analysis that already determined the true effect. As I mentioned while describing the data collection, the only meta-analysis focusing on the elasticity of trade with respect to trade cost is the one included in the Cookbook of Head & Mayer (2013). Since their meta-analysis was published in 2013 and researchers of the primary studies had done their regression before, there is no reason to suspect them that they would adjust their elasticities because of the Head & Mayer (2013) meta-analysis.

The results from FATs are presented in Table 6.1 The table is divided into two panels, where panel A depicts the unweighted regression and panel B, on the contrary, depicts the regression weighted by their precision. Both tables are then divided into four columns. Moreover, regression (6.1) is heteroscedastic, I involve robust standard errors, which are clustered at the level of primary studies. The panel A is divided into four columns according to the particular range of estimates:

1. I include all estimates in my dataset,
2. I include only elasticities reported in published journals,
3. I include the fixed effects for each study to control for method or other quality characteristics specific to studies,
4. I use the logarithm of the number of observations in the gravity model as an instrument for the standard error of the estimates.

The results of the part A of the FAT 6.1 can be summarized as follows. The first column of part A stands in the estimates of the parameters from equation 6.1 using all 1100 trade cost coefficients in my dataset. The coefficient representing the explorer of publication bias is statistically insignificant and close to zero, while the estimated coefficient beyond bias ($Trade\ cost_0$) is statistically significant at 1%. As the estimate of $Trade\ cost_0$ is equal to -2.27 that is close to the mean of the trade cost effect reported in all studies, the potential publication selection does not produce any bias. Thus, nor one of the test confirm any significant evidence of publication selection. The second column of part A in Table 6.1 representing the estimates reported in published studies yield the similar result as in the first column. Moreover, the estimated coefficient beyond bias of published studies is even closer to the mean of the trade cost effect. Havranek & Irsova (2011) noticed that studies published in peer-reviewed journals might have tendency to show substantially more publication bias than unpublished handwritings. While the results of my collected estimates yield reverse output, either in the extent of publication bias, or in the mean underlying estimated coefficient beyond any potential bias. The result is not surprising, since the meta-analysis summarized the mean and median of the trade cost effect was introduced by Head & Mayer (2013). Thus, authors of the primary studies were not influenced by any statistical values. By estimating equation (6.1) with the fixed effects, I examined the method and other quality characteristics specific to individual study. The advantage for using this kind of estimation method is exactly the collecting multiple estimates per study. The coefficient corresponding to the extent of publication bias is statistically significant at 1% level. The evidence of publication bias might be caused by leaving out another outliers. The estimates of the outliers are distant from the mean of the estimated trade cost coefficient, which is lower than the results in the first column and simultaneously lower than the mean of trade cost effect.

The limitation of equation (6.1) arises from the potential correlation between $SE(Trade\ cost_{ij})$ and the error term ω_{ij}. Havranek *et al.* (2015) pointed out that the correlation might come to pass as some method choices affect both the estimated trade cost coefficient and the corresponding standard error. For meta-analysts this control for potential endogeneity is needed, as they might feel they have lack of all relevant information on the methodology used in particular study. To avoid this issue I use the logarithm of the number of observations in the gravity equation as an instrument variable for the coefficient representing the explorer of publication bias $SE(Trade\ cost_{ij})$. The results of the last column in part A of Table 6.1 indicates the evidence of publication bias, as the estimated coefficient beyond bias is distant form the mean of trade cost effect. Part A of Table 6.1 shows that the occurrence of the publication selection is not so evident, thus, I follow Havranek & Irsova (2015) and add the additional FAT to investigate for publication bias regard to potential heteroscedasticity.

Havranek & Irsova (2011) noticed that equation (6.1) exposes the heteroscedasticity as the explanatory variable is a sample of the standard deviation of the dependent variable. Stanley (2005) presented that the specification (6.1) is usually estimated by weighted least squares. With the correct weight, this method decreases the sum of weighted square residuals to generate residuals with a constant variance. Part B of Table 6.1, extended the test for detecting publication bias on the level of weighted regression. The results are divided into four columns based on the following criteria:

1. I include all estimates in my dataset weighted by their precision,
2. All estimates are weighted by the inverse of the number of estimates reported in primary studies,
3. In addition to the previous weight, I added the weighting by the RePEc discounted recursive impact factor of the journal where the study was published,
4. All estimates except for the above mentioned are weighted by the number of citations per year in Google Scholar.

Determining the efficient weight to use might cause obstructions. The most common weight among meta-analyst is to multiply equation (6.1) by the inverse number of corresponding standard error, the precision. The first column of part B refers to the evidence of the publication bias. Moreover, the estimated coefficient beyond bias is different from the mean of the trade cost effect. The next three columns are related to the alternative approach, the values based on theory, study or literature. In the second column of part B I include all estimates in my dataset weighted by the inverse number of estimates reported in primary studies. Generally, observations with small variances should have relatively large weights and vice versa. The results do not show signs of publication bias. Nevertheless, by adding weight of additional characteristics of primary studies (the RePEc discounted recursive impact factor and the number of citations per year in Google Scholar) the results record the signs of publication selection. By adding more weight, the estimated coefficient beyond bias is getting closer to the mean of the trade cost effect.

The extension of the funnel asymmetry test finally confirmed the presence of publication selection that was already investigated during visual test. As I have already outlined in Figure 6.1 the occurrence of publication bias can vary with using different method or different model. Table 6.2 shows the difference

Table 6.1: Funnel asymmetry test

A: Unweighted regressions	1	2	3	4
SE (Publication bias)	-0.181	-0.155	-0.238**	-3.751
	(0.241)	(0.237)	(0.106)	(3.929)
Constant (effect beyond bias)	-2.272***	-2.438***	-2.198***	2.321
	(0.580)	(0.609)	(0.135)	(6.054)
Observations	1090	1023	1090	1090

B: Weighted regressions	1	2	3	4
	1	2	3	4
SE (Publication bias)	-1.999***	-0.572	-1.144**	-1.191**
	(0.723)	(0.360)	(0.524)	(0.534)
Constant (effect beyond bias)	-0.0987	-1.275***	-1.923***	-2.028***
	(0.297)	(0.319)	(0.604)	(0.667)
Observations	1069	1090	1023	962

Standard errors in parentheses
Standard errors are clustered at the study level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

between applying structural and naive gravity model. Using naive gravity confirms the evidence of publication bias as the standard error is statistically significant at 1%. On the contrary, using structural gravity model does not yield any sings of publication bias as $Trade\ cost_0$ is close to the overall mean.

