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FACULTY OF SOCIAL SCIENCES
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The Role of Offshore Companies in Public Procurement in the EU

Bachelor's thesis

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Study program: Economics and Finance

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Declaration of Authorship

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Prague, May 9, 2019

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Abstract

Corporate income taxation constitutes a significant share of government revenue on which public expenditure depends heavily, and when multinational enterprises (MNEs) engage in abusive tax practices it adds to the average taxpayer's burden. Additionally, when awarding public contracts to companies connected to notorious havens the efficiency of public spending cannot be ensured. Using data on ownership structures of government suppliers, this paper employs the gravity theory and aims to recognise tax havens' activity on the EU's public procurement market. The gravity model identifies territories with up to 99% unexplained flows of their total procurement supply. In these countries increased risk of abuse is expected and outflow of taxable revenue can be assumed. It is estimated that companies based in or linked to tax havens annually supply about EUR 67 billion worth of EU's public contracts above the natural levels predicted by the gravity model based on economic and geographical determinants.

JEL Classification	H87 F17, H26, F23
Keywords	public procurement, gravity models, tax havens, tax evasion

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Abstrakt

Daň z příjmů právnických osob tvoří významný podíl vládních příjmů, na něž značně spoléhají státní rozpočty. Nadnárodní korporace nezřídka optimalizují výši daňového základu strategickým rozmístěním svých dceřiných společností a využívají nesrovnalostí v daňových systémech jednotlivých zemí. Zároveň nelze nadále zajistit efektivnost v alokaci veřejných prostředků. S využitím databáze vlastnických struktur vládních dodavatelů aplikuje tato práce gravitační rovnici a identifikuje aktivitu daňových rájů na evropském trhu veřejných zakázek. Gravitační model nachází offshorová teritoria s až 99 % nevysvětlitelných toků z celkové hodnoty dodaných tendrů. V těchto zemích lze očekávat zvýšené riziko zneužití a předpokládat významný odliv zdanitelných příjmů. Dle odhadů ročně zadají evropské země firmám napojeným na daňové ráje zakázky v hodnotě o 67 miliard EUR více než je predikováno gravitačním modelem na základě ekonomicko-geografických podmínek.

Klasifikace JEL	H87 F17, H26, F23
Klíčová slova	veřejné zakázky, gravitační model, daňové ráje, daňové úniky
Název práce	Role zahraničních firem ve veřejných zakázkách v EU
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Acronyms

BEPS Base Erosion and Profit Shifting

CEPII The Centre d'Études Prospectives et d'Informations Internationales

EU European Union

EU28 28 European Union Member States

FSI Financial Secrecy Index

GDP Gross Domestic Product

MEAT Most Economically Advantageous Tender

MNE Multinational Enterprise

MRT Multilateral Trade Resistance Term

OECD Organisation for Economic Co-operation and Development

OLS Ordinary Least Squares

PPML Poisson Pseudo-Maximum Likelihood Estimator

PPE Property, Plant and Equipment

Bachelor's Thesis Proposal

Author	Thao Trang Do
Supervisor	Mgr. Miroslav Palanský, M.A.
Proposed topic	The Role of Offshore Companies in Public Procurement in the EU

Motivation

Purchase by governments and state-owned enterprises of goods and services represents a significant share of taxpayers' money, thus the process is expected to be executed effectively, efficiently, and most importantly to be consistent with the public interest. More so, public tenders should be administrated wisely and the entire mechanism needs to be supervised and developed continuously, as there are constantly opportunities for improvement. In my thesis, I focus on the role of offshore companies in the public procurement process in the European Union. Evidence (e.g. Cobham and Janský, 2017; Janský and Palanský, 2018) suggests that a significant portion of the offshore companies' profits is shifted to tax havens, consequently causing tax revenue loss to governments. The aim of my thesis is to quantify the share of public procurement supplied by offshore companies across the EU and the tax revenue loss that results from the fact that these companies shift some of their profits outside the jurisdictions in which they supply public procurement.

There are various studies and literature (e.g. Clausing, 2009; Rose and Spiegel, 2007) covering the topic of tax havens and the area of public procurement; however, the role of offshore companies in public tenders has not yet been fully explored. More so, the existing research seems to neglect to provide a bridge between these two areas. There are firms who compete for tenders in the public sector but then shift their profits to tax havens in order to avoid corporate taxation. These multinational enterprises are consequently the source of government tax revenue losses; nonetheless, the absence of sufficient comprehension of the issue provides capacity for further research.

Hypotheses

Hypothesis #1: Offshore companies are successful when they compete for public tenders, as they may hold certain advantages (such as the ability to offer lower bidding prices due to their lower effective tax rates) as opposed to the local companies.

