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Double Taxation Treaties' Impact on Intermediate Trade

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Abstract

The aim of this thesis is to investigate double taxation treaties impact on intermediate trade. Based on a panel data sample of five partner countries and 39 reporter countries over the period 1990-2012, the impact of signing DTTs on imports of intermediate trade in goods between two countries is analysed through a Gravity model. The main results show that DTT signing is associated with an increase in imports of intermediate goods. The baseline regression is estimated with OLS using fixed effects with logged values of intermediate trade as dependent variable, a bilateral mass variable of countries' GDP, a dummy variable with unity 1 when signing a DTT and a distance variable, as explanatory ones. However, due to a large fraction of zero trade flows in the sample, the magnitude of the effect is hard to determine. To check for robustness when dealing with zero trade flows, methods for sample selection bias have been estimated. Despite this, signing DTTs appears to have a positive impact on intermediate trade. The findings further reveal the importance for future research to investigate how DTTs are affecting intermediate trade in the presents of selection bias.

Key words: *Double taxation treaty, DTT, Intermediate trade, Gravity model, Fixed effects, Heckman, Poisson regression*

Abbreviations

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BEC	Broad End-use Categories
BIT	Bilateral Investment Treaty
BTDIxE	Bilateral Trade Database by Industry and End-use category
CIF	Cost, Insurance and Freight
DTT	Double Taxation Treaty
FDI	Foreign Direct Investment
FOB	Free on board
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
IBFD	International Bureau of Fiscal Documentation
MNE	Multinational enterprise
OECD	Organisation for Economic Co-operation and Development
PTA	Preferential trade agreement
QoG	Quality of Government
RoW	Rest of the World
STAN	Structural analysis
WTO	World Trade Organization

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1. Introduction

The last decades have given rise to a new composition of trade, namely trade in intermediates are becoming widely spread across the world and consists today of around 60 percent of worlds exports.[1] Production sharing, offshoring, vertical specialization and global value chains have shown that multinational firms are more reliant on the international arena. Offshoring and vertical specialization are central features of the globalization era, where trade in intermediate goods has resulted in a rapid change in the trade structure.[2]

Along with globalization and changes in international trade, transfer pricing problems emerged as a new phenomenon. This encouraged multinational enterprises (MNEs) to manipulate their pricing policies as they realized that profits were under taxation in the state were they operated.[3] This led to taxation issues as on one hand brought advantages for MNEs and on the other hand disadvantages for nations. As OECD was founded in 1950s, with one of its principal aim to promote trade between members and assist in removing trade barriers in connection to taxation issues, the importance of double taxation treaties (DTTs) grew. The main purposes of DTTs are the settling of common problems that arise in connection to international juridical taxation, as double taxation and the prevention of tax evasion. Therefore OECD established a model for generating DTTs, *the OECD Model Tax Convention on Income and Capital*, with the purpose to prevent and document taxation issues.[4]

In the end of 2008 there were a total of 2 805 DTTs, 2 676 bilateral investment treaties (BITs) and 273 international agreements (other than DTTs and BITs, including preferential trading agreements) that contained investment provisions.[5] Existing studies, analysing the impact of different trade agreements and economic incentives on intermediate trade are focusing on trade agreements, instead of taxation agreements, this thesis aims to contribute as a new angle of the topic by investigating DTTs impact on intermediate trade.

Empirical evidence indicates that DTTs trigger higher foreign direct investments (FDI) and a desirable goal for almost every policy maker is to increase investment flows in their

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[1] Gamberoni, Lanz & Piermartini (2010), *Timeliness and Contract Enforceability in Intermediate Goods Trade*
[2] Canals & Sener (2014), *Offshoring and intellectual property rights reform*
[3] Miller & Oats (2014), *Principles of International Taxation*, p. 134
[4] ibid, p. 135
[5] UNCTAD (2009b), *Trade and Development Report*

country. Investment growth depends to a large extent on a prevailing investment climate, which can be reached with help from DTTs.[6] Increased FDI flows contributes to both income growth and factor productivity in host countries. Depending on the endowments of the recipient, FDI tends to increase output growth through higher productivity in OECD countries and through capital accumulation in non-OECD countries (mostly Asian countries).[7] Since the mid-1980s Asia´s share of worldwide FDI inflows has doubled from 10 to 19 percent and at the same time their exports of intermediate goods rose 9 percent from 1995 to 2009. In comparison to the rest of the world, Asia is the most attractive market in relation to FDI inflows.[8]

FDI is often seen as an incentive to promote trade and there have been many studies, focusing on FDI in relation to taxation treaties. With an on-going discussion whether trade and FDI are substitutes or complements and due to the increase in vertical specialization, most empirical evidence have found a complementary effect between them.[9] Therefore DTTs should increase FDI and hence more vertical integration and therefore more trade in intermediates. The aim of this thesis is to assess DTTs impact on intermediate trade, with the following research question;

- What impact do double taxation treaties have on intermediate trade flows?

The outline will be to set the countries included in the Nordic Convention (1996) as a reference group and Asia as a response group, by conducting an event analysis. The year a DTT entered into force will be set as the event year, with groups of countries that have adopted DTTs and others who have not. By observing the effect of a dummy variable with unity 1 when adopted a DTT and 0 otherwise, the impact on intermediate trade flows will be studied. Due to the fact that there was an increasing amount of signed DTTs during the 90s and that intermediate trade data is available from 1990 and onward the time horizon 1990-2012 is well motivated for this study.[10]

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[6] Barthel, Busse & Neumayer (2010), *The impact of double taxation treaties on foreign direct investment: Evidence from large dyadic panel data*
[7] OECD paper (2001), *Growth, Technology Transfer and Foreign Direct Investment*
[8] WTO (2011), *Trade patterns and Global Value Chains in East Asia: trade in goods to trade in tasks*
[9] Türkcan (2007), *Outward foreign direct investment and intermediate goods exports: Evidence from the USA*
[10] See Appendix table A2 over signed DTTs

Although trade flows consist of exports and imports, this thesis focuses on the import of intermediate goods, as the exports simply are mirror flows of the imports when dealing with bilateral trade flows. In contrast to the data availability of intermediate services, it is easy to distinguish commodities between consumption, capital and intermediate goods with the BEC classification, whereby trade in intermediate goods is investigated in this dissertation.[11] This thesis studies the impact of DTTs on income and capital, and more specifically, the overall impact of signing a DTT on intermediate trade. Thus, country-specific cases goes beyond the scope of this paper.

The outline of the thesis is as follows: after the introduction, part two includes history and development of DTTs, the connection to intermediate trade and earlier studies on the field. Part three describes the theoretical framework, including the background of the Gravity model, its framework and the model specification used in this analysis. The fourth part describes the data, its sources and how it has been modifies. The econometric methodology will be presented in part five, where the chosen models are systematically described and ordered. The empirical results will be presented in part six. The findings and their implications are further discussed in part seven. Finally, part eight ends with overall conclusions and reflections.

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[11] WTO (2011), *Trade patterns and global value chains in East Asia: trade in goods to trade in tasks*

2. DTT and Trade

The first part contains a background on the history of DTTs, as well as their evolution and purpose. A further explanation of the OECD Model Tax Convention on Income and Capital is also presented. Followed by part two where the connection between DTTs and intermediate trade will be presented and the last part will review previous studies on the field.

2.1 Background of DTTs

"A double taxation convention is an agreement, which is concluded between two States in order to prevent a person who is fully liable to tax in one of the States (or sometimes in both States) from being taxed on the same income (or capital) in both States".[12]

DTTs are usually bilateral between two taxing states, in the context of DTTs and international jurisdiction the use of states refers to countries. The contracting state decides how their tax system shall interact in line with the main purposes of a DTT in order to prevent tax evasion, provide a legal and secure fiscal system, enforce international trade, investment and technology transfer, protect taxpayers and prevent discrimination.[13] DTTs are under international law and regulated under *the Vienna Convention on the Law of Treaties* from 1980. This implies that tax treaties are to protect taxpayers and can therefore never make a taxpayer worse off than under domestic law.[14]

The history of DTTs goes back to the end of the 19th century, the treaty between Prussia and Austria-Hungary shaped developments even before the First World War. In 1928 the first draft of a Model Tax Convention was reported, although at this time the importance of formal tax treaties were still rare.[15] In line with the globalization era and international trade flows, new problems started to arise. Transfer pricing was one of them, and the understanding that multinational enterprises could make profits by manipulate their pricing policies made states with low taxation particularly attractive. Followed by the Carroll Report 1933, which particular dealt with this type of problem and many states around the world entered into DTTs.[16] As OECD was founded in the 1950s with one of its aim "*to promote*

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[12] Rasmussen (2011), *International Double Taxation*, p. 1
[13] Miller & Oats (2014), *Principles of International Taxation*, p. 125
[14] ibid, p. 126
[15] Miller & Oats (2014), *Principles of International Taxation,* p. 133
[16] ibid, p. 134

trade between its member nations" it automatically had to deal with trade barriers in the form of taxation issues. Due to the increase of interdependence and co-operation among members of OECD the importance of preventing international double taxation grew and led to a new need for a more specific regulation. The work resulted in *the draft Model Tax Convention on Income and Capital* (further on the OECD Model), which since 1963 has served as the model for tax treaty agreements. Almost all treaties are based on the OECD Model, which has been widely used for a long time. This convention was a first documented step in the process of international double taxation and served with the purposes of DTTs to,