In Appendix B in Table B.1 I have include additional FATs to further investigate the publication selection among different characteristics of structural gravity model. Panel A describes a division of the subsample according to several important characteristics. The results are divided into four columns based on the following criteria:

1. I include only estimates dealing with the MR terms through ratios,
2. I include only estimates dealing with the MR terms through fixed effects,
3. I include only coefficients estimated using bilateral tariffs,
4. I include only coefficients estimated using exchange rates changes.

The results in Panel A also confirms the outputs from visual tests. The publication bias is the most distinct while the authors used the ratios to deal with the multilateral resistance term, since the explorer of publication bias

$SE(Trade\ cost_{ij})$ is statistically significant at 1% level. Moreover, the overall mean is the closest to the estimated coefficient beyond bias using identifying variables falling into groups of bilateral tariffs.

In addition, Panel B examine the various kind of the fixed effect that deal with the multilateral resistance. The results are divided into three columns based on the following criteria:

1. I include coefficients estimated dealing with the MR terms through country fixed effects,
2. I include coefficients estimated dealing with the MR terms through sector fixed effects,
3. I include coefficients estimated dealing with the MR terms through year fixed effects.

The results, however, report the publication bias among studies, where authors control for the multilateral resistance through the country and year fixed effect. The following chapter devotes to describe the further diversity within inclusion of different explanatory variables in a particular study.

Table 6.2: Funnel asymmetry test for different gravity models

	Naive gravity	Structural gravity
SE (Publication bias)	-0.535***	-0.039
	(0.246)	(0.258)
Constant (effect beyond bias)	-4.030***	-2.160***
	(0.990)	(0.547)
Observations	150	940

Standard errors in parentheses
Standard errors are clustered at the study level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 7

Why trade cost effect vary

7.1 Explanatory variables

The effect of trade cost on the international trade varies across particular studies as I detected in previous chapters. In Chapter 6 I referred how the estimates of the elasticity are correlated with the reported standard errors. In this part I am going to present a number of explanatory variables as sources of heterogeneity in estimated effect and replace them by the SE (trade cost) in equation. The explanatory variables represent the characteristics of the estimates as well as the primary studies. By removing these characteristics in prior chapter I avoid the heteroscedasticity that obviously occurs among primary studies.

Table 7.1 presents all the variables that I collected from primary studies, shows summary statistics and explains their meaning in detail. I follow the same method as Havranek & Irsova (2015) and I weight the regression by the inverse of the number of estimates per study. I reach more comparable data as each primary study has the same weight. The last column of the table thus represents the mean weighted by the inverse number of the estimates recorded in particular studies.

All of the authors of the primary studies occurring in my dataset apply the gravity equation to detect the impact of trade cost on the international trade. I categorize the explanatory variables in very similar way as I did in my bachelor thesis or as Havranek *et al.* (2015) did, since the border or distance effect are also considered as key variables that influence the international trade. I divide the variables into following groups:

- Data characteristics
- Countries surveyed

- Sectors examined
- Specification characteristics
- Data source
- Treatment of multilateral resistance
- Treatment of zero trade flows
- Control variables
- Distance effect
- Publication characteristics

7.1.1 Data characteristics

I include several variables that are related with year of dataset in particular studies. I proceed in the same manner as in my bachelor thesis. One of the most important characteristics was the age of the samples on which the gravity equation was estimated. I control them by creating a new variable that determine a midpoint of the sample to be able to say whether the effect of trade cost will vary in time. The most likely explanation why the mean of trade cost has diminishing effect are probably the integration of emerging markets and also the continuing economic globalization as already indicated Havranek & Irsova (2015) in their meta-analysis about the border effect.

In addition, the knowledge of the year or the period when estimated data were collected was conducive to determine other variables. The authors of the primary studies examined the effect of trade cost on the international trade in two different ways. First group of the researchers explored this effect individually for particular sector. Second group of the authors did not considered any various kinds of sectors. They take either one kind of sector or do not distinguish sector at all. Moreover, I reflect the level of aggregation of countries in the gravity equation, meaning that the authors ever examined the effect of trade cost of between one specific country and the rest of the world. Therefore, I add a dummy that equals one if the data are disaggregated at the sector or country level.

I include dummy variable 'panel' to observe whether panel or cross-sectional data cause systematic systematic deviations in the effect of trade costs. Finally, 21 from 60 studies counted on cross-sectional data but only about 54% of estimates descend from studies using panel data (meaning that even if the percentage ratio of estimates is comparable, the authors give higher priority to use panel data). I also add the logarithm of number of observations of each study. In the same manner I include this number of observation per year to create more comparable variable.

7.1.2 Countries surveyed

My dataset includes studies that examine the effect of trade costs for different regions all over the world, thus I use several dummy variables to control for this inconsistency. Besides other things diverse countries may indicate different elasticities of substitutions between foreign and domestic products that may influence the estimated effect.

I consider a possibility of occurrence of deviations between the estimates within developed or emerging countries. Thus I include several dummy variables on the basis of frequency of the exploration the following countries within primary studies: the US, the EU, the OECD, Japan, Canada and the emerging countries (including both transition and developing economies). The first paper related to the trade cost Bergstrand (1985)) was focused on the data on the international trade among 15 OECD countries. Many others have followed him, and 9% of all estimates in my dataset use data of OECD countries or their combination with other countries. Nevertheless, the data of OECD does not have the most frequent use. Trade cost effects are mostly estimated for the US (47%), Japan (45%), the EU (44%), Canada (30%) and emerging countries (26%). The reference category for above listed dummies is remaining countries and their combinations or the entire world.

7.1.3 Sectors examined

The researchers examine also the effect of trade cost for different sectors. They wanted to prove how sectoral resolution influences the international trade. The authors of primary studies hold three different methods. The first two methods are very similar, that is, either they do not ponder sectoral heterogeneity at all or they ponder only one of many sectors, for example Blonigen & Wilson (2010) consider only steel industry. By using last method the authors disaggregate the effect of trade costs in different sectors. For example Caliendo & Parro

(2014) include the sectoral heterogeneity in production to quantify the trade and welfare effects from tariff changes.