Hypothesis #2: Offshore companies are more successful in some countries and in some sectors than in other ones.

Hypothesis #3: Offshore companies from tax havens which supply public procurement in the EU are responsible for a significant share of the tax revenue gap.

Methodology

In the proposed thesis, theoretical framework defining key principles, basic concepts, and references to existing research regarding public procurement and tax havens will be provided. The next step will be a simple theoretical model, which will demonstrate an offshore company's ability to bid a significantly lower price, consequently win the tender and still earn greater profits than a local firm with identical costs that originally offered higher price. Data regarding public procurement contracts in the European Union (DIGIWHIST) will be used for further research purposes, as we have obtained detailed information on firms, which participated in these tenders. Data with specific variables will be extracted from the database (name of the firm, sector, country, owner, etc.). The data will be inspected and descriptive statistics methods will be used after the initial encounter. In the empirical part of thesis, we want to know what portion of public tenders is allocated to offshore companies and which tax havens are mostly responsible for the greatest losses in the tax revenue. Furthermore, when the specific numbers are known, further analysis will be performed in order to quantify government losses caused by the firms which shift their profits to tax havens in order to avoid corporate taxation and to promote financial secrecy.

Expected Contribution

As we have only recently obtained the aggregate data of public procurement contracts for the entire European Union (DIGIWHIST Researchers, 2019), the data have not been yet fully examined and processed. Therefore, the descriptive statistics summarizing the data will be highly beneficial themselves. Also as mentioned above, the existing research studies the two main topics separately, but a bridge between tax havens and public tenders has not been provided. This interconnection is one of the key aims of the proposed thesis.

Outline

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Author Supervisor

Chapter 1

Introduction

A significant share of government revenue is underpinned by income taxes paid by multinational enterprises (MNEs). In 2016 the corporate income tax accounted for about 7.5% of total tax revenue on average in EU Member States (EU28), 9% among Organisation for Economic Co-operation and Development (OECD) countries and up to 30% in the rest of the world (OECD, 2018; Eurostat, 2018). When large corporates exploit discrepancies and mismatches contained in taxation policies and avoid paying various kinds of taxes by shifting their profits elsewhere, consequently, base erosion and profit shifting (BEPS) affect governments worldwide and deprive their economies as well as their overall health. The companies strategically either shift their profits to low-tax jurisdictions or let them artificially "disappear" as the ultimate beneficial owners often cannot be even identified due to a lack of financial transparency in the so-called tax havens. Additionally, highly secretive countries undermine governments' efforts to fight abusive tax practices and corruption. Although financial secrecy has been an issue for decades, and it was therefore subjected to scrutiny in the past, it is only in the recent years that debates over low-tax rate jurisdictions have been raised in relation to government expenditure and how government losses can be minimised in the area of public spending.

Purchases by governments and state-owned enterprises of goods and services represent a significant share of taxpayers' money; the government expenditure accounts approximately for 45.8% of GDP on average among European countries (Eurostat, 2019). The process of selection in public procurement is, thus, expected to be executed effectively, efficiently, and most importantly to be consistent with the public interest. Currently, different selection procedures are applied when awarding public contracts, including the most economically

advantageous tender (MEAT) or the lowest price criterion. While these strategies may deliver satisfying and reasonable results to some extent, the origin of the companies supplying these tenders is frequently omitted due to insufficient tools to appropriately classify them. This is often caused by complex structures that are built within the MNEs, which then use various types of instruments, such as shell, offshore, or letterbox companies to hide their profits to avoid taxation. This consequently indicates that when the public tenders are awarded to companies with links to tax havens it can potentially lead to a significant outflow of tax revenue that would be otherwise paid to the local government.

Evidence provided by Cobham and Janský (2017), and later also supported by extended research of Janský and Palanský (2018), suggests that a significant share of the profits from Foreign Direct Investment (FDI) is shifted to tax havens which consequently causes corporate tax revenue loss to governments. In this paper, I refocus the attention from corporate income tax evasion in FDI and general tax avoidance to that which results from participation of such companies on the public procurement market. More specifically, the role of offshore companies in the public procurement on the European Union (EU) market is explored by employing any connections to tax haven jurisdictions the supplying firms may hold within their ownership structure. The original aim was to confirm and measure tax revenue losses within the government expenditure. However, the problem with quantifying tax revenue losses is that due to high financial secrecy in some of the countries data on actual profit shifted are unavailable. Thus, information on ownership links of European procurement suppliers is used instead. While legitimate reasons for a government supplier to be based in or otherwise connected to a notorious tax haven are extremely rare, admittedly, having links on tax haven countries does not necessarily mean that such companies avoid taxation or engage in other abusive practices. These reasons can, for example, include historical colonial links, trade agreements, or other bilateral relationships naturally increasing the trade between a pair of countries. In order to provide a potential rationale for suspicious connections to established aggressive tax regimes, I examine the data using a gravity model which appropriately explains variation in the data, estimates a natural level of procurement supplied between individual countries, and identifies the excess public tenders supplied by companies with questionably located affiliates. Resulting residuals then report essential information about procurement flows which cannot be explained by the model, and thus cannot be linked to any actual activity, which demonstrates the immediate risk exposure to profit

shifting to either avoid taxation or hide the ultimate beneficiaries. In this paper, I recognise the most popular tax havens on the EU procurement market and by establishing the immediate risk exposure I estimate the taxable revenue outflow.