- provide means of settling, upon a uniform basis, the most common problems which arise in the field of international juridical taxation;
- prevent evasion of tax;
- protect taxpayers against the risk of double taxation where the same income is taxable in two states;
- provide certainty of treatment for cross-border trade, investment and transfer of technology;
- prevent discrimination between taxpayers;
- provide a measure of fiscal and legal certainty in international operations.[17]

A tax treaty is not created over a night, it may tax several years from the start of the negotiations until the treaty will entry into force. The process is complex and sometimes the parties cannot agree and the treaty is never put into use. External influences such as economic and domestic changes, which determine the contracting states situation plays an important role for the success of the process. Key stages in the process of a DTT starts with signing a treaty, after that it needs to be ratified and adopted as a law. When the treaty is ratified the entry into force is the date when is becomes legally binding.[18]

As an internationally accepted model, the OECD Model bring some advantages; common rules of interpretation, major aid to treaty negotiations and certainty for MNE´s resident in a state using the model. The OECD Model is not binding for any state it rather works as a guideline and template for conducting tax treaties.[19] An important benefit from the OECD Model is that it provides a certain security to tax implications in connection to international

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[17] Miller & Oats (2014), *Principles of International Taxation,* p. 125
[18] ibid*,* p. 132-133
[19] ibid*,* p. 135

business. The treatment for tax purposes between the two contracting states will be equal when expanding operations in the other state take place. Under a DTT, in a situation if double taxation should occur, the taxpayer has the right to involve both tax authorities to consult with each other in order to solve and prevent the resulting situation.[20]

Although intermediate trade vary from country to country and so do the DTTs, the impact of the international taxation extended beyond the OECD members, with negotiations between members and non-members of OECD. The OECD Model Convention was used as basis for the *United Nations Model Double Taxation Convention between Developed and Developing Countries* from 1997, which was a huge step in recognizing the influence of double taxation.[21]

As previously mentioned, bilateral DTTs are common between two countries, although with some exceptions. In 1996, the Nordic countries (Denmark, Finland, Norway, Iceland and Sweden) entered into a convention on income and capital, which provides a practical example of a multilateral convention between a group of member countries that follows the principles of the Model Convention.[22]

2.2 Intermediate trade and its connection to DTTs

Intermediate trade flows are becoming increasingly important in the global production chain, as of today around 60 percent of world exports consist of intermediate trade flows.[23] This generates a process where more countries are involved and take part in the production process. International production sharing, especially in the manufacturing sector and global value chains has shown that multinational companies are more dependent on foreign inputs than on domestic ones, implying an increase in trade flows of intermediate goods.[24]

Intermediate trade occurs when firms are splitting their production across several countries, commonly known as offshoring or production sharing.[25] Another name for this is vertical specialization, where the vertical trading chain stretches across countries and each country is specialized in a particular stage of the production process. Vertical specialization has been

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[20] United Nations (2007), *Model Double Taxation Convention – between Developed and Developing countries*
[21] IBFD Tax Research Platform, *OECD Income and Capital Model Convention* (2000)
[22] IBFD Tax Research Platform, Income and Capital Tax Treaty – Nordic Convention (1996)
[23] WTO - Staff Working Paper (2010), *Timeliness and Contract Enforceability in Intermediate Goods Trade*
[24] Hummel et al. (2001), *The nature of growth of vertical specialization in world trade*
[25] Feenstra (2004), *Advanced International Trade,* p. 100

widely studied and many models have been focusing on the impact of increase vertical specialization on factor prices, production and trade patterns. A key part of vertical specialization is that countries sequentially are linking together in the goods production. One specific feature of this linkage is the amount of imported intermediate goods, which are used by a particular country to produce final goods and later export them to another (a third) country. A formal way of classifying vertical specialization is through three definitions. Firstly, a good should be produced in two or more stages. Secondly, two or more countries should provide value-added during the production process. Lastly, at least one country must use imported inputs in the production stage that ends up with an output to be exported. The first and second definitions do also fit as descriptions for trade in intermediate goods, whereas the case for the third one is that it is only the subset of intermediate goods imports that become embodied in exported goods.[26]

This changed characteristics of trade brings about the most important developments in the international trade area and shows that the composition of trade varies among countries. However, this change has brought many implications in the way of understanding trade policies. The way of thinking of products as "made in Taiwan" or "made in Japan" does no longer exist; it is rather "made in the world" that is the case. The emerge of "Factory Asia" primarily reflects the rise of mass marketing in the West and tends to influence the consumption pattern in higher developed countries especially the US market. The developed demand-supply relationship between the US and Asia is one trade effect, where the Asian economies have been ordered in a structure depending on their comparative advantages. This has changed over time, as changes in economic roles within East Asia and closer regional integration with industrial interconnection. Due to Association of Southeast Asian Nations (ASEAN) and Asia Pacific Economic Cooperation forum (APEC), trade within supply chains has accelerated.[27]

Already during The Second Unbundling, Baldwin defined production as "sliced and diced" in separate fragments that are spread around the world.[28] Grossmann and Rossi-Hansberg presents an new paradigm marked as "trade in tasks", instead of simply creating more trade

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[26] Hummel et al. (2001), *The nature of growth of vertical specialization in world trade*
[27] WTO (2011), *Trade patterns and global value chains in East Asia: trade in goods to trade in tasks*
[28] Baldwin (2006), *Globalisation: the great unbundling(s)*

in goods global integration is marked with more trade of intermediate goods and services due to the widespread phenomenon offshoring. Countries are no longer exclusive in their final export, instead they specialize in specific stages of the production chain.[29] This trade in tasks adds value along the production chain due to the specialization in parts and components in different economies. The original outline from traditional trade theory, which says that trade, is determined due to a country´s comparative advantage of producing a final good is now threated by the comparative advantages of "tasks". This rapid expansion of "trade in tasks" has benefitted from an increased FDI inflow in Asia, between 1985-1995 the amount doubled and have continued to increase since then. In Asia FDI inflows tends to increase output growth through capital accumulation, due to it slices up specialization patterns and hence increase vertical integration. FDI inflows have played an important role in the development of trade in intermediate goods as it slices up the production process and contributes to a structural and geographical diversification of MNEs.[30] With empirical evidence saying that DTT triggers FDI, the indirect link would be a positive impact from DTTs on intermediate trade.[31]

As the section above indicates, the determinants of trade in intermediate goods are vital to understand the patterns of trade flows and so are the effects that arise in connection to trade changes. Europe and Asia are two areas where the production and export of intermediate inputs mainly is concentrated, where Asian exports of intermediate goods is a fast growing market. The integration of production sharing can be displayed through the increasing volume of trade in intermediate goods. Of Asia´s total imports, intermediate goods consists of more than 60 percent, which makes Asia the world´s key player in international production sharing.[32]

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[29] Grossmann & Rossi-Hansberg (2006), *Trading tasks: a simple theory of offshoring*
[30] WTO (2011), *Trade patterns and global value chains in East Asia: trade in goods to trade in tasks*
[31] Barthel, Busse and Neumayer (2010), *The impact of double taxation treaties on foreign direct investment: evidence from large dyadic panel data*
[32] WTO (2011), *Trade patterns and global value chains in East Asia: trade in goods to trade in tasks*

2.3 Previous studies on DTTs

The impact of DTTs and BITs on foreign direct investments has been studied extensively over the last 10-20 years. The discussion goes in both directions, though the overall result shows that taxation treaties trigger higher FDI flows.[33]

Neumayer presents the first study with evidence that developing countries that have signed DTTs with other higher developed countries or a higher number of DTTs with important export partners, do receive more FDI in total.[34] Moreover, Barthel, Busse and Neumayer argue that most of the earlier studies are suffering from either a narrow or non-representative sample size when collecting the FDI data. Therefore, they address the question whether a DTT leads to more bilateral FDI between the two countries in question. Their study differs from others as they extend the dataset by using a dyadic country dataset with both developed and developing countries over a longer time period instead of an aggregated dataset. Their results indicate that DTTs do lead to between 27 and 31 percent higher FDI stock.[35]

Blonigen presents a critical review of the last international investigations on the fundamental factors that drive FDI behaviour of MNEs, where he highlights taxes as one external factor. He concludes that policies dealing with double taxation will affect a MNE's incentive to invest. Another highlighted determinant of FDI is the importance of the quality of institutions. Institutions are persistent, present a view on a country´s infrastructure and emphasize the impact of how well-functioning the markets are. Blonigen argues that depending on these factors the FDI flows will either increase or decrease.[36]

Based on data on OECD countries during the period 1982-1992, Blonigen and Davies further examine the influence of bilateral tax treaties on FDI. Their result shows that DTTs also have a dampening effect on FDI as they reduce tax avoidance, tax evasion and other

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[33] Barthel, Busse and Neumayer (2010), *The impact of double taxation treaties on foreign direct investment: evidence from large dyadic panel data*

[34] Neumayer (2007), *Do double taxation treaties increase foreign direct investments to developing countries*

[35] Barthel, Busse and Neumayer (2010), *The impact of double taxation treaties on foreign direct investment: evidence from large dyadic panel data*

[36] Blonigen (2005), *A review of the empirical Literature on FDI Determinants*

legal tax-saving strategies such as transfer prising regulations for MNEs.[37] Egger et al. follow the same results by estimating the effect of tax treaties on bilateral stocks of outward FDI from OECD countries, during 1985-2000. The study finds a significant negative impact of newly implemented DTTs on outward FDI stocks.[38]