I use the following dummy variable to control for this sectoral heterogeneity: Agriculture, Animals, Transport, Services, Manufacturing and Raw materials. Since some of the appointed sectors mingle, I define them in detail. A dummy variable 'Agriculture' combines the following subsectors: agriculture products, agro food, vegetable fats, animal fats, oils, cereals, coffee, tea, cheese, milk, meats, breeding, tobacco, rice, wheat and others. Agriculture sector certainly consists both animal and crop production, thus I include a dummy variable 'Animals' to distinguish them. A dummy variable 'transport' represents the following subsectors: fuels, machinery, transport equipment, vehicles, aircraft, vessels, mechanical appliances, shipping, travel and other transport. Among Service sector belong also following subsectors: office, communication, and telecommunication, software, operating leasing, insurance, business, and finance. I define a dummy variable 'Raw materials' that contains for example coal, metal, silver, rubber, wood and others. 'Manufacturing', on the contrary, represents a group of final product, industries or manufactures. Among this group I classify also the textile or plastic products.

7.1.4 Specification characteristics

All of the primary studies apply the gravity equation to measure the effect of trade cost on the international trade. They use still the specific characteristics of collecting data and determining dependent variable to customize the gravity equation. The authors of primary studies take imports and exports for given trade pairs as single variables and then they determine the sum as trade flow. The primary studies then by estimating the gravity equation contend with an issue that Baldwin & Taglioni (2007) named 'silver medal mistake'. Since the gravity equation is always estimated in logs, the authors commit to use the log of the sum of bilateral trade as response variable instead of the sum of the logs. Baldwin and Taglioni (2007) refer that the silver medal mis-specification leads to an upward bias. This statement comes from the fact that the log of the sum (incorrect method) overestimates the sum of the log (correct method). The silver medal mistake thus implies that the authors are working with an overestimate of trade flows. I define three dummy variables: total trade, import and export to determine whether the particular study is affected by the preceding issue. I also examine if the authors consider the trade flows only in one direction. Furthermore, I distinguish studies that have a data on the international trade flows from studies that use production data to estimate between-country trade flows. Only about one fourth of the studies have access to production data. Many authors encounter an issue that certain to production data are limited and must deal with it in a different way. For instance Romalis (2007) suggest a solution that even if the industry data was not available, the share of a country's output that got exported was simply estimated as the proportion of each reporting country's GDP that got exported using World Development Indicators data. I also include the dummy variable to control whether the researchers use the instruments to account for the potential endogeneity of GDP in the gravity equation. Authors often used the IVs estimation method when they expect the correlation between the explanatory variables and the error terms, for example due to measurement error, omitted variables, or other sources of simultaneity bias. I fluently use the same example, since Romalis (2007) had limited access to industry data he measured supply with error term and he applied then the IVs method. The IVs took care not only of the traditional simultaneity bias but also of measurement error.

7.1.5 Data sources

Anderson & Van Wincoop (2004) notice the limitation of the trade barriers within particular studies for several reasons: the absence of data, data that are useful just in combination with another fragmentary data, and aggregation bias. Studies estimating the trade cost effect use different database to collect data. I use the several dummies to determine the dataset of particular studies. Authors frequently use the software developed by World Bank - WITS that allows them access to several databases. Trade and tariff data are available in the following databases: COMTRADE, TRAINS, and IDB.

The UNCTAD Trade Analysis Information System (TRAINS) provides all data on tariffs, non-tariff barriers, and trade flows at the 6 digit level of the Harmonized System (HS) product classification for about 5000 products, expect that it contains only import flows. About 10% of the all trade cost estimates are obtained from TRAINS database. The United Nations Commodity Trade Statistics Database (UN Comtrade) provides data on import and export flows (about 13% of studies). I also include the dummy variable IMF that contrarily represents data from International Monetary Fund databases (also about 13% of studies employed).

7.1.6 Control variables

During assembling my data matrix I search for the explanatory variables that occur in most of primary studies. The researchers typically include: common language, adjacency (contiguous countries), and membership in a FTA member. I examine what impact has inclusion of these variables on the elasticity of trade costs. The dummy variable FTA represents many free trade agreements. The authors usually mentions NAFTA (a free trade agreement that entered into force between the USA, Canada and Mexico in 1994), APEC (a forum for 21 Pacific Rim member economies that supports free trade throughout the Asia-Pacific region), or Mercosur (a sub-regional bloc included Argentina, Brazil, Paraguay, Uruguay and Venezuela).

A variable has the same value for all of country pairs in several cases (for example between Canada and the US, (Head 2001)). These studies cannot use dummy variables common language or control for FTA. I use the same coding as Havranek *et al.* (2015) and put '0' for common language and FTA member meaning that these control variables are omitted even though they could be included.

7.1.7 Distance effect

In my bachelor thesis I was focused on the diversity of distance effect in primary studies. The effect of distance belongs to other of the essential elements that explain the international trade flow. Anderson & Van Wincoop (2001) noticed that distance is closely related to trade costs, since for example transport costs are increasing in distance. During this meta-analysis I add the dummy variable that equals one if the distance effect is included in the gravity equation exploring the effect of trade cost on the international trade. Apart from the occurrence of the variable 'distance' in the gravity model within particular primary study I focus on the way of its measure.

I include the dummy variable to control whether the authors ponder the actual distance or whether they calculate distance applying the great-circle formula. This great-circle or so-called orthodromic formula measures the shortest distance between two points, measured along the surface of the sphere. It is necessary to know only the latitude and the longitude of capitals for each country. Head & Mayer (2013) notified of the shortcomings of this measure such as the shipping route vary from the great-circle route, especially when they pass over the poles. It implies that using the great-circle formula leads to an upward bias in the estimated effect.

7.1.8 Treatment of multilateral resistance

Baldwin & Taglioni (2007) note not only decline of bilateral barriers to trade, but also the multilateral interactions between economies have positive impact on the increased interest of companies to enter new markets. The authors of the primary studies deal with the issue of multilateral trade resistance in different way. Head & Mayer (2000) come with an idea to include 'remoteness term' standing for the inverse ratio between distance and GDP as proxy of how remote the trading partners are. About 14% of studies in my data matrix include the remoteness term.