An EU Horizon 2020 funded project, DIGIWHIST, provides a unique database of procurement data from 33 jurisdictions (28 EU member states, Norway, the EU Institutions, Iceland, Switzerland, and Georgia) collected by key researchers from University of Cambridge, UK; Hertie School of Governance, Germany; Government Transparency Institute, Hungary; DATLAB, Czech Republic; Open Knowledge Foundation Deutschland, Germany; and Transcrime, Italy (2019). Additionally, the data employed in this paper are relatively recent, thus, fundamental examination of the database solely is also highly beneficial.

For the analysis, the data available on public procurement contracts collected by DIGIWHIST researchers are employed together with a gravity dataset from France's leading institute for research in international economics, Centre d'Études prospectives et d'informations internationales (CEPII). Specific determinants affecting the total volume of potential outflow of resources within public procurement are examined, aiming the attention to the counterpart countries with lower local nominal corporate income tax rate, high financial secrecy, or recognition on tax havens listings. The aim of this paper is to provide a fundamental overview on potential risk of outflow of government resources when public tenders are awarded to firms with links to tax havens, identify potential tax havens within the European Union, confirm the existence of third-country havens and their participation in the European procurement market, and explain which factors may affect the total volume of these public tenders and potential risk exposure associated. The general hypothesis examined in the thesis is as follows: When public procurement tenders are allocated to companies with links to tax havens, a significant share of the income tax revenue is most likely lost to these havens by profit shifting.

The gravity model identifies countries where increased risk of abuse is expected and predicts that in several territories up to 99% of their procurement supply cannot be explained, and therefore cannot be linked to any actual economic activity. Using the gravity equation I establish the most popular tax havens on the European public procurement market; these include Cyprus, Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, Qatar, United Arab Emirates, Singapore and most likely also Curaçao and Liechtenstein. Based on the empirical analysis, at least EUR 67 billion of taxable revenue

outflow is expected annually on the EU procurement market.

Additionally, European countries are recognised as possible havens, which further suggests that even EU Member States should be subjected to monitoring regardless their status, as neglecting aggressive tax practices within the Union's borders may undermine any of the EU's future endeavours in fighting tax havens and corruption.

To the best of author's knowledge, this is the first study to analyse the most common tax havens used by government suppliers in the European Union. It confirms the presence of abusive tax practices on the EU procurement market and aims to join other authors which support the most frequently debated solution to the problem, banning the companies from the market. While in most markets such policy would not be easily implemented, the public sector provides the perfect ground for taking the first offensive step against harmful tax regimes, and with the already established EU Black List and Grey List, this appears to be an executable and effective strategy. Furthermore, this paper suggests a relatively unexplored application of the gravity model in identification of excessive trade with certain countries as a sign of abusive practices.

Since the existing research on the specifics of relation between companies which are linked to low-tax-rate jurisdictions and the public procurement market is not abundant, associated issues are discussed separately covering tax havens, revenue loss from corporate tax avoidance, and the procurement market characteristics in order to identify the potential risk exposure to revenue loss in this area. A brief description of the employed dataset follows and an exhaustive overview of gravity literature is provided in order to build the appropriate foregrounds for the empirical model. While the public procurement market may hold certain distinctive characteristics, such as for example specific selection methods or cases of positive discrimination towards small and medium-sized companies as discussed e.g. by Nicholas and Fruhmann (2014), in which it deviates from the conventional conception of international trade market, the gravity principle still holds and can be utilised. The analysis may be limited by such inconsistencies; however, as long as gravity features can be observed in the data, a gravity model offers the best possible solution available in current research. As can be seen in the past five decades, the gravity equation has been very popular among international economists. Its success is underpinned by its consistency across different datasets, fitting well statistically, and exploiting rather intuitive characteristics of trade data (Brakman and Begeijk, 2010). Thus, any sectoral divergence from the traditional use of

the model is considered as minor.