Di Giovanni examines the impact of various macroeconomic and financial variables on cross-border M&A activities as a component of FDI during the 90s for 193 countries. By using a simple Gravity model he finds evidence that financial market development plays a significant role, and further that distance has a negative effect while a common language has a positive effect. He concludes that high tax rates in the target country provides disincentives to invest, however the evidence shows that bilateral tax agreements have a positive effect.[39] In conclusion, studies that have been conducted using bilateral FDI data do not find a positive effect of DTTs on FDI. However, studies that have used aggregated data in larger and more representative samples do often find a positive relationship between DTTs and FDI.[40]

Most theories of multinational firms indicate that it is the type of trade that determinates if FDI and trade are substitutes or complements. The increased demand for intermediate goods in vertical relationships has resulted in empirical evidence for potential complementary effects and the substitution evidence from trade in final goods.[41] Blonigen investigates whether FDI and exports are substitutes or complements by examining product-level data on a disaggregated level, where he can separately identify the substitution from complementary effects.[42] Further explanations for the strong complementarity in empirical work, is the multi-product nature of a firm (vertical production relations between the products of the firm) and the existence of sources of positive spurious relationships between FDI and trade.[43]

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[37] Blonigen & Davies (2002), *Do Bilateral Tax Treaties Promote Foreign Direct Investment?*
[38] Egger et al. (2006), *The impact of endogenous tax treaties on foreign direct investment: theory and evidence*
[39] Di Giovanni, Julian (2005), *What Drives Capital Flows?*
[40] Barthel, Busse and Neumayer (2010), *The impact of double taxation treaties on foreign direct investment: evidence from large dyadic panel data*
[41] Türkcan (2007), *Outward foreign direct investment and intermediate goods exports: Evidence from USA*
[42] Blonigen (1999), *In search of substitution between foreign production and exports*
[43] Forte (2004), *The Relationship between Foreign Direct Investment and International Trade*

Nevertheless, the potential impact of DTTs on intermediate trade has not yet been investigated to the same extent as the impact of DTTs on FDI flows. This implies an area where more research and analyse can be done. Though, instead of analysing the impact on FDI flows in relation to signed DTTs, this thesis investigates the impact on intermediate trade when countries are adopting DTTs. Therefore, this study seeks to investigate whether there might be an additional purpose for signing DTTs, as it may contribute to increased intermediate trade.

3. Gravity model

This chapter presents the underlying framework and descriptions of the Gravity model. First it covers the background and the empirical use of the model, following by the theoretical framework and ending with an estimation specification of the Gravity equation.

Background of Gravity model

This study aims to investigate bilateral trade flows of intermediate goods between reporter and partner countries using the Gravity model. Gravity equations have long been widely used for analysing international trade relations, especially because of their high explanatory power and the empirical success of predicting trade flows.[44] The model connects trade flow effects such as institutions, custom unions, exchange-rate mechanisms, historical and cultural ties as well as identities and international borders.[45]

The Gravity model originates from Sir Isaac Newton´s work on *Law of Universal Gravitation,* as it states that bilateral trade between two countries is directly proportional to their respective economic size and inversely related to the associated trade costs. Larger countries and countries that are more similar in their relative sizes tends to trade more with each other. Trade in goods implies that goods, which are produced in one country, will be sent to all other countries in proportion to the size of the purchasing country´s GDP.[46]

Theoretical framework

The well-known Gravity model has been criticized for lacking in theoretical specifications and therefore suffers from incorrect model specification. Anderson and van Wincoop (2003)

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[44] Baldwin & Taglioni (2006), *Gravity for dummies and dummies for gravity equations*
[45] Anderson & van Wincoop (2003), *Gravity with Gravitas: A Solution to the Border Puzzle*
[46] Feenstra (2004), *Advanced International Trade*, p. 144-145

extend the standard model by introducing exporter and importer fixed effects and thereby adding strong theoretical foundations to the model.[47] They state that the standard model has two major limitations: first, estimation results are biased due to omitted variables and second, the model does not allow for comparative statistics due to the exclusion of trade barriers.[48]

By including implications of border effects such as transport costs and tariffs, which implies that the prices are no longer equalized across countries, the extended model becomes more complex.[49] It includes a wider approach as the impact of borders both on intranational trade (within a country) and international trade are taken into consideration.[50]

Standard assumption in the Gravity model is that all goods are differentiated by place of origin. Extended in this model is that each region is specialized in their production of only one good and the supply of each good is fixed.[51] Assuming a specific utility function, the CES specification, the border effects will be taken into account and there is identical and homothetic preferences. The following equation

$$U^j = \sum_{i=1}^{C} N^i \left(c^{ij} \right)^{\frac{(\sigma-1)}{\sigma}}$$

indicates the utility for country j, where country $i=1,\ldots$, C produces N^i products and c^{ij} denotes the consumption (hence consumption is the same as exports) of any product sent from country i to country j. The representative consumer in a country maximizes the utility with respect to the budget constraint $\sum_{i=1}^{C} N^i p^{ij} c^{ij} = Y^j$. Here σ denotes the elasticity of substitution among all goods, Y^j is the aggregated expenditure and income in country j and p^{ij} is the price of country i goods for country j consumers.[52] This is a result from assuming that all products exported by country i sell for the same price p^{ij} in country j. As clarification, the prices includes the transport costs from country i to country j on a basis of CIF prices (cost, insurance, freight) and the local prices p^i for goods produced in country i

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[47] Feenstra (2004), *Advanced International Trade*, p. 144-145
[48] Anderson & van Wincoop (2003), *Gravity with Gravitas: A Solution to the Border Puzzle*
[49] Feenstra (2004), *Advanced International Trade,* p. 152
[50] Anderson & van Wincoop (2003), *Gravity with Gravitas: A Solution to the Border Puzzle*
[51] ibid, p. 174
[52] Feenstra (2004), *Advanced International Trade,* p. 152-153

are net of any price basis on FOB prices (free on board). Samuelson introduced the relationship among these prices in 1952, as the "iceberg" transport costs, which describes that there would always be some amount that "melts" along the way. The relationship is $p^{ij} = T^{ij}p^i$, where T^{ij} is the trade cost factor between i and j. Assume also that for each good that is shipped from i to j the exporter incurs export costs which is equal to T^{ij}- 1 of country i goods.[53]

An expression for demand for each product c^{ij}, within or between countries, can be derived from the above expressions, $c^{ij} = \left(\frac{p^{ij}}{P^j}\right)^{-\sigma}\left(\frac{Y^j}{P^j}\right)$, where P^j is the price index for country j, defined as $P^j = \left[\sum_{i=1}^C N^i \left(p^{ij}\right)^{(1-\sigma)}\right]^{\frac{1}{(1-\sigma)}}$.

From the demand and price index expressions above the equation for the total value of exports from country i to j will be,

$$X^{ij} = N^i p^{ij} c^{ij} = N^i Y^j \left(\frac{p^{ij}}{P^j}\right)^{1-\sigma}.^{[54]} \qquad\qquad \text{Eq. 1}$$

Anderson and van Wincoop use the market-clearing condition, $y^j = \sum_{j=1}^C c^{ij}T^{ij}$, to further simplify the Gravity equation by multiplying it with the price p^i. Further they use FOB prices to find an implicit solution and suppose that the transportation costs are symmetric $T^{ij} = T^{ji}$. Hence, it follows an implicit solution to the market-clearing condition above,

$$\left(P^j\right) = \sum_{i=1}^C s^i \left(T^{ij}/P^i\right)^{1-\sigma}, \text{where the price indices are solved.} \qquad \text{Eq. 2}$$

By incorporating price indices and trade costs into the Gravity equation one ends up with the following equation,

$$X^{ij} = s^i Y^j \left(\frac{T^{ij}}{P^i P^j}\right)^{1-\sigma} = \left(\frac{Y^i Y^j}{Y^w}\right)\left(\frac{T^{ij}}{P^i P^j}\right)^{1-\sigma}.^{[55]} \qquad \text{Eq. 3}$$

Equation 3 shows that bilateral trade between countries depend on the size of their GDPs and their implicit price indices. In theory the price indices, P^i, are referred to as "multilateral resistance" variables as they depend on all bilateral resistances T^{ij} (transport costs) and

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[53] Feenstra (2004), *Advanced International Trade,* p. 152-153
[54] ibid, p. 153
[55] Feenstra (2004), *Advanced International Trade,* p. 156-157

implies a rise in the index as there is a rise in trade barriers with all trading partners.[56] A key implication of this theoretical approach of the Gravity equation is that trade between countries is determined by relative trade barriers. The trade between two countries depends therefore on the bilateral trade barrier between them, relative to average trade barriers that both countries face with all their trading partners.[57] The trade costs T^{ij} are not observed and can therefore be assumed to equal a function of observed variables such as,

$T^{ij} = distance_{ij}^{\beta} e^{-\beta DTT_{ij}}$. Taking logs of the equation, we obtain,

$$ln\tau_{ij} = \beta_1 lndist_{ij} - \beta_2 DTT_{ij}. \qquad \text{Eq. 4}$$

To estimate the Gravity equation above (equation 3), the GDP terms have to be moved to the left side, take logs and substitute for the trade costs (equation 4), which yields,

$$ln\left(\frac{x_{ij}}{y_i y_j}\right) = a_{0ij} + \alpha_1 lndist_{ij} + \alpha_2 DTT_{ij} + ln\left(P^i\right)^{\sigma-1} + ln\left(P^j\right)^{\sigma-1} + \varepsilon_{ij} \qquad \text{Eq. 5}$$