About 9% of studies follows the non-linear estimation method developed by Anderson & Van Wincoop (2004). They come with an idea to estimate the full general equilibrium model applying an iterative NLS procedure in Gauss to resolve multilateral resistance term as a function of observables. Eaton & Kortum (2002) and later Head and Mayer (2000) come with another consistent estimation method: by adding the odds ratio they avoid the issue of estimating the imports inclusive value (it consists of the list of potential suppliers taking into consideration their distance, seize, or border effect). The estimation of the effect of inclusive value seems difficult as it depends on parameters that are already contained in the gravity equation to be estimated. About 18% of studies used this method.

More than half of the primary studies deals with the MTR by country-level fixed effects introduced for the estimation of the gravity equation by Harrigan (1993) and later Feenstra (1994). The country has a tendency to export large amount relative to its GDP. By using the fixed effect the authors anticipate any unobservable that contributes to change the aggregate level of imports or exports of a country. While Country fixed effects capture systematic differences in the financial environment across countries (for example bankruptcy laws), sector fixed effects (issuing various kinds of industries) control for systematic differences in risk and performance across sector types. I also include the variable year fixed effect that in contrary control for differences in the bilateral trade across years (as many authors take account of panel data).

7.1.9 Treatment of zero trade flows

Many researchers proved that even if they applied the Newtonian gravity model, the trade between regions can be really zero. These zeros appear due to using of panel data meaning that the regions did not trade in a given time. The occurrence of observations for which the dependent variable is zero cause an additional issue for the use of the log-linear form of the gravity equation Silva & Tenreyro (2006). The simplest way how to solve this issue is to add one to each observation or use the log linear transformation. About 11% of estimates in my dataset was affected by this simplest method.

Silva & Tenreyro (2006) subsequently confirm that estimating the log-linearized equation by ordinary least squares (OLS) can cause significant biases. Many authors, who encounter this issue apply the different model to estimate the elasticity. About 18% of studies estimate the gravity model using Tobit model or Poisson pseudo maximum likelihood (PPML) that Silva & Tenreyro (2006). Finally some of the authors decide to omit zeros from their data sets.

7.1.10 Publication characteristics

In the previous chapter I explained the process of gathering the dataset by using the RePEc database. I focused on the inclusion of the journal impact factors to easily recognize differences in quality not covered by the variables relating to methodology. The impact factor is used as a proxy to compare the importance of an academic journal within the field of study. Even though there are many impact factors I took account of the RePEc Recursive Discounted Impact Factors that reflects not only where each study was published but also the quality of citations that are split by their age in years (i.e. one for the current year). The main advantage of the RePEc database is also that it covers nearly all economic journals and working paper series. The additional way to emphasize the importance of a particular study is including dummy variable that equals one if the economic paper was published in a refereeing or peer-reviewed journal. Disdier & Head (2008) presented in their studies that refereeing journals could have more significant and accurate norms in methodology, which resulted in the occurrence of publication bias in other estimates. Among those journals belong the Review of Economics and Statistics, the American Economic Review and the Journal of the International Economics.

I also include the variable year of the first publication of such study in Google Scholar for several reasons. I can examine the possible trend in the estimates of the elasticity in recent years. Latest studies can profit from the application of new econometric models, covering different country characteristics. At last the transport costs has been changed over time mainly due to strategic agreement among countries. Another variable that characterizes particular studies is also the Google Scholar citations. I consider the logarithm of the mean of that citations obtained per year plus one that I have proved their worth in my Bachelor thesis. This form is used precisely because many studies published in more recent year have incomparable amount of citations than older ones.

Table 7.1: Description of used variables

Variable	**Description**	**Mean**	**SD**	**WM**
trade cost	"The estimate of trade cost effect on the international trade"	-2.47	4.64	-1.72
se	Estimated standard error of trade cost.	1.18	2.05	0.78
Data characteristics				
Mid year	The mid year of the sample on which the gravity equation is estimated (base is the sample minimum: 1870).	121.26	13.67	121.84
Panel data	=1 if panel data are used in the gravity equation.	0.54	0.50	0.66
Dissagregated	=1 if data are disaggregated.	0.62	0.49	0.33
Obs.per year	The logarithm of the number of observations per year included in the gravity equation.	1.86	0.36	1.81
No.of years	The logarithm of the number of years.	1.36	1.35	1.67
Countries surveyed				
US	=1 if the trade cost effect is estimated for the US (or combinations of country groups)	0.47	0.50	0.32
Canada	=1 if the trade cost effect is estimated for Canada (or combinations of country groups)	0.30	0.46	0.24
Japan	=1 if the trade cost effect is estimated for Japan (or combinations of country groups)	0.45	0.50	0.27

. . . continued

Variable	Description	Mean	SD	WM
EU	=1 if the trade cost effect is estimated for the EU (or combinations of country groups)	0.44	0.50	0.36
OECD	=1 if the trade cost effect is estimated for OECD countries.	0.09	0.29	0.16
Emerging	=1 if the trade cost effect is estimated for transition or developing countries.	0.25	0.44	0.27
Sector examined				
Agriculture	=1 if the trade cost effect is estimated for agriculture sector.	0.35	0.48	0.25
Animals	=1 if the trade cost effect is estimated for animal husbandry.	0.05	0.22	0.04
Transport	=1 if the trade cost effect is estimated for transport industry.	0.25	0.43	0.14
Service	=1 if the trade cost effect is estimated for service sector.	0.11	0.32	0.06
Raw Materials	=1 if the trade cost effect is estimated for raw materials.	0.11	0.33	0.12
Manufacture	=1 if the trade coes teffect is estimated for manufacturing or production sector.	0.58	0.49	0.61
Specification characteristics				
Total trade	=1 if the researchers sum export and import trade flows before taking logarithm form	0.23	0.42	0.38
Imports	=1 of the researchers measure only import flows	0.61	0.49	0.34
Exports	=1 of the researchers measure only export flows	0.22	0.42	0.36
No internal trade	=1 if within-country trade flows is estimated using production data	0.35	0.48	0.28
Asymmetry	=1 if the estiamte measures the international trade flows in one direction	0.58	0.49	0.38