The value of public procurement supplied from one country to another is estimated based on the gravity forces between the countries. I exclude data on countries suspected of being a tax haven in the estimated model and then use the estimated coefficients resulting from the model as a base for prediction for the entire dataset. Obtained parameters provide the magnitude of individual effects of the discussed independent variables on the procurement volume supplied. Furthermore, the countries previously excluded from the original model, i.e. established tax havens are examined based on the predicted and actual values in the dataset. Model's residuals are analysed, and significant outliers are subjected to further examination.

The thesis is structured as follows: Chapter 2 summarises key literature and theory on profit shifting problematique, tax havens, and public procurement in the EU. Chapter 3 describes the data structure, Chapter 4 provides theoretical framework for building the model, and Chapter 5 reports the empirical findings. Finally, Chapter 5 evaluates the model, discusses the contribution and gives suggestions for further research.

Chapter 2

Theory and Literature

As indicated in the previous section, there is a fundamental scarcity of existing research of tax evasion within the public procurement market. Thus, this chapter primarily aims to provide a comprehensive overview of literature regarding individual areas associated with the issue in scope separately; and attempts to converge the pre-existing knowledge to establish appropriate foregrounds for further analysis.

The first part of the existing literature review related to the topic in scope mostly focuses on evidence of international corporate tax evasion in general, base erosion and profit shifting to low-tax-rate jurisdictions and various methods in which multinational enterprises are frequently engaged in order to avoid paying their taxes. Overview and recent development of established tax havens by the European Commission is provided as well as potential European low tax rate jurisdictions based on relevant listings, namely the EU Black List, EU Grey List, OXFAM (European Commission, 2018; Langerock and Hietland, 2019). Furthermore, the empirical literature and existing evidence regarding the government revenue loss due to the frequent international corporate income tax evasion are revisited. For it is the tax revenue losses within government expenditure in scope, the later section provides a summary of the public procurement market characteristics, key principles and concepts, its classification and legal framework by which it can be distinguished from the regular international trade market. As tax revenue losses to governments occur with increasing intensity in relation to the traditional conception of international trade or foreign direct investment, I suspect that tax avoidance behaviour occurrence within the public procurement market is not insignificant.

2.1 Corporate Income Tax Evasion

Most of the existing empirical literature, which examines the multinational firms' behaviour set by a model of profit-maximizing in this context, deals with base erosion and profit shifting in relation to the destinations' lower effective tax rates. While there has always existed a consensus on the presence of the significant effect of taxes on the volume of foreign direct investment flows, it was not until the 1980s that researchers attempted to identify the precise magnitudes of such tax effects. The earliest work regarding profit shifting includes Hartman (1982), Boskin and Gale (1987), and Newlon (1987) who primarily examined the responsiveness of foreign direct investment to the after-tax real rate of return with the use of aggregated time series data. Later research extended the existing empirical literature with estimating the same effects by using cross-sectional data. Mentioned works investigating the issue in scope mostly focus on the capital outflow from high-tax jurisdiction rather than addressing specifically the concern to where the profits are subsequently shifted. These for example include a study proposed by Grubert et al. (1991) who provided estimates of the effect of local tax rate on the allocation of real capital. In their study, the logarithm of the net stock of property, plant, and equipment (PPE) is regressed on the average effective tax rate by which they obtain elasticity describing how the demand for capital changes appropriately with the tax levels. They found that there is a statistically and economically significant strongly negative effect of tax with coefficient of -0.11. Although in the U.S. direct investment context, this finding supports the general hypothesis that higher tax levels encourage profit shifting elsewhere. This proposition is only further confirmed by the subsequent re-estimation by the same authors (Grubert and Mutti, 2000). While the evidence proposed by Grubert and Mutti can appear to be providing rather implications of the discussed effects, as it relies purely on the statistical relationship between corporate income tax rates and the profitability of U.S. affiliates, it does support the general hypothesis that taxation is an important determinant of the location of business activity abroad. Moreover, seminal work of Grubert et al. from 1991 has been recently updated by Mutti et al. (2019). The present analysis confirms that effective tax rates continue to influence U.S. MNEs' location decisions.

As addressed by Altshuler et al. (2000) in International Taxation and Multinational Activity, Hines Jr. and Rice (1994) were one of the first researches shifting the focus to the existing tax havens. In their research, they employed