This is an empirical version of the Gravity equation where the log of observed trade flow is equal to the log of the true trade flow plus an error term. Where the dependent variable on the left hand side is bilateral trade relative to the product of GDPs. The right hand side consists of distance between country i and j, the effect of signing a DTT as a dummy variable with unity 1 if signed and 0 otherwise and the multilateral resistance terms $(ln\left(P^i\right)^{\sigma-1}, ln\left(P^j\right)^{\sigma-1})$. These terms are replaced when estimating with fixed effects. The fixed effect approach estimates the border effect terms as part of the regression without relying at the formula in equation 2. This method is considered to be the preferred empirical method as it provides consistent estimates of the average border effects across countries and is easy to implement.[58]

Specification

In line with the theoretical framework documented above, the model used for this thesis will follow the regression of the Gravity equation estimated with fixed effects,

$$lntradeflow_{ijt} = \alpha_{0ijt} + \alpha_1 lnmass_{ijt} + \alpha_2 dtteffect_{ijt} + \lambda_t + \varepsilon_{ijt}. \qquad \text{Eq. 6}$$

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[56] Anderson & van Wincoop (2003), *Gravity with Gravitas: A Solution to the Border Puzzle,* p. 176
[57] ibid, p. 177
[58] Feenstra (2004), *Advanced International Trade,* p. 161-162

The fixed effects model includes individual-specific intercept terms, α_{ij}, which captures unobservable effects. Furthermore, it allows for unobserved and misspecified time-invariant differences across countries, which simultaneously could explain trade volume between two countries.[59] Cheng and Wall argue in their study that the Gravity equation for a country-pair may have a unique intercept i.e. different for each direction of trade where α_{ij} is the "specific country-pair effect" between countries. [60] This specific "country-pair" effect includes the effects of all omitted variables that are country specific but remain constant over time such as language and distance. Using this approach implies that distance will be omitted from the model, as it controls for all variables that do not change over time. The λ_t is a vector of time fixed effects.

The dependent variable is the bilateral imports of intermediate goods, between country *i* and *j* in year *t, tradeflow,* in logarithm values. Consider bilateral trade between two countries, there is four observations of bilateral trade flow, which can be used. Nations spend more time on measuring imports than exports due to the avoidance of tariff fraud, therefore the standard choice is to use the import data. Within EU trade is gathered from VAT statistics since 1993 and therefore this point is reversed among EU members.[61] This thesis estimates import flows, due to that the dataset consists of the same set of reporter and partner country´s exports it will be defined as mirror flows from imports. For this analysis, the import flows also are chosen from the importance of vertical specialization when countries import inputs to the extent of producing the final good and export it.[62]

The explanatory variables *lnmass* and *dtteffect* are the two main important independent variables in the baseline specification. *Lnmass* is created from data on GDP in current prices (US dollar) from the reporter and the partner countries over a time range from 1990 until 2012. The data is collected from The World Banks World Development Indicators. *Lnmass* is an economic bilateral mass variable, and as the product of two nation´s GDPs it works as a solution instead of separately estimating the partner and reporter GDP variables.[63]

[59] Verbeek (2012), *A Gudie to Modern Econometrics,* p. 374
[60] Cheng & Wall (2005), *Controlling for Heterogeneity in Gravity Models of Trade and Integration*
[61] Baldwin & Taglioni (2006), *Gravity for dummies and dummies for gravity equations*
[62] Hummel et al. (2001), *The nature of growth of vertical specialization in world trade*
[63] Baldwin & Taglioni (2006), *Gravity for dummies and dummies for gravity equations*

To capture the effect of signing a DTT the dummy variable *dtteffect* has been constructed in the following way. For DTTs signed before 1990 the binary variable is 1 and so it follows for the ones who are adopting a DTT during the 90s, which implies that it is 0 for countries who not have signed DTTs. In total the dataset consists of 195 possible bilateral groups which could have DTTs or not, with five reporting countries and 39 partner countries.

When estimating alternative specifications without fixed effects *lndist* will be included in the model. Distance is a common explanatory variable in the standard Gravity model and can be seen as a bilateral trade cost due to the natural barriers that occurs between two countries, i.e. natural distance. The model indicates a negative relationship between trade and distance and implies a negative impact on trade the greater the distance is between two trading countries.[64] Measuring distance between two countries is not a well-defined concept as it can be done in many different ways. The most common and simplest way is the measure of the great circle distance between capitals and this practice is followed in this thesis. The variable *lndist* is a natural log of the geographic distance between the capitals of two countries, and is included in below specification.[65]

$$lntradeflow_{ijt} = \alpha_o + \alpha_1 lnmass_{ijt} + \alpha_2 dtteffect_{ijt} + \alpha_3 lndist_{ijt} + \varepsilon_{ijt} \qquad \text{Eq. 7}$$

Due to the importance of contracts and good legal institutions when one wants to measure trade in intermediate goods with the Gravity equation, the model is extended with different interaction variables.[66] Interactions are made between *dtteffect* and *distance*, *dtteffect* and *regime*, *dtteffect* and *colonized*. *Regime* and *colonized* are both binary variables, *regime* describes country *i´s* regime type and is coded 1 if the country has a parliamentary system and 0 otherwise. *Colonized* displays information whether a country has a colonial origin, where 0 is never colonized and 1 if it historically has been a colony. When interacting these variables with *dtteffect,* the parameter coefficient on the interaction variable captures the differential impact of a DTT on intermediate trade depending on institutional and historical influences.

[64] Feenstra (2004), *Advanced International Trade,* p. 145
[65] Baldwin & Taglioni (2006), *Gravity for dummies and dummies for gravity equations*
[66] ibid

4. Data

According to the general Gravity model the dataset often consists of a dependent variable and three explanatory variables, economic mass, bilateral distance and the policy variable of interest, which in this case is the effect of signing a DTT.[67] The subsequent section consists of a presentation of the data used for the variables in the model specification.

The data underlying the analysis of this paper is annual import data in intermediate trade flows of goods, between the reporting and the partner country, covering the period 1990-2012. The data is collected from *STAN Bilateral Trade Database by Industry and End-use category* (BTDIxE) from OECD library and is measured in values of thousands US dollars. This database is an extended version of the original BTD, which only provides bilateral trade in goods by industry but now also covers statistic of goods broken down by end-use categories. By breaking down trade in goods in line with their end-use categories there is new dimensions in the detailed classification system presented, which can be used for trade in goods. The bilateral trade flows of imports can broadly be classified into three groups; intermediate goods, household consumption goods and capital goods. This is called the BEC (Broad End-use Categories) classification and has been widely used in many studies. Due to the end-use breakdown in BTDIxE, it specially provides insights in the pattern of trade in intermediate goods between countries, which is used for this study. The data breakdown covers 66 detailed and aggregated economic activities based on the new classification ISIC Rev. 4. This thesis includes all breakdown activities, as it is not aiming to analyse a specific one.[68]

The selection contains five reporting countries, included in the Nordic Convention from 1996: Denmark, Finland, Iceland, Norway and Sweden. These countries can be argued to include similarities in terms of size, location, and cultural and historical aspects. The partner countries are set to 39 Asian countries, resulting from the selection of data on intermediate trade as breakdown. Included countries are reported in Appendix table A1.

Data on DTTs is collected from IBDF portal, a cross-border tax enterprise portal, where all

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[67] Baldwin & Taglioni (2006), *Gravity for dummies and dummies for gravity equations*
[68] OECD (2014), *BTDIxE Documentation*

tax treaties worldwide can be found.[69] The date used for breakdown of the dummy variable is the *in force date.* As the bilateral trade data starts in 1990 three different groups have been arranged in relation to when a DTT was signed, before and after 1990 and one for the absence of a DTT. This breakdown can be seen in the table below and breakdown over country-specific cases is presented in table A2 in the Appendix.

Reporter	Partner - no DTT signed	Partner - DTT signed before 1990	Partner - DTT signed after 1990
Denmark	20	8	11
Finland	20	7	12
Iceland	34	0	5
Norway	21	8	10
Sweden	21	11	7

Table 4.1: Authors own compilation, source IBDF-portal

The data used for model estimations is a panel dataset, with repeated observations over countries collected over a number of periods.[70] It includes time range, reporter, partner, intermediate trade values, GDP, distance and if and when a DTT was signed.

Data over bilateral distance is collected from CEPII, which is a research centre in international economics located in France. The dataset from CEPII is dyadic, in the sense that it includes distance variables valid for pairs of countries. The variable includes different measures of bilateral distances (in kilometres), where in this thesis the measure of bilateral distance between the capital´s of country pairs has been used.[71]

When creating interaction dummies, data on regime type and colonial origin has been collected from QoG database[72]. The regime variable is originally coded as 0 when there is a presidential system in the country and 2 when there is a parliamentary system. 1 in the middle describes a system of a strong president elected by assembly. I have recoded the variable to a dummy with 0 as presidential system and 1+2 levels of systems as a 1 in the binary variable.