. . . continued

Variable	Description	Mean	SD	WM
Instruments	=1 if the instrument variable is used to correct for the endogeneity of GDP	0.25	0.49	0.33
Data source				
TRAINS	=1 if the researchers used a data from TRAINS database.	0.15	0.36	0.05
COMTRADE	=1 if the researchers used a data from COMTRADE database.	0.19	0.40	0.14
WITS	=1 if the researchers used a data from WITS database.	0.06	0.23	0.05
IMF	=1 if the researchers used a data from IMF database.	0.10	0.30	0.14
Treatment of multilateral resistance				
Control for MR	=1 if the gravity equation count for multilateral resistance terms.	0.42	0.49	0.49
Remoteness	=1 if the remoteness term is included.	0.08	0.27	0.12
Theory	=1 if the nonlinear estimation method is applied	0.06	0.23	0.09
CFE	=1 if destination fixed effect is included.	0.42	0.49	0.41
Year FE	=1 if year fixed effect is included.	0.13	0.45	0.16
Sector FE	=1 if sector fixed effect is included.	0.28	0.34	0.18
Ratios	=1 if trade flow is normalized by trade with self.	0.26	0.44	0.32
Treatment of zero trade flows				
Zero omitted	=1 if observations of zero trade flows are omitted.	0.17	0.38	0.15
Zero plus one	=1 if the researchers add one to overall observations of zero trade flows.	0.11	0.32	0.21
PPML	=1 if the researchers applied Pseudo Poisson Maximum Likelihood method to estimate the gravity equation.	0.03	0.16	0.05

. . . continued

Variable	Description	Mean	SD	WM
Tobit	=1 if the researchers applied Tobit model to estimate the gravity equation.	0.02	0.14	0.04
GMM	=if the gravity eauation is estimated by Generalized Method of Moments	0.05	0.21	0.01
Control variables				
FTA	=1 if the gravity equation controls for free trade agreements.	0.08	0.29	0.13
Language	=1 if the gravity equation controls for common language.	0.33	0.64	0.46
Adjacency	=1 if the gravity equation controls for adjacency.	0.32	0.52	0.25
Distance effect				
Distance	=1 if the gravity equation measure also the distance effect on the international trade.	0.15	0.68	-0.09
Actual	=1 if the actual road/sea distance is used instead of great-circle formula.	0.23	0.42	0 .37
Publication characteristics				
journal	=if the study is published in top ranked journals	0.29	0.45	0.31
published	=1 if the study is published in a peer-reviewed papers.	0.94	0.24	0.95
firstpub	Year when the study first appeared in Google Scholar. (base 1985)	21.94	6.93	22.41
impact	Recursive discounted RePEc impact factor of the journal (collected in January 2017).	0.81	0.90	0.70
lnyearcits	Log of the mean number of Google Scholar citations (collected in January 2017).	4.41	2.16	3.92

7.2 Meta-regressions results

In the following part, I cover the empirical results for meta-regression analysis. The goal of this chapter is to resolve the diversity concerning the integration of various explanatory variables. Additionally, I attempt to detect the potential dependence among the variables of a particular study. I intend to run a regression with the trade cost coefficient as the dependent variable and all the characteristics of data, methodology, and publication as predictor variables. The rigours of the regression might be including many redundant variables. Therefore, I run several regressions including different subsets to investigate the robustness of results. I am going to apply a cluster for individual study as I have already done in Chapter 6, since the estimates form the same study might due to their similarity cause a distortion of the outputs to detect a potential heterogeneity. I also use the weights of the inverse of the number of estimates in a particular studies as Havranek & Irsova (2015). With this weights, I am able to get more accurate results.

The following equation (7.1) enables to involve all characteristics that are included in the estimates:

$$Trade\ cost_{ij} = Trade\ cost_0 + \beta \cdot SE(Trade\ cost_{ij}) + \gamma X_{ij} + \omega_{ij} \tag{7.1}$$

where X_{ij} is a vector of the meta-independent variables, which explain the diversity within the estimates. Havranek & Irsova (2011) explain that in this case the constant must be interpreted along with X_{ij}.

The first control why trade cost effects vary among primary studies is shown in Table B.3 in Appendix B. In the left-side of the table are results of OLS regression of all estimation method and characteristics. On the contrary, the right-hand side of the table represents the results based on the robustness check using weighted regressions. Since each primary study report more estimates than other, the results are not likely to be accurate without this weight. The weighted regression, thus, yield more robust outputs in predicting trade cost effect on the bilateral trade flows. From both parts of Table B.3 is evident the importance of the inclusion of weights into the regression, as the outputs of both regression diverge. Some of the explanatory variables have the significant impact on the trade cost coefficient. Among those variables belongs primarily year of the dataset, the disaggregation of the data, the data related to the US, Canada, or service sector. Moreover, the results confirm that the important variable is whether both countries speak the same language. As I have already detected in Chapter 33 the publication characteristics has a large impact on the trade cost effect. Nevertheless, even if many explanatory variables are not significant, they still might be jointly significant.

Raftery *et al.* (1997) notified an issue of accounting for model uncertainty in linear regression models. Conditioning the only selected model disregards model uncertainty, and thus results in the underestimation of uncertainty while drawing conclusions about the amount of interest. The problem of a large number of explanatory variables in my dataset that might lead to the model uncertainty can be solved by Bayessian model averaging (BMA). The model contains the averaging over all possible regressions that involves a subset of overall explanatory variables. The approach is time-consuming, as it would be necessary to make regressions of 2^n possible combinations, where n represents a number of explanatory variables[1].

I decided to solve the issue by using restricted models. I divide the list of explanatory variables into two groups. First group includes all explanatory variables related to the source of dataset: countries surveyed, sector examined and data source. Second method contains all explanatory variables related to the gravity model and each study: treatment of multilateral resistance, specifications characteristics, treatment of zero trade flows, control variables, distance effect and publication characteristics. In addition, I add data characteristics among the explanatory variables included in the second group, even if they might be more related to data set.