the same 1982 BEA data as Grubert and Mutti (1994), the difference is in the sample used. While Grubert and Mutti (1994) analysed the allocation capital by affiliate companies of U.S. parents by host countries, Hines Jr. and Rice (1994) examined the U.S. MNEs' activity and behaviour from the opposite perspective with the sample of non-bank affiliates of American parent companies. This led to 73 countries in the sample set of which 41 were tax havens with little real capital. By regressing the logarithm of PPE on host-country average tax rates, they obtain the tax elasticity of -3.3. Based on their empirical results, Hines Jr. and Rice (1994) concluded that a 1 percentage point increase in after-tax real rate of returns will result in a 2.3% increase in the real capital stock of the U.S. affiliates. It is suggested that the higher elasticity was found by inclusion of the tax havens which further indicates that higher tax rates provide incentives to profit shifting to lower-tax jurisdictions. Moreover, their findings report that U.S. affiliates located in tax havens account for more than 20% of U.S. FDI and more than 30% of the foreign profits of U.S. firms. As Hines Jr. (2000) summarises research of his predecessors all the above-mentioned works using cross-sectional data indicated a significant tax effect on the investment location and decision of multinationals in the U.S. market context. For more comprehensive overview of base erosion and profit shifting see De Mooij and Ederveen (2005), Dharmapala (2014), and Slemrod (2007).

While financial secrecy and tax evasion by multinational enterprises has been a major issue to the world economy for years, only recently the concerns over profit shifting, tax avoidance, and to which extent the subsequent government revenue loss affects the economy has intensified among both the policy makers and the academia. Due to an increasing intensity of the issue, an initiative The Base Erosion and Profit Shifting (BEPS) Action Plan was adopted by the Organisation for Economic Co-operation and Development (OECD) and G20 countries in 2013, formally acknowledging the BEPS problem and recognising the necessity of financial transparency to be promoted among participating countries. The OECD (2015) reports that the revenue losses from BEPS are estimated at USD $100 - 240$ billion annually, i.e. from $4 - 10\%$ of global corporate income tax revenue. Several studies present comparable results (e.g. OECD, 2015; Crivelli et al., 2015; De Mooij and Ederveen, 2005). Nonetheless, Clausing (2016) contradicts that the losses from corporate income tax are only somewhere between USD 77 and 111 billion to the U.S. Government, which is later supported by research proposed by Dowd et al. (2017). Despite the fact that the mentioned studies diverge in minor details, they consistently agree on

the general outcome, as they all state the problem of profit shifting is significant and increasing over the years.

The most recent findings related to base erosion and profit shifting are presented in the latest OECD (2018) report and updated database, Corporate Tax Statistics. It is reported that regardless of the trend of decreasing corporate income tax rates over the past two decades, corporate income taxation remains an essential source of government revenues worldwide and its share on the total tax revenue has significantly increased since 2000. More so, the 2016 data demonstrate that while in OECD member states the corporate tax revenues constitute 9% of the total tax revenues, the CIT is even more important to developing economies where it accounts for 15.3% in Africa and 15.4% in Latin America and the Caribbean of total tax revenue on average.

Overall, as several researchers confirmed in their studies mentioned earlier in this section, the nominal corporate income tax rates are important determinants of U.S. MNE's location decisions and business activity abroad; it is apparent that a significant share of their profits when shifted abroad will be directed to low-tax rate jurisdictions, and thus in the following section low-tax rate jurisdictions classified as tax havens are reviewed.

2.2 Tax Havens

As globalisation has begun to dominate the markets, tax havens have become the central issue within the corporate taxation scrutiny. It is appropriate to provide fundamental information on tax havens and their main characteristics in order to proceed with further investigation later in the empirical section. While several countries have been identified as notorious and established tax havens due to the complete absence of any taxation, among which the Cayman Islands, British Virgin Islands, or Bermuda are listed for instance (OECD, 1998). It is only in the recent years both researchers and policy makers have been conducting extensive investigation to provide a realistic perspective and proper comprehension on tax havens.

Tax havens are not always necessarily independent states, they are also very frequently islands or territories which are subjected to another state's authority, for instance, British Virgin Islands or Cayman Islands. Tax havens are also often classified as territories with the absence of any taxation; however, regions, where certain taxes are levied, low rates are offered, or suitable conditions for tax base erosion and profit shifting are provided, are likewise recognized as tax

havens (Dharmapala and Hines Jr, 2009). As previously discussed, all these characteristics which establish a tax haven are often accompanied by significant levels of financial secrecy (Shaxson, 2012).

Tax havens presence has been widely recognised since early 1920s (Palan et al., 2013), but it has not been appropriately defined till the OECD formally addressed the issue in 1998 and set out a framework for approaching the problem of no or only nominal tax jurisdictions (tax havens), preferential regimes, and how they affect the location of business activity. The report classified the harmful preferential regimes based on four key factors as follows:

(i) The regime imposes no or low effective tax rates on income from geographically mobile financial and other service activities,

(ii) the regime is ring-fenced from the domestic economy,

(iii) the regime lacks transparency,

(iv) there is no effective exchange rate of information with respect to the regime (OECD, 1998).