Colonial origin is originally coded in a range from 0 to 10, where 0 is never colonized and 1-10 covers the former colonial ruler of a country. As for this thesis the interest lies in whether

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[69] www.ibfd.org
[70] Verbeek (2012), *A Guide to Modern Econometrics,* p. 372
[71] www.cepii.fr
[72] QoG: *Quality of Government Institute* - an independent research institute within the department of Political Science at the University of Gothenburg

a country has been colonized or not in its history, the variable is recoded to 0 – never colonized and 1- former colony. Both variables are derived from a cross-section dataset in year 2009.[73]

5. Methodology

This section will present the econometric models for estimating the data and to address the research question. The choice of the baseline model goes in line with previous studies and theories, however this model will be tested and compared with other specifications.

Fixed effects

When working with a static linear panel data model as in this thesis it implies that the variables are strictly exogenous and not dependent on current, future or past error terms. Linear panel data models are usually estimated with either fixed effects or random effects.[74] Common methods when one want to estimate the Gravity equation with panel data is the cross-section or pooled-cross-section method, however these methods have failed to explain heterogeneous trading relations. Therefore a lot of studies are using fixed effects in the Gravity equation, which also is the case of the baseline regression, equation 6, in this thesis.[75]

The fixed effects model is a linear regression model where it is usually assumed that all x_{ijt} are independent of all u_{ijt} i.e. allows the intercept to vary between the individual units *i* and *j,* hence in this study *i* and *j* refers to countries. The purpose of a fixed effect model is to eliminate all the individual effects α_{ij}, the parameters can be estimated with OLS with estimators such as the fixed effect estimator or the LSDV (least squares dummy variable) estimator.[76] The LSDV estimator can be used when dealing with country specific effects by creating a dummy variable for each country, which implies a regression with many numerical regressors, depending on the dataset. However, the fixed effects estimator is thus a simpler way to obtain the same results, which is based on deviations from individual means instead of the individual effects.[77]

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[73] The QoG Standard Dataset – Codebook (2013)
[74] Verbeek (2012), *A Gudie to Modern Econometrics,* p. 374
[75] Cheng & Wall (2005), *Controlling for Heterogeneity in Gravity Models of Trade and Integration*
[76] Verbeek (2012), *A Guide to Modern Econometrics,* p. 376-377
[77] ibid, p. 377

The dummy variable of interest, capturing the event of signing a DTT and estimating the impact on intermediate trade in the regression, when controlling for fixed effects and country characteristic, is obtained as,

$dtteffect_{ijt} = 1$ if country i signed a double taxation treaty with country j in period t

$dtteffect_{ijt} = 0$ otherwise. Recall the specification of equation 6, a log-linear model for intermediate trade with $lntradeflow_{ijt}$, as the dependent variable in the baseline regression for estimation below,

$$lntradeflow_{ijt} = \alpha_{0ijt} + \alpha_1 lnmass_{ijt} + \alpha_2 dtteffect_{ijt} + \lambda_t + \varepsilon_{ijt} \qquad \text{Eq. 6}$$

where λ_t is time fixed effects, α_{ij} is country-pair fixed effects, $lnmass_{ijt}$ is time-varying country characteristics, the product of GDP between two countries.[78]

Sample selection bias

When working with bilateral trade data over a certain time period it is common that some trade flows are zero, which is the case in the dataset used for this thesis. It is well known that zero values of the dependent variable can create potentially large biases in the parameter estimations.[79] However, some reports of zeros could be of the nature of missing data, rounding errors or omissions, but it appears that most of zeros actually reflect the true absence of trade between two countries and this is quite common in international trade. The underlying background to the zero-values is not certain, it could be several different reasons that determine why two countries do not trade with each other. It is common to use former trade agreements as one determinant to the background for trade relations between countries. GATT/WTO are not only said to increase the intensive margin, countries trade more with each other, but also the extensive margin which is creating new trading relations.[80] This implies that these zero-values could hold important information, which will go missing when estimating the data with the linear model and fixed effects as described above. Usually when estimating the Gravity model, the positive values are just included whereby zeros are excluded from the model, which indicates a loss of information and could underestimate the effects of trading relations. The results can therefore provide biased estimates and issues of sample selection can be observed.[81] When the sample used for analysis not is randomly

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[78] Verbeek (2012), *A Guide to Modern Econometrics,* p. 380

[79] Tobin (1958), *Estimation of Relationships for Limited Dependent Variables*

[80] Lui (2007), *GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification*

[81] Helpman et al. (2007), *Estimating trade flows: Trading Partners and Trading Volumes,*

drawn from a larger population, sample selection bias occurs. Standard estimates and tests may result in misleading inferences when dealing with selection bias. The general understanding of when selection bias occurs is when the zeros are not randomly dropped.[82]

With the pros and cons of excluding or including the zeros in an OLS regression described above, the baseline regression in this thesis will include all values, as adding 1 when taking the logarithms of the dependent variable keeps the zeros as zeros. The second approach will be to estimate the baseline regression without the zeros.

Another approach when dealing with a dataset consisting of a large number of zeros, the Tobit II model (also referred to as the sample selection model) is the traditional model to describe the selection problem. The model is a good choice to treat zero trade as corner solution problems.[83] However, this model has been questioned in the way of dealing with heteroskedastic or non-normal residuals.[84]

Further on the Heckman approach considers the case when sample selection bias arises in the OLS estimator, consisting of a sample selection and an outcome equation.[85] The Heckman approach consists of two different estimation methods, the Maximum Likelihood estimation and the Two-Step estimation. The latter one has a desirable feature of allowing the sample selection and the behavioural equations to be estimated independently.[86] However this simplifies the model by assuming that trade decisions are taken independently, which somehow seems implausible in a world where decisions on whether to trade and how much to trade rather is determined from firms profitability. Therefore it is found that the ML estimator generally provides better and more efficient results than the Two-Step estimation.[87]

A likelihood test is used to test for independence of the selection and outcome equations, with the specification of the null hypothesis that the correlation coefficient, ρ, equals zero.

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[82] Verbeek (2012), *A Guide to Modern Econometrics,* p. 257
[83] ibid, p. 248
[84] Lui (2007), *GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification*
[85] Consisting of a binary variable, *impdum,* included in the selection sample: unity 1 if positive trade, 0 otherwise.
[86] Duan et al. (1983), *A comparison of alternative models for the demand for medical care*
[87] Puhani (2000), *The Heckman Correction for Sample Selection and its critique*

Rejection of the null hypothesis means that OLS will produce biased estimates.[88] Helpman et al. investigates the intensive and extensive margins of international trade by applying a two-step estimation procedure, first testing whether there is a selection bias.[89] In line with Helpman´s approach, the Heckman approach in this thesis will follow a two-step estimation to clarify if the model is suffering from selection bias and depending on the result further estimate the regression with the ML estimator.

The use of a Poisson regression is another approach to estimate the Gravity equation, which yields that the model will be estimated in its multiplicative form (without taking logarithm on the dependent variable) with the PML (pseudo-maximum-likelihood) technique. Santos Silva and Tenreyro, who argued that due to Jensen´s inequality, a log-liner model couldn't be expected to provide unbiased estimates when the model is dealing with heteroskedasticity. Further they discuss the problems of defining the zero values of the dependent variable, which arises when the values are converted into logarithms.[90] The Poisson estimator is often used for count data and when the Poisson distribution is correct and having a random sample this produces a consistent, asymptotically efficient and normal estimator.[91] To address issues of heteroskedastic or non-normal residuals the Poisson regression turns out to be suitable.[92]

From the methods and models described above the econometric specification in this thesis will be to use the log-linear panel regression estimated with OLS and fixed effects (including all values) as the baseline regression. To check the importance and impact of zero-values, further estimation specifications such as excluding zeros in the OLS estimation, Heckman selection approach and the Poisson regression will be used. Due to that the bilateral trade data, which is used in this thesis starts from 1990 and that some countries signed DTTs earlier than that, the DTTs signed before 1990 have been eliminated from the models estimations.

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[88] Verbeek (2012), *A Guide to Modern Econometrics,* p. 249
[89] Helpman et al. (2007), *Estimating Trade Flows: Trading Partners and Trading Volumes*
[90] Silva & Tenreyro (2006), *The Log of Gravity*
[91] Verbeek (2012), *A Guide to Modern Econometrics,* p. 231-232
[92] Lui (2007), *GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification*

6. Empirical results

In this part the results from estimating equation 6 over the time period 1990-2012 are presented, using the entire sample of panel data with different methods for regression specifications.

In order to estimate the log-linear regression of the Gravity equation with the full sample the dataset is converted into a panel set. The result for the panel variable, consisting of 190 bilateral groups and 4 320 observations, is strongly balanced over the years 1990-2012.

Descriptive statistics

Table 6.1 below displays descriptive statistics for the dependent and independent variables used in the regressions. It further shows the mean value, standard deviation, maximum and minimum value for 4 320 observations. Due to logarithmic values the standard deviations are very low and implies smooth variations for estimating the regressions in linear form. In my log-linear baseline Gravity regression, estimated with OLS, the dependent variable *lntradeflow* is substituted by *ln(tradeflow +1)* to keep the zero trade values after taking logarithms.

Mean Estimation	Number of obs: 4320			
Variables	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
lntradeflow	6.6072	4.4308	0	16.5322
lnmass	50.1169	2.5599	41.7619	56.7233
dtteffect	0.2928	0.4551	0	1
lndist	8.6821	0.45584	6.7942	9.4267
dist_dtt	2.5547	3.9823	0	9.3006
regime_dtt	0.1155	0.3197	0	1
colonized_dtt	0.1737	0.3789	0	1

Table 6.1: Summary statistics for the main variables

As presented in the table above, the average intermediate trade between a country-pair in the dataset amounts to 6.6 thousand US dollar and it consists in a range from 0 as the minimum trade to a value of 16.5 thousand US dollar as the maximum. Notable is the difference in economic performances among the sample countries revealed by the standard errors for *lnmass,* which amounts to 2.6 percent on average and indicates the various sample of countries included.