The results of OLS regression of dataset are reported in Table7.2. Some of the explanatory variables, that I have expected to raise heterogeneity in Chapter 5, have no significant influence to the elasticity of trade with respect to trade costs. On the contrary, there are some variables within a particular subset of studies that have an appreciable impact on trade cost coefficients. Within countries surveyed, the most significant impact represents US and Canada, even at 1% level. The investigating of the international trade in the US leads to obtain smaller trade cost coefficient (approximately by 2.7). In addition, the international trade including Canada within the research will records a very similar that decrease a trade cost coefficient by about 2.5. The research of the international trade including data from Canada and the US is favoured,

[1]My dataset consists of 51 explanatory variables. Thus, it would be needed to make regressions of 2^{51} possible combinations

Table 7.2: OLS - data source of primary studies

Response variable:		Robust	
Trade cost coefficient	Coef	Std.er.	p-value
Countries surveyed			
US	-2.669	0.988	0.007
Canada	-2.504	0.876	0.004
EU	1.487	0.989	0.133
Japan	1.331	1.244	0.286
OECD	0.382	0.650	0.557
Emerging	0.144	0.688	0.834
Sector examined			
Agriculture	1.316	0.749	0.079
Animals	-1.310	1.423	0.357
Transport	-0.530	0.708	0.455
Raw Materials	0.354	0.680	0.602
Service	2.640	0.891	0.003
Manufacture	0.354	0.630	0.579
Data source			
TRAINS	-2.554	0.690	0.000
COMTRADE	-1.639	0.766	0.028
WITS	-1.987	1.911	0.298
IMF	2.351	1.127	0.037
Constant	-1.884	0.711	0.008
Studies	58		
Observations	1090		

since there are many studies in my dataset that did so. Among explanatory variables within sector examined has the largest impact the service sector that increase the effect of trade cost about 2.5.

The most important subset of the explanatory variables represents a data source of a particular study. Almost all of the variables has a significant impact on the elasticity of trade with respect to trade cost at least at 5% level of significance. The authors who deal with a dataset from TRAINS and COMTRADE negatively influence the trade cost coefficient, by about 2.55 and 1.64, respectively. Contrarily, using a data from IMF has a positive impact on the coefficient, on average by about 2.4.

The using of different data source report significant results, thus I exclude the explanatory variables within sectors and countries examined subsets and make a regression of restricted model. The results of the restricted model including only data source are reported in Table 7.3. The constant can be explained as the trade cost effect for the remaining data source of the esti-

Table 7.3: Restricted model - data source of primary studies

Response variable:	Restricted model		
Trade cost coefficient	Coef	Std.er.	p-value
TRAINS	-3.816	0.679	0.000
COMTRADE	-1.268	0.764	0.100
WITS	-1.643	1.583	0.298
IMF	0.652	0.705	0.355
Constant	-1.357	0.475	0.004
Studies	58		
Observations	1090		

mates that are included in my dataset. Even if all of independent variables are not significant, the reported data source might be still jointly significant as [$F_{4.57}$=11.87, $p \leq 0.01$]. The most significant impact on the estimates has a data from the above mentioned database, TRAINS. Table 7.3 confirms that the data from WITS that contains TRAINS and COMTRADE databases yield the most significant results with a negative impact on the trade cost coefficient.

Table 7.4: OLS - methodology of primary studies

Response variable:	Restricted model		
Trade cost coefficient	Coef.	Std.er.	p-value
Data characteristics			
Mid year	0.040	0.034	0.239
Panel data	-3.525	1.818	0.053
Dissagregated	-0.043	0.591	0.943
Obs.per year	-0.698	0.681	0.305
No.of years	1.714	0.678	0.011
Specification characteristics			
Total trade	-1.700	1.101	0.123
Imports	-1.489	0.868	0.086
Exports	0.043	0.959	0.964
Asymmetry	-1.087	0.871	0.212
No internal trade	-1.528	0.629	0.015
Instruments	0.739	0.648	0.254
Treatment of multilateral resistance			
Control for MR	0.244	0.682	0.720
Remoteness	1.464	0.934	0.117

Theory	-2.816	1.154	0.015
CFE	-0.582	0.574	0.310
Sector FE	0.453	0.658	0.491
Year FE	-0.237	0.587	0.687
Ratios	-0.003	0.776	0.997
Treatment of zero trade flows			
Zero omitted	1.935	0.865	0.025
Zero plus one	1.197	0.802	0.135
PPML	-0.007	0.746	0.992
Tobit	0.766	0.880	0.384
Control variables			
FTA	0.210	0.518	0.685
Language	-1.877	0.183	0.001
Adjacency	0.659	0.379	0.083
Distance effect			
Actual	0.286	0.482	0.554
Distance effect	0.004	0.001	0.001
Publication characteristics			
journal	-2.218	0.836	0.008
published	-2.137	1.133	0.089
impact	-0.108	0.532	0.839
lnyearcits	0.001	0.001	0.752
firstpub	-0.140	0.078	0.074
Constant	1.137	3.688	0.758
Studies	58		
Observations	1090		

Table 7.4 shows the results of the second group of explanatory variables. The restricted model reports the jointly significant explanatory variables as the [$F_{32.56}$=45.61, $p\leq$ 0.01]. The most explanatory variables do not yield the significant effect on the trade cost coefficient. On the contrary, there are many variables that significantly influence the elasticity of trade with respect to trade costs. For this reason I exclude all jointly insignificant variables to obtain a restricted model that can be more useful in predicting distance effect on trade flows.

The restricted model that includes only jointly significant varaibles is presented in Table 7.5. The estimates of the studies reported in top ranked journal have on average by 2.12 lower value than the variables reported in the outliers. Generally, each primary study that is published has significant impact on the trade costs coefficient. In addition, the number of years in the data has also significant effect on the coefficient, but contrarily it increases the trade cost coefficient on average by 1.35 at least at 5 % level of significance . The negative impact has the preference for panel data over cross-sectional (by about -3.38). The authors of the primary studies also investigate how the distance influence the international trade. The additional research has, however, an exiguous impact on the elasticity of trade with respect to trade cost. The measuring distance effect increase trade cost coefficient by about 0.005. On the contrary, the control for the common language significantly influenced the overall effect of trade cost on the international trade, approximately by -2.06. The negative effect on the trade cost coefficient has also the situation, when the authors estimate international trade flows by using production data or when they measure only import flows even at 10 % level of significance.