A framework for assessing whether a jurisdiction was a tax haven was consistently based on the following criteria: (i) whether a jurisdiction imposes no or only nominal taxes; (ii) lack of effective exchange of information; (iii) lack of transparency and (iv) the absence of a requirement that the activity is substantial.

The list was later on updated several times; in 2001 the OECD Forum of Harmful Tax Practices decided to omit the last criterion; thus, a new list was released in 2002 based on the first three criteria only. Later changes in the list were minor and regarded mostly exclusion of a few countries which acknowledged deficiencies in their tax system and agreed to implement changes soon.

The most notable listing was created in late 2017 as part of the EU's external strategy for taxation and was first agreed by Member States on December 5, 2017 (European Council, 2017). As the former approach appeared to be insufficient, the Commission has suggested that a common EU list of non-cooperative tax jurisdictions could be a more effective in confronting the problem of abusive tax practices in third countries. The criteria used in the listing process to assess countries are following:

(i) Transparency: The European Union requires compliance with international standards on information exchange, both the au-

tomatic and requested, ratified OECD's multilateral convention for which bilateral contracts with individual Member States could be substituted.

(ii) Fair Tax Competition: Compliance with the EU's Code of Conduct or OECD's Forum on Harmful Tax Practices, i.e. in case no or zero-rate corporate taxation is applied, the country must ensure that artificial offshore structures without real economic activity are not encouraged.

(iii) BEPS implementation: The country must either comply with or have committed to implement the OECD's Base Erosion and Profit Shifting minimum standards. (European Council, 2017)

The adoption of such listing is intended to contribute to current existing strategies to oppose and tackle the problem of harmful tax regimes which enable tax evasion. The EU list of non-cooperative tax jurisdictions comprises of 2 separate lists; as for the latest developments there are 15 jurisdictions identified on the EU Black List (European Commission, 2019a). Furthermore, there are countries which currently do not comply with the rules but have addressed the existing problems and have committed to implement strategies to improve their taxation regimes in the future. These countries constitute a separate watchlist (EU Grey List), in which governments have committed to make required changes in their practices. Although the common EU listings have appeared to be significantly more effective with countries addressing the problems and committing to change, when it comes to countries within the Union's borders it overlooks abusive practices among its own members. As Oxfam researchers (Langerock and Hietland, 2019) indicate in their latest publication, the EU neglects to identify and assess tax havens among its Member States. Oxfam has assessed all 28 EU Member States and identified following countries: Cyprus, Ireland, Luxembourg, Malta, the Netherlands, and Switzerland. The EU Black List and EU Grey list will be adopted in my analysis together with the results of the latest Oxfam assessment (for the listings see Table 2, Table 1, and Table 3).

2.3 Public Procurement

Public procurement serves as a tool to ensure the efficient use of public resources and its compliance with the public interest when governments and state-owned companies directly enter the market of goods and services. Government and state-owned companies' expenditure constitute a significant portion of the overall country's GDP (OECD, 2018), and thus such transactions are subjected to a neatly defined framework in order to prevent issues, such as corruption or violation of competition rules. As tax revenue losses to governments occur with increasing intensity in relation to corporate foreign direct investment, I suspect that tax avoidance behaviour occurrence within the public procurement market is not insignificant. Furthermore, besides the risk of tax evasion, profit shifting behaviour is also frequently accompanied by a tendency to hide the beneficiaries in order to cover a potential conflict of interest.

As I want to apply the gravity model of international trade on public procurement analysis, it is appropriate to outline the key principles that define such a unique market. The conceptual framework including the basic concepts, legal matters and the processes will be provided in this section. All businesses based in the EU have the right to compete for public contracts in other EU countries. EU procurement law provides a set of harmonised rules for government and other public tenders above certain threshold (see Table 4 for detail). For lower value contracts, national legislation applies, which is required to correspond with the EU regulation. For all public contracts following rules apply:

(i) No discrimination against other EU members,

(ii) specific brands, trademarks or patents cannot be required,

(iii) supporting documentation issued by another EU country should provide the same level of guarantee as national ones,

(iv) disclosure of information to all competing businesses regardless where they are based in (European Commission, 2019b).

There are different types of public procurement procedures applied in the EU market. First, these include open procedure, where all business can participate. Secondly, restricted tenders are only for those who are pre-selected, then they are negotiated procedures or competitive dialogue. Even though the EU procurement law forbids to openly discriminate other EU countries, I suspect there may be a significant border effect indicating a home bias created by favouring local companies. This is further examined in the analysis.

Where national law applies, established policies are consistent within the European Union, the aim is to ensure protective measures preventing any traditional economic abusive behaviour that may occur within the transactions such as corruption or cartel collusion, and to achieve a transparent competitive public market. The European Union Procurement Law is established by the fundamental principles derived from the European Community Treaty. These general regulations are bound to be consistent with any national legal regulation within individual member states. The general principles include transparency, non-discrimination, equal treatment, and mutual recognition. To ensure compliance with the regulations, the Office for the Protection of Competition supervises all public market activities.