Furthermore table 6.3 below provides an overview of the statistic for signing a DTT among the reporting countries. As mentioned before the dataset consists of 39 partner countries. Among the Nordic countries the process of signing or not signing a DTT are quite similar

except from one country, Iceland, which differs in the way of just having five DTTs signed and in place with partner countries. For further regressions the DTTs signed before 1990 are excluded from the model, as this thesis will focus on the impact by adopting a DTT, the ones signed before 1990 are not essential for the analysis. This implies a dataset consisting of 3 538 observations instead of 4 320 as it was before the exclusion of the early signed DTTs.

Reporters	no DTTs signed	DTTs signed before 1990	DTTs signed after 1990
Denmark	20	8	11
Finland	20	7	12
Iceland	34	0	5
Norway	21	10	8
Sweden	21	11	7
Total	116	36	43

Table 6.2: Authors own compilation, source IBDF-portal

To be statistically sure regarding the choice of random or fixed effects a Hausman test[93] is performed, the two covariance matrices used in the test will be specified and based upon a common estimate of disturbance variance.[94] Both tests provide Chi2 values of 0.000 and therefore the null hypothesis can be rejected in favour for choosing the fixed effect estimator.

When using either random or fixed effects models it is assumed that the presence of α_i shall capture all correlation between the unobservables in different time periods. This implies that the presence of autocorrelation in u_{it} shall not lead to inconsistency of standard estimators, however, it results in that they no longer are efficient. To avoid misleading inferences, robust standard errors in the use of OLS and fixed effects estimator have been included. This inclusion will adjust their standard errors for general forms of heteroskedasticity and autocorrelation.[95]

Turning to the results, table 6.4 below shows the results of the log-linear panel regressions with fixed effects and robust standard errors, with logged trade in intermediate goods

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[93] Hausman test consists of a null hypothesis where x_{it} and α_i are uncorrelated and tests whether the fixed effects and random effects estimators are significantly different - Adkins & Carter-Hill (2008), *Using Stata for Principles of Econometrics,* p. 358

[94] Hausman specification test - Sigmamore and Sigmaless are recommended when one want to compare fixed effects and random effects linear regression as they much more likely produce a non-positive definite covariance matrix - Stata.com

[95] Verbeek (2012), *A Guide to Modern Econometrics,* p. 389-390

(import flows) as dependent variable. Column 1 displays the baseline log-linear panel regression (equation 6), estimated by OLS and the three main explanatory variables. The variable that captures the distance relationship between two countries, *lndist,* is omitted in all of the regressions as the model includes fixed effects. Seen in table 6.3 is the summary statistics for *lndist,* when the within standard deviation is zero as the statistics indicates, it means that within observations on each country have no variation or that the distance is constant. Therefore, this kind of variable will be eliminated with the fixed effects transformation.[96]

Variable		Mean	Std. Deviation	Min	Max
lndist	overall	8.6921	0.4584	6.7942	9.4267
	between		0.4595	6.7942	9.4267
	within		0	8.6821	8.6821

Table 6.3: Summarize statistics for *lndist* [97]

Consider the coefficients for *lnmass*, which are indicating good estimates in all regressions, as the theoretical prediction is 1.[98] The dummy testing for the DTT effect shows a positive and significant parameter value in regression 1, which indicates of an impact on intermediate trade. When keeping all other things equal, two countries who have a DTT in place would trade 125 percent more, $(e^{0.8133} - 1) * 100$, in relation to not have a DTT in place.

Dependent variable	Log intermediate trade import flows from country i to country j		
Sample coverage	1990-2012, observations 3538, groups 156		
	* significant at 10%, ** significant at 5%, *** significant at 1%		
	Robust standard errors used in all regressions		
Variables	1.Basline Panel regression FE	2. Panel regression FE	3. Panel regression FE
lnmass	0.8328	0.9355	0.9306
	(0.2545)***	(0.2351)***	(0.2362)***
dtteffect	0.8133	15.7682	15.8401
	(0.3039)**	(3.7205)***	(3.7208)***
lndist	omitted	omitted	omitted
	----	----	----
dist_dtt		-1.7456	-1.7494
		(0.4188)***	(0.4206)***
regime_dtt			-0.0937
			(0.1013)
colonized_dtt			-0.0117
			(0.0903)

Table 6.4: How DTTs affect intermediate trade - Panel regressions with fixed effects

Columns 2 and 3 includes additional explanatory variables such as the interaction variables *distance* and *dtteffect*, *regime* and *dtteffect*, *colonized* and *dtteffect*. When these interaction terms are

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[96] Adkins & Carter-Hill (2008), *Using Stata for Principles of Econometrics,* p. 355
[97] STATA command xtsum used for *lndist,* which summarizes cross section and time series data.
[98] Feenstra (2004), *Advanced International Trade*, p. 144-145

added to the regressions the coefficients for the DTT dummy increases dramatically, as both the main dummy and its interaction needs to be included in the model this is quite normal. This indicates that the value of *dtteffect* alone not shall be interpreted, as it is only significant when distance is zero. The values of 15.76 and 15.84 in the regressions are therefore not of interest as the variable distance never will take a value of zero.[99] The coefficients of *dist_dtt* are similar in both column 2 and 3, highly significant at a 1 percent level and with negative signs. Neither *regime_dtt* nor *colonized_dtt* are significant when adding them to the regression, which can be seen from the results in column 3. Hence, the variables *regimetype* and *colonized* are also included in the model with insignificant estimates, though not displayed in the table above. However, it is important to note that the coefficients for *lnmass* do not change that much, according to theory unity, when adding the interaction terms to the model.

Sample selection

Building on the previous section with the results from the baseline regression and due to that the dataset consists of around 18 percent zeros in the bilateral trade flows, further models are estimated in order to check for robustness of the results. Zero trade flows are actually quite common in bilateral international trade and the standard way to estimate the Gravity equation is to only include the positive trade flows. However this could lead to biased estimates due to excluding important information and result in classical sample selection issues.[100] To correct for this potential bias, I have used three different regression methods in order to determinate whether the zero trade flows have any sufficient role in the model.

Table 6.5 below presents the results from estimating the bias decomposition in relation to zero trade flows for the Gravity model with help from the Heckman selection method, Poisson regression and the exclusion of zeros in the trade flows.

In order to compare the different methods in table 6.5 and due to that the Heckman method cannot include fixed effects, the regressions are controlled with reporter, partner and year fixed effect manually.

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[99] UCLA, Regressions with STATA, *Chp. 7: More on interactions of categorical and continuous variables*
[100] Helpman et al. (2007), *Estimating trade flows: Trading Partners and Trading Volumes*

Dependent	Log intermediate trade import flows from country i to country j			
Sample	1990-2012			
	* significant at 10%, ** significant at 5%, *** significant at 1%			
	Robust standard errors used in all regressions			
Variables	1. Baseline Panel	2. Panel regression, zeros	3. Heckman ML	4. Poisson
lnmass	0.8328	1.5250	1.2421	0.5586
	(0.2545)***	(0.1918)***	(0.0289)***	(0.0003)***
dtteffect	0.8133	0.1860	1.5279	0.1369
	(0.3039)**	(0.1562)	(0.1146)***	(0.0003)***
lndist	omitted	-1.7725	0.1082	-1.6182
	----	(0.8652)**	(0.0905)	(0.9851)*
Observations	3538	2874	3538	3538
Groups	156	151	156	156

Table 6.5: Bias decomposition

The second column displays the results from excluding the zero trade flows from the baseline log-linear panel regression, which can be seen from the lower number of observations included. This method when just considering the positive trade flows, is usually used when estimating the Gravity model, however it leaves out important information. *Lnmass* is significant and notably it provides an almost twice as high positive value of the coefficient compared to the baseline regression, which goes against the theory of unity to 1. The major difference from the baseline regression is that *dtteffect* no longer is significant for the model. Hence *lndist* is not omitted in this regression, due to estimation without controlling for fixed effects and is therefore significant with a negative sign on the estimated elasticity, which is in line with theory.[101]

The results of the Heckman ML procedure are shown in column 3 and fits the regression model with selection using an estimator of the zero trade flows. In the two-step estimation of Heckman the model tests whether there is a selection bias and through the ML estimation both the selection and the outcome equations are taken into consideration.[102] By creating a dummy variable if countries are trading with each other or not and controlling manually for fixed effects, the ML estimation provides significant and positive estimation elasticities for *lnmass* and *dtteffect*. The parameter value of *lnmass* is shortly above 1, which works well according to theory. All other things equal, two countries who have signed a DTT would increase their intermediate trade 360 percent more, $(e^{1.5279} - 1) * 100$, than if the countries not would have a DTT in place. The magnitude of this result is much larger than

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[101] Feenstra (2004), *Advanced International Trade*, p. 151
[102] Heckman (1979), *Sample Selection Bias as a Specification Error*

the corresponding estimate obtained from baseline regression. However, *lndist* is not significant in this Heckman ML estimation.