Table 7.5: Restricted model - methodology of primary studies

Response variable:	Restricted model		
Trade cost coefficient	Coef.	Std.er.	p-value
Panel data	-3.378	1.798	0.060
No.of years	1.347	0.625	0.031
Imports	-0.998	0.545	0.067
No internal trade	-1.076	0.638	0.092
Theory	-1.626	1.213	0.180
Zero omitted	1.129	0.774	0.144
Language	-2.054	0.773	0.008
Adjacency	0.046	0.559	0.935
Distance effect	0.005	0.002	0.002
journal	-2.115	0.698	0.002
published	-2.051	0.723	0.005
firstpub	-0.054	0.078	0.257
Constant	2.855	1.325	0.031
Studies	58		
Observations	1090		

7.3 Discussion of heterogeneity

The restricted models highlight the several explanatory variables, that has a large impact on the trade cost coefficients. The size of the impact of particular significant variables on the effect of trade costs on the international trade is consistent with the wild range of collected estimates. The results form the restricted models are consistent with the theory. Caliendo & Parro (2014) highlight the importance of sectoral heterogeneity, intermediate goods and sectoral linkages for the quantification of the welfare gains from tariffs reduction. Several authors of primary studies (De Sousa *et al.* (2012), Estevadeordal *et al.* (2003), or Head & Mayer (2000)) explored the significant impact of countries examined on the trade costs coefficients. The results of MRA confirmed the investigation of the US market has a significant negative effect on outputs. The significant impact on the trade cost coefficient has also the year and mainly the source of the data. The other important aspect is whether the primary study is published and additionally reported in top ranked journals.

The application of the restricted models, however, has some shortcomings. The researchers should examine more combinations of explanatory variables to be sure that the model is the most robust. Raftery *et al.* (1997) describe two alternative approaches to apply the BMA model - Occam's Window[2] and Markov chain Monte Carlo approach. Havranek & Irsova (2015) applied a Monte Carlo Markov Chain algorithm which directly explicates the exact solution.

The results of the Table 7.5 confirms that by dropping some of the explanatory variables, the linear regression becomes more robust. Nevertheless, by using above mentioned approach, BMA computes a weight (the posterior model probability) that investigates how well the models fits the data. For a particular explanatory variable the researchers then compute the posterot inclusion probability[3], which detects how likely the explanatory variable should be included in the true model Havranek & Irsova (2015). I thus recommend to further verify the value of the explanatory variable and its inclusion in the gravity model by the applying BMA.

[2]Occam's Window is an ad hoc procedure that indicates a small set of models over which a model average. It indicates the null model as the only one to be considered, or as one of a small number of models including the null model, thus largely resolving the problem of selecting signifficant models for a null relationship, Raftery *et al.* (1997).

[3]The posterior inclusion probability, which is the sum of the posterior model probabilities of the regressions in which the variable is included Havranek & Irsova (2015).

Chapter 8

Conclusion

The main objective of this thesis is to uncover whether the researchers who have been exploring the impact of trade costs on the international trade publish their results with a clear consistence, or if the reported coefficients are for some reason biased. The thesis provides a meta-analysis of 1090 estimates collected from 58 studies ranging from -20 to 20 with the mean estimate -2.47. Meta-analysis is an econometric method that is applied to summarize and evaluate the results of primary studies in order to correct these results from publication selection and other distorting and deflecting effects.

The only other quantitative research that has been focused on the elasticity of trade with respect to trade costs was presented by Head & Mayer (2013). The authors computed the mean and the median estimates of the trade costs coefficients and compared the overall effect with a separate summary statistics for particular groups within all studies. They investigated the effect on the estimates by using different gravity models, controlling the gravity equation for multilateral resistance term. They also distinguished what kind of identifying trade costs the authors of primary studies had examined.

I tested for publication selection bias in my dataset in order to determine whether sample of estimates were adjusted to obtain statistically significant outputs. The first method, the funnel plots, graphically shows the evidence of the publication bias, since the shape of the plot deviates a funnel. I followed the division of the dataset applied by Head & Mayer (2013) and investigated evidence of the publication bias within different subgroups. I found some evidence of publication bias within all of the subgroups. I partly confirmed this findings by the other method - funnel asymmetry test. The funnel asymmetry tests did not verify so strong evidence of publication bias as the funnel plots.

The explanation of this detection might be a number of outliers that for example investigate the different kinds of trade costs. Many authors also detect a small negative effect of trade costs on the bilateral trade that rather covert to zero than the mean effect. This group of studies are working papers, thus I recommend for further research to omit them.

The elasticity of trade with respect to trade costs has became the important part of the gravity model, that belongs to one of the most robust empirical findings in economic sphere. The effect of trade cost on the international trade has been varied within particular studies. I clarify the differences in the estimates by diverse source of data, used methods of estimation, and publication characteristics. The significant impact on the trade cost coefficient has the investigation of trade costs within different countries, mainly the US, which is in line with results within some primary study (for instance Estevadeordal *et al.* (2003) or Head & Mayer (2000)). The other significant influence provides the investigation of data from different sectors, mainly service sector. The results are consistent with for example Caliendo & Parro (2014). The important role plays the source of dataset, which also confirmed Anderson & Van Wincoop (2004). The trade costs effects vary similarly by using different methods of estimation and especially the publication characteristics. The result of MRA shows that the quality of a journal where the study is reported high importance carries.

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Appendix A

Studies included in Dataset

Table A.1 contains a list of 58 primary studies used for meta-analysis. 28 of them is collected by myself, the rest is adopted from the overall dataset carried out by Head & Mayer (2013). Online appendix of their studies is accessible on-line at: `http://sites.google.com/site/hiegravity`