Furthermore, the European Commission adopted a common public procurement strategy in October 2017 in order to improve the EU public procurement practices. Among other policies, the EU committed EUR 1.3 trillion under the World Trade Organization's Agreement on Public Procurement. However, while advocating greater openness to third countries, the EU must still ensure compliance with its regulation (European Commission, 2019c). Moreover, as tax evasion discussed in the previous sections is becoming more severe every day, Skuhrovec (2019) points out that public procurement is the perfect ground where governments and other public bodies should start to fight against the tax haven abuse.

Chapter 3

Data

3.1 Data Description

The gravity models of international trade typically involve a large database compiled from multiple sources, because not only the fundamental data on the flows under scrutiny, in this case the volume of public procurement tenders, but also traditional gravity bilateral variables are required. These include proxy variables for an approximation of trade costs, such as mutual distance, common border, or possibly various trade agreements. In this paper, the data in scope are provided by participants of the DIGIWHIST project and key researchers in the French Centre For Research And Expertise On The World Economy (CEPII).

Fundamental evidence for this paper consists of the dataset collected by key researchers from University of Cambridge (UK), Herie School of Governance (DE), Government Transparency Institute (HU), DATLAB (CZ), Open Knowledge Foundation Deutschland (DE), and Transcrime (IT) as part of the EU-funded project DIGIWHIST - The Digital Whistleblower (2019). The project is the first to provide such a unique aggregated database for all EU countries, Switzerland, Liechtenstein and Norway. It covers 12 years (2007 - 2018) of procurement contracts data from all publicly available databases in Europe. 255 624 suppliers (10%) were identified and matched with the individual tenders, these companies were examined up to the 20th level of their ownership structures with the help of Orbis, published by Bureau van Dijk, a Moody's Analytics company (Skuhrovec, 2019).

As financial secrecy has been constantly a concern for countries worldwide, the controversy among European countries has been brought up to light by this

project. It aims to increase trust in governments and improve the efficiency of government spending. The data was collected, structured and compiled from information on individual public procurement contracts of all 28 EU member states and ownership structures of the supplier companies. The data provide valuable information, but at the same time they suffer from several limitations. While the transactions incorporated in the database are dated from 2007 to 2018, it is only a fraction of the contracts, which carry the information (for coverage in individual countries see Table 5). Additionally, some countries are deficient, for example Croatian data is not available until its joining the European Union in 2013, or there is only a single observation for Estonia in 2009. Admitting the data is flawed and frequent missing observations are reported, the database still bears valuable information to be used in my research. Nevertheless, with this in mind, the original data are examined closely by individual country pairs and years to detect potential noisy observations. More so, this refers to the most apparent limitation which arises with the provided information, i.e. the share of the total number of tenders within a country covered is not consistent and balanced across all of the countries nor the years in scope.

The original DIGIWHIST dataset reports each contract as one observation. For purposes of this paper, I obtain data grouped by origin and supplier country for each year available, resulting in 10,275 observations in total. It might be suggested by the structure of the provided database that panel data methods should be employed as opposed to the preferred cross-sectional data estimation methods; however, another issue arises as mentioned earlier in this section. If a panel data view is applied instead of the cross-sectional, I would face a substantially imbalanced panel due to the missing data in certain years for some pairs of countries (e.g. Croatia), or inconsistent coverage by the sample over the years. Thus, the data were grouped by country and partner country to allow for cross-sectional analysis.

As described earlier in this section, the fundamental unit in the data is not a single country or jurisdiction, but instead the dataset consists of pairs of countries. These are represented by variables *country* for the contracting authority and *counterpart_country* for the supplier. For both the countries who participate in the transaction DIGIWHIST provides a unique country code to assist merging with other datasets, their GDPs, population, nominal corporate tax rate, financial secrecy index and whether they are listed as a non-cooperative jurisdiction on the EU blacklist or grey list as of December 4, 2018. While all of these variables are country-related, the key variable of interest is

a number respective to the transactions in scope, i.e. the volume of public procurement supplied from a counterpart country to the contracting authority country in the respective year, *tot_pp_value_from*. In order to account for all possible connections and exploit the information on suppliers' ownership structures, DIGIWHIST provides the data as follows: The value of procurement supplied is obtained by a risk method. Each contract available in the database is examined and linked to countries from which the supplier company is co-owned by a share larger than 10%. The entire value of the tender is then allocated to each country to which co-ownership can be traced. Thus, the following must be repeatedly reminded. Although it is very likely having suspiciously located affiliates does not necessarily mean that such companies engage in abusive tax practices. With this in mind, I examine the risk exposure to a potential outflow of taxable revenues, as having strategically located affiliates can be a sign of possible profit shifting.