In the Poisson regression the dependent variable, intermediate trade, is estimated without taking logs, as the model indicates that this addresses the problem of heteroskedasticity in the standard log-linear model.[103] This results in a lower coefficient (not in line with theory) for *lnmass* but still highly significant for the model. *Dtteffect* is highly significant, at a 1 percent level, for the model, whereby the estimated coefficient indicates that signing a DTT seems to have a lower effect on intermediate trade as in the baseline regression. The variable *lndist* is also significant for the model however, only at a 10 percent level. The estimated coefficient indicates of a negative relationship between trade and distance, which is in line with theory.

The Heckman two-step model provides statistics over Heckman´s lambda also known as the inverse Mills ratio, its significance tells us that the model is suffering from selection bias, see table 6.6 below.[104] The table further shows statistics from Wald-tests performed in the both estimations, which shows that the models are statistically significant. The Heckman ML estimation tests, with help from a likelihood ratio test, the null hypothesis that ρ is equal to zero, where ρ indicates the correlation between the error terms of the outcome and the selection equations. The null hypothesis can be rejected and this concludes that the Heckman procedure is appropriate.

Variables	1. Heckman two-step estimation	2. Heckman ML estimation
λ	-1.7705	
	(0.1615)***	
ath ρ		-0.4925
		(0.0670)***
ln σ		0.8600
		(0.0175)***
Wald test	2899.07 ***	3167.08***
Observations	3538	3538
* significant at 10%, ** significant at 5%, *** significant at 1%		

Table 6.6: Heckman statistics

Shown in the table are the arc hyperbolic tangent $ln\left(\frac{1+\rho}{1-\rho}\right)$ of ρ and the natural logarithm of σ, as the ML estimation not directly reports ρ and σ.[105] The ML estimation provides

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[103] Silva & Tenreyro (2006), *The Log of Gravity*
[104] Verbeek (2012), *A Guide to Modern Econometrics,* p. 249
[105] Haq et al. (2010), *Does the Gravity Model suffer from Selection bias?*

estimates of ρ within the range -1 to 1, as the value here is -0.49 it indicates a downward bias (estimates are on average lower than the true parameter) for the dependent variable on the explanatory ones. As the estimates of ρ and σ both are statistically significant it is indicating that when the zeros are ignored it will result in biased estimates.[106]

Overall the regressions above indicate different kinds of results, as they differ both in estimated coefficient value and variable significance. Depending on how the Gravity model is estimated the result can be interpreted in different ways, which will be of further discussion and analysis in the next section.

7. Analysis

This part will further outline and discuss the empirical results from last section and when appropriate relate to previous studies and theories.

According to the empirical evidence of this study, signing DTTs seem to have an impact on intermediate trade. However, due to a large fraction of zero trade flows in the sample, the magnitude of the effect is hard to determine. Described in the introduction, a general objective of signing a DTT is to protect taxpayers, however with a purpose to improve international trade. As intermediate trade is becoming an essential part in international trade, the choice of adopting a DTT could be a crucial factor for a country´s development. The empirical results of this study points to a certain extent out that there is an impact, a positive effect, on intermediate trade when a DTT is in place. The effect can be seen in table 6.5 estimates on the parameters for *dtteffect,* which all are indicating a larger extent of intermediate trade when having a DTT in place, everything else is kept equal. Nevertheless, this positive effect differs in the way on how the bilateral trade data is modelled. Depending on the method of choice the results from the estimated regressions indicate different significance and parameter values of the DTT effect.

Previous studies that are in line with theory when one want to model the Gravity equation on bilateral trade data usually adds fixed effects to the OLS regression. However, most

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[106] Hall (1999), *Notes on Sample Selection Models*

studies only include the positive trade flows and therefore important information will go missing.[107] When it comes to actually looking at the data and take the zero trade flows into account, this method has been questioned due to sample selection bias.[108] This study uses an OLS regression with fixed effects on the full data sample as the baseline regression. Hence, treating zero trade flows properly is important both for statistical and economic preferences.

Due to that the countries included in the sample have historically and different economic preferences the trade patterns among the country-pairs are expected to differ, some countries trade more with each other than others.[109] As the dataset includes zero values of trade between some countries, this has led to an investigation in whether to consider these zero trade flows or not and the issues when dealing with sample selection bias. In my baseline regression the full data sample is used, which implies that the zero trade flows are ordered to the same process as to the positive ones and the results can be seen in table 6.4. Due to that it includes a log-linear function of the dependent variable it creates an immediate difficulty when trade is zero. I have therefore replaced the value of imports by the value of imports plus one, which implies allowing the log of zero values to take a zero value. The results from the baseline regression follows the theory developed by Anderson and van Wincoop in connection to the Gravity model using fixed effects and the parameter value of *lnmass,* 0.83, from the estimation goes in line with this theory. When controlling for fixed effects the distance variable will be omitted from the regression, as it controls for variables that not are varying with time, which is the case here.[110]

The results from adding additional interaction variables into the baseline regression are shown in table 6.4. First, adding the interaction term *dist_dtt,* which is a combination of a continuous variable that measures distance between two countries and a category dummy variable that shows if a country-pair has adopted a DTT, the value of the estimated parameter elasticity is -1.74. The interpretation of this value is that the greater distance between two countries the less effect a DTT between them will have on intermediate trade. In the standard trade theory of the Gravity model the distance is said to have a negative

[107] Cheng & Wall (2005), *Controlling for Heterogeneity in Gravity Models of Trade and Integration*
[108] Lui (2007), *GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification*
[109] Feenstra (2004), *Advanced International Trade*, p. 144-145
[110] ibid, p. 145

influence on trade, the greater distance between two trading partners the less trade, which goes in line with the above result. When adding this interaction term the estimated parameter for *lnmass* slightly changes, but only to the better value, 0.93, in accordance with theory. However, when including *regime_dtt* and *colonized_dtt* the results show no significance values for these interactions. Neither *regime* nor *colonized* provide any significant estimates alone. These insignificant results indicate that the regime type and the relation of previous colonized or not have no significant relation to whether or not countries signs DTTs.

Moreover, these results differ from earlier studies on determinants for FDI, where the quality of institutions are said to play an important role.[111] Furthermore, they contradict in relation to the theory, which says that a country´s historical and institutional preference usually plays an important role in relation to signing preferential trade agreements (PTA). When it comes to the extent of defining a DTT as a PTA, they both tend to discriminate in the context of treating all countries on equal terms, whereas they often favours partners over non-partner. According the traditional view of PTAs, they mostly handle preferential tariffs and as tariffs are just one form of tax, the new way of specialization and regionalism in intermediate trade could be defined with help from the system of DTTs.[112] Due to these insignificant results, it is difficult to distinguish the actual effect from historical preferences as it seems to be some sort of misleading information from the variables regime and colonized. Important to note is that the inclusion of the suggested interaction terms do not provide any vital changes to the main variables.

When expressing the log-linear regression by excluding the zeros from the model information will go missing, which could be seen from the insignificance value of the *dtteffect* and almost a double estimated value of *lnmass*. This specification seems quite unreliable in relation to the theory for Gravity equation, as it indicates that the zeros have an important impact in the model. As in this case when dealing with a fraction of zeros in the dataset the choice is however quite uncertain and difficult in the way of excluding or including zeros. Both methods contradict each other in the way of thinking of the presence or non-presence of zero trade flows. The overall estimation results differs quite much between the two

[111] Blonigen (2005), *A review of the empirical Literature on FDI Determinants*
[112] The World Bank (2011), *Preferential trade agreement policies for development – a Handbook*

methods, hence the baseline model presents the most accurate parameter terms in accordance with theory.

The specifications presented in table 6.5 have all both advantages and disadvantages. However as the statistics from Heckman´s lambda in table 6.6 indicates that the model is suffering from selection bias, the Heckman approach would be to argue for. This approach relies on the assumption that trade flows are ordered depending on a selection process of their trading relations and trading pattern.[113] It seems quite reasonable that countries select their trading partners depending on historical relations and that the trade volume will depend on underlying features of the market. However, as the Heckman model not can control for bilateral fixed effects it weakens the model in the aspect of historical trading relations. Anyhow by including time, reporter and partner effects some controls can be made but not in the same extend as to the fixed effect estimation. Heckman method would be favourable if there is an underlying selection process for trade and in the cases when there is a selection to trade between countries.[114]

The estimation results in the Heckman specification generates a parameter value of 1.52 for *dtteffect*, which is indicating that signing a DTT has a major effect on intermediate trade. This estimated parameter value indicates the largest impact on intermediate trade considering all methods used. With a marginal effect of 360 percent increase in intermediate trade between the two countries in question, all other things kept equal. The effect is in relation to previous studies on FDI and the measured impact from DTTs also significantly higher. Whereas studies from Neumayer and Barthel et al. predicts between 20-40 percent increased FDI flows as results form a conclusion of a DTT.[115] In some extent, it somehow underpins the importance of former trading agreements in relation to trade.[116] The parameter value of *lnmass* is in line with theory, though a slightly higher value than the prediction. Notable is the insignificant value of the distance variable, according to the theory distance is one of the main explanatory variables in the Gravity model when not controlling for fixed effects,

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[113] Heckman (1979), *Sample Selection Bias as a Specification Error*
[114] ibid
[115] Neumayer (2007), *Do double taxation treaties increase foreign direct investments to developing countries*
Barthel et al. (2010), *The impact of double taxation treaties on foreign direct investment: evidence from large dyadic panel data*
[116] Lui (2007), *GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification*

hence here the results is indicating the opposite. This gives an indication that the result is sensitive to model specifications when not able to control for fixed effects.