Table A.1: List of primary studies used

Ahn *et al.* (2011)	Anderson & Marcouiller (2002)	Anderson *et al.* (2015)
Arkolakis *et al.* (2012)	Baier & Bergstrand (2001)	Békés *et al.* (2012)
Bergstrand (1985)	Bergstrand (1989)	Berman (2009)
Berman *et al.* (2012)	Besedeš & Cole (2017)	Blonigen & Wilson (2010)
Caliendo & Parro (2014)	Cipollina *et al.* (2010)	Cipollina *et al.* (2016)
Costinot *et al.* (2011)	Costinot *et al.* (2011)	De (2009)
De Sousa *et al.* (2012)	Dutt & Traca (2010)	Eaton & Kortum (2002)
Egger & Pfaffermayr (2003)	Egger & Prusa (2016)	Emlinger *et al.* (2006)
Erkel-Rousse & Mirza (2002)	Estevadeordal *et al.* (2003)	Fink *et al.* (2005)
Fontagné *et al.* (2005)	Francois & Woerz (2009)	Fugazza & Nicita (2011)
Gervais *et al.* (2011)	Hayakawa (2014)	Hayakawa (2013)
Head & Ries (2001)	Hertel *et al.* (2007)	Hummels (1999)
Chevassus-Lozza *et al.* (2005)	Jacks *et al.* (2010)	Jakab *et al.* (2001)
Keita (2016)	Lai & Trefler (2002)	Lanati (2013)
Liapis (2011)	Martínez-Zarzoso *et al.* (2003)	Matyas *et al.* (1997)
Martínez-Zarzoso *et al.* (2003)	Matyas *et al.* (1997)	Mayer *et al.* (2005)
Melo *et al.* (2012)	Nahuis (2004)	Novy (2006)
Novy (2013)	Olper & Raimondi (2009)	Owen & Winchester (2014)
Robertson & Estevadeordal (2009)	Romalis (2007)	Tharakan *et al.* (2005)
Thursby & Thursby (1987)	Vezina *et al.* (1987)	Xu (2000)

Appendix B

Other results

Table B.1: FAT - Structural gravity distribution

	1	2	3	4
SE (Publication bias)	0.224	-0.112	0.154	-0.244***
	(0.335)	(0.264)	(0.620)	(0.0225)
Constant (effect beyond bias)	-1.739***	-2.117***	-2.702***	-1.109**
	(0.633)	(0.770)	(0.652)	(0.482)
Observations	184	765	637	312

Standard errors in parentheses

Standard errors are clustered at the study level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: FAT- ditribution of fixed effects

	1	2	3
SE (Publication bias)	0.242	0.557	-1.955***
	(0.220)	(1.084)	(0.535)
Constant (effect beyond bias)	-1.949**	-3.673***	-1.525*
	(0.887)	(0.927)	(0.801)
Observations	453	303	146

Standard errors in parentheses

Standard errors are clustered at the study level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.3: Meta-regression results

Response variable:	OLS			Weighted regression		
Trade cost coefficient	Coef	Std.er.	p-value	Coef	Std.er.	p-value
Data characteristics						
Mid year	0.405	0.013	0.003	0.036	0.018	0.044
Panel data	-1.657	1.283	0.197	-1.778	0.926	0.204
Dissagregated	0.512	0.461	0.267	0.896	0.441	0.043
Obs.per year	-1.074	0.739	0.146	-0.207	0.609	0.631
No.of years	0.703	0.407	0.084	0.525	0.391	0.180
Countries surveyed						
US	-1.346	0.449	0.011	-1.660	0.449	0.000
Canada	-0.391	0.639	0.540	-1.126	0.617	0.040
EU	0.775	0.525	0.140	0.018	0.513	0.972
Japan	0.697	0.715	0.329	1.126	0.753	0.135
OECD	1.234	0.568	0.030	1.194	0.540	0.027
Emerging	0.199	0.606	0.742	0.111	0.478	0.817
Sectors examined						
Agriculture	0.694	0.556	0.211	1.701	0.619	0.548
Animals	0.383	0.384	0.318	-0.610	0.786	0.438
Transport	0.558	1.240	0.652	-0.959	0.616	0.119
Raw Materials	0.493	0.563	0.381	0.866	0.566	0.126
Service	0.601	0.609	0.324	2.127	0.715	0.003
Manufacture	0.024	0.382	0.950	-0.169	0.406	0.677
Specification characteristics						
Total trade	-4.146	1.915	0.030	-0.745	1.111	0.502
Imports	-1.971	0.901	0.029	-0.757	.713	0.289
Exports	-1.845	0.965	0.056	-0.697	0.911	0.444
Asymmetry	-3.334	0.993	0.001	-1.691	0.550	0.002
No internal trade	-1.919	0.753	0.004	-1.012	0.476	0.034
Instruments	0.870	0.649	0.180	1.642	0.739	0.026
Data source						
TRAINS	-3.785	0.700	0.000	-2.697	0.689	0.000
COMTRADE	0.916	0.766	0.232	1.466	0.832	0.078
WITS	0.752	1.067	0.481	-1.503	0.833	0.071
IMF	3.464	0.748	0.000	4.045	0.807	0.000

Treatment of multilateral resistance						
Control for MR	-0.964	0.696	0.166	-1.425	0.578	0.013
Remoteness	1.603	1.065	0.132	1.565	0.616	0.011
Theory	-1.429	0.922	0.150	-1.061	0.917	0.247
CFE	0.549	0.529	0.300	0.702	0.453	0.121
Sector FE	-0.882	0.454	0.052	-1.118	0.535	0.037
Year FE	0.405	0.583	0.487	-0.092	0.455	0.828
Ratios	0.676	1.250	0.589	0.148	0.709	0.835
Treatment of zero trade flows						
Zero omitted	0.766	0.632	0.226	1.681	0.539	0.002
Zero plus one	-0.496	0.716	0.489	0.503	0.588	0.392
PPML	-0.409	0.701	0.559	-0.606	0.559	0.278
Tobit	1.224	1.125	0.276	2.482	1.513	0.101
Control variables						
FTA	0.159	0.404	0.693	-0.129	0.346	0.710
Language	-0.832	0.354	0.019	-1.806	0.407	0.000
Adjacency	0.497	0.335	0.138	0.116	0.291	0.444
Distance effect						
Actual	-0.629	0.368	0.088	0.578	0.368	0.117
Distance	0.002	0.001	0.008	0.004	0.001	0.000
Publication characteristics						
journal	-4.135	0.876	0.000	-4.626	0.794	0.000
published	-2.081	1.114	0.062	-2.149	0.841	0.011
impact	0.832	0.239	0.000	0.946	0.231	0.000
lnyearcits	-0.001	0.001	0.234	-0.000	0.001	0.844
firstpub	-0.109	0.072	0.128	-0.093	0.052	0.076
Constant	3.539	2.218	0.208	-0.742	2.948	0.801
Studies	58			58		
Observations	1090			1090		