Considering the Poisson regression where the dependent variable, intermediate trade, is estimated without taking logarithms. The estimation provides significant results for all variables, however lower estimates as to the baseline regression. The measured product of GDP are here not as generally believed close to 1, instead the estimated elasticity is just 0.55. The underlying background for this result could be depending on the country sample and that smaller countries tend to be more open to international trade. The role of geographical distance has an estimate of -1.61, which lies slightly under the estimation of OLS without zeros and goes well in hand with theory, which predicts a strong negative relationship between distance and trade.[117] Results from Santos Silva and Tenreyro´s study, regarding the importance of a trade agreement, indicated that the Poisson regression provided lower estimates for preferential trade agreements as to the OLS estimation. Whereby defining DTT as a PTA this seems to be the case in my results as well. The OLS estimation provides an expected increase of 125 percent in intermediate trade from signing a DTT, whereas Poisson estimates indicates an average enhancement around 15 percent. This result is of course strikingly as the difference of DTTs impact on intermediate trade lies between 125 - 15 percent from one model to another.

Overall, this study aimed to investigate the impact of signing DTTs could have on intermediate trade and a direct glance on the results indicates a positive impact. The dummy variable *dtteffect* provides in general significant and positive estimates in all regressions. However, the results differ depending on the choice of estimation method, which can be seen in table 7.1 below. The table presents an overview from all methods used of the estimated parameter value on *dtteffect* (originally presented in table 6.5). The percentage impact a DTT has on intermediate trade is calculated with the formula displayed in the bottom of the table. Calculations made provide direct evidence of the impact signing a DTT has on intermediate trade. As already mentioned the magnitude of the impact varies depending on the choice of estimation method.

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[117] Feenstra (2004), *Advanced International Trade*, p. 151

Variable	1. Baseline Panel	2. Panel regression, zeros	3. Heckman	4. Poisson
dtteffect-parameter	0.8133	0.1860	1.5279	0.1369
% effect on dep.	125.53	20.44	360.85	14.67
Formula to compute the effect: (e^(parameter value)-1)*100 = percentage change				

Table 7.1: Overview of results from table 6.5

This thesis has ended up with a discussion of on how the Gravity model should be estimated in the case when zero trade flows are to consider in the dataset. The main arguments goes towards the Heckman modelling, as its test indicates that the model is suffering from selection issues in relation to how the zero trade flows should be captured correctly. Notably, when arguing for the Heckman method it is with the awareness of possible misspecifications when not being able to use fixed effects in the model. However, the huge differences of the impact a DTT has on intermediate trade depending on the choice of technique, reflects the difficulty to argue for a specific method.

8. Conclusion & Reflections

This last part will summarize the concluding remarks and present reflections made during writing as well as in connection for future research.

To address the research question, by examining the potential effect signing DTTs would have on intermediate trade, this thesis locates an overall positive impact, however with underlying issues of sample selection bias.

Results from the baseline regression show, from all three model-specifications, a positive effect from signing a DTT on intermediate trade. The same results are found when estimating the baseline regression with methods such as Heckman, Poisson and OLS without zeros. However, the magnitude of the effect differs quite much between the methods used. The main arguments goes in favour for the Heckman approach, though with the awareness of sensitivity regarding specifications in relation to fixed effects.

This thesis ends up in a situation where it is hard to make a straightforward conclusion. It rather culminates in a discussion on whether the impact of signing DTTs on intermediate trade actually exists or not, or to which extent it exists. This can in some aspects be seen as a disappointment for the study, but in somehow it still indicates a sort of result. Reflection made, as the results are indicating different positive effects of signing a DTT, it suggests that more research is needed in the area. As the author did not find any previous studies over DTTs impact on intermediate trade the topic needs to be further investigated and brought into the light. Hoping that this study provides some kind of important empirical results, which are worth looking deeper into, the discussion of the existence of the DTT effect in relation to intermediate trade will be rendered for future analysis.

Furthermore, some reflections raised during working with this thesis will follow in order to ease the process for future research. The first reflection considers the issues when working with zero trade flows in the dataset, such problems needs to be outlined and ordered with a well thought out method. However, as earlier studies are arguing in different directions the choice is not simple to make. When the zeros are correctly handled, the impact of the results will be of greater substance.

Another thought for future research is the impact signing DTTs would have in relation to developed and developing countries. In this study focus lies on the Nordic countries and their trading relations with Asian countries when it comes to intermediate trade flows. Differentiating between developed and developing countries have not been done in this thesis, as it goes outside the scope, but this could be of interest for future studies. This differentiated view could contribute to the investigation were the greatest importance of having a DTT in place could be most influential to enhance trade.

Ways of extending the robustness check of the results, could be adding more explanatory variables, which would be in line with the Gravity model. For example variables such as countries openness to trade, sharing a common language, members of unions and trade agreements could be of interest for this kind of modelling. As the main variable of interest in this study is the dummy variable, indicating the DTT effect and due to time limitations this study did not include variables such as the one described above. Another desirable explanatory variable would be the quality of institutions for each country, hence the regime type is maybe not the most accurate way of measuring this impact. Data on the quality of institutions was collected, but as it did not cover all countries in the dataset used for this thesis, it could not be of any use.

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Appendix

Table A1: Country sample

Sample: 39 Asian partner countries & 5 reporting Nordic countries	
Bahrain	Denmark
Bangladesh	Finland
Bhutan	Iceland
Burnei	Norway
Cambodia	Sweden
China	
Georgia	
Hong Kong	
India	
Indonesia	
Iran	
Israel	
Japan	
Jordan	
Kazakhstan	
Korea	
Kuwait	
Kyrgyzstan	
Lebanon	
Macao	
Malaysia	
Maldives	
Mongolia	
Nepal	
Oman	
Pakistan	
Philippines	
Qatar	
Russia	
Saudi Arabia	
Singapore	
Sri Lanka	
Syrian Arab Rep.	
Taipei	
Thailand	
Turkey	
United Arab Emirates	
Viet Nam	
Yemen	

Table A2: DTTs divided into countries

Reporter	no DTT signed	DTT signed before 1990	DTT signed after 1990	Reporter	no DTT signed	DTT signed before 1990	DTT signed after 1990
Denmark	Bahrain	Japan	Israel	**Iceland**	Israel		Korea
	Burnei	Korea	Turkey		Japan		China
	Bhutan	India	China		Turkey		India
	Cambodia	Indonesia	Russia		Indonesia		Russia
	Taipei	Kyrgyzstan	Bangladesh		Bahrain		Viet Nam
	Hong Kong	Malaysia	Georgia		Bangladesh		
	Iran	Pakistan	Kuwait		Burnei		
	Jordan	Sri Lanka	Philippines		Bhutan		
	Kazakhstan		Singapore		Cambodia		
	Lebanon		Thailand		Taipei		
	Macao		Viet Nam		Georgia		
	Maldives				Hong Kong		
	Mongolia				Iran		
	Nepal				Jordan		
	Oman				Kazakhstan		
	Qatar				Kuwait		
	Saudi Arabia				Kyrgyzstan		
	Syrian Arab Rep.				Lebanon		
	United Arab Emirates				Macao		
	Yemen				Malaysia		
Total	20 st	8 st	11 st		Maldives		
Finland	Bahrain	Japan	Israel		Mongolia		
	Bangladesh	Korea	Turkey		Nepal		
	Burnei	Indonesia	China		Oman		
	Bhutan	Malaysia	India		Pakistan		
	Cambodia	Philippines	Russia		Philippines		
	Taipei	Sri Lanka	Georgia		Qatar		
	Hong Kong	Thailand	Kazakhstan		Saudi Arabia		
	Iran		Kyrgyzstan		Singapore		
	Jordan		Pakistan		Sri Lanka		
	Kuwait		Singapore		Syrian Arab Rep.		
	Lebanon		United Arab Emirates		Thailand		
	Macao		Viet Nam		United Arab Emirates		
	Maldives				Yemen		
	Mongolia				Total	34 st	0 st	5 st
	Nepal							
	Oman							
	Qatar							
	Saudi Arabia							
	Syrian Arab Rep.							
	Yemen							
Total	20 st	7 st	12 st				

Norway	Bahrain	Israel	Japan	Sweden	Bahrain	Israel	India
	Burnei	Korea	Turkey		Burnei	Japan	Russia
	Bhutan	China	India		Bhutan	Korea	Georgia
	Cambodia	Indonesia	Russia		Cambodia	Turkey	Kazakhstan
	Taipei	Malaysia	Bangladesh		Taipei	China	Malaysia
	Georgia	Pakistan	Kazakhstan		Hong Kong	Indonesia	Philippines
	Hong Kong	Philippines	Nepal		Iran	Bangladesh	Viet Nam
	Iran	Sri Lanka	Singapore		Jordan	Pakistan	
	Jordan		Thailand		Kuwait	Singapore	
	Kuwait		Viet Nam		Kyrgyzstan	Sri Lanka	
	Kyrgyzstan				Lebanon	Thailand	
	Lebanon				Macao		
	Macao				Maldives		
	Maldives				Mongolia		
	Mongolia				Nepal		
	Oman				Oman		
	Qatar				Qatar		
	Saudi Arabia				Saudi Arabia		
	Syrian Arab Rep.				Syrian Arab Rep.		
	United Arab Emirates				United Arab Emirates		
	Yemen				Yemen		
Total	21 st	8 st	10 st	Total	21 st	11 st	7 st