In order to implement the gravity model of trade, the database needs to be enhanced with bilateral data on all country pairs covered. French research institute CEPII provides a gravity dataset containing all fundamental bilateral variables for all world pairs of countries covering information from 1948 to 2015. Variables primarily include mutual distance, GDP, international organisations membership (e.g. EU, OECD) and variables which can proxy the trade cost. These allow the estimation of the public procurement supplied as a function of GDP, population, mutual distance and trade costs. For a summary of variables used in analysis see Table 7.

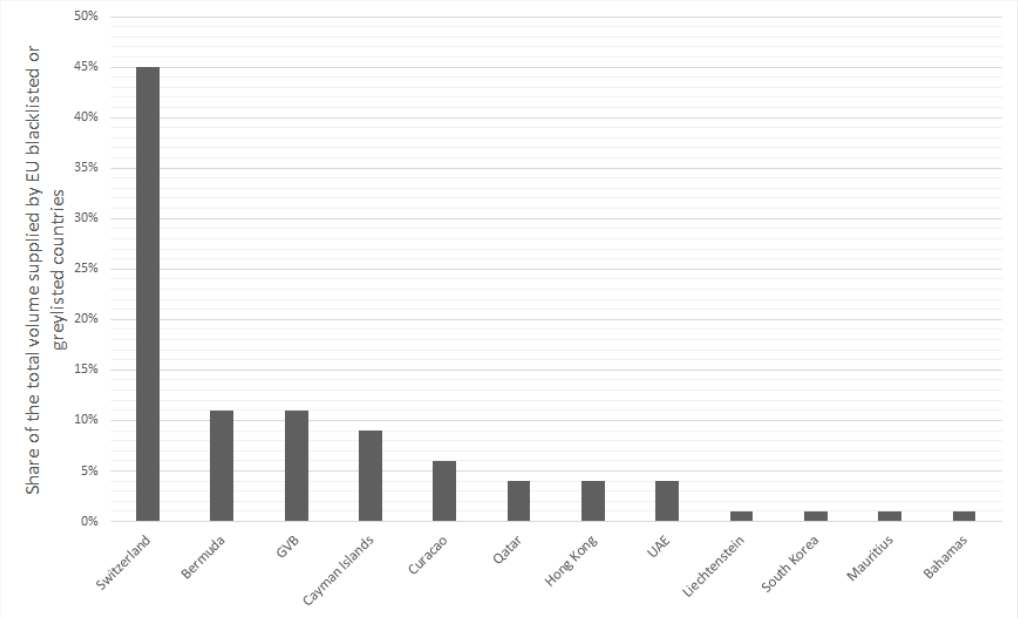
3.2 Descriptive Statistics

This section summarises key figures and the most recent findings by DIGIWHIST researchers (Skuhrovec, 2019). Based on the data collected, the author concludes that roughly around 5% of value of EU public procurement is supplied by tax haven companies. In his analysis he finds that about 10,000 government suppliers are co-owned from countries such as the Bermudas, British Virgin Islands or Cayman Islands - territories listed as harmful tax regimes by the EU. Skuhrovec (2019) states that about EUR 56 billion worth of public tenders was supplied by such companies over the past 12 years (2007 - 2018). However, he stresses that since reliability of the data is not consistent across all of the EU countries and only about 10% of all the suppliers were identified and examined,

there is still a great uncertainty about the real share of contracts awarded to tax haven based companies.

As EU blacklist and greylist were applied in his analysis; therefore, notorious EU havens were not subjected to the examination (Langerock and Hietland, 2019), and thus, naturally, the most frequently observed tax haven country in the sample is Switzerland. This finding is consistent with the general expectations due to Swiss economic ties, its location, and certainly its size. Others, however, include countries such as Bermuda, British Virgin Islands or Cayman Islands which seems to be far more alarming as intuitively there is rarely any physical economic activity based in these territories. Additionally, Skuhrovec (2019) examines the data and presents an overview of most popular tax havens using the EU Black List and EU Grey List (see Figure 3.1).

Figure 3.1: Tax Havens Popularity



Depicted tax havens are sorted by their share of the total volume of public tenders EU listed countries supplied to European governments over the 12 year period. *Source:* Skuhrovec (2019)

Skuhrovec (2019) also provides coverage of input data for individual contracting authorities in the sample. The per cent share represents the number of tenders where the supplier company and its ownership structure have been identified on the overall number of tenders available in the given country, which may vary depending on the quality of acquired procurement data (for detailed

listing see Table 5). I will use the figure for drawing estimates on the entire EU procurement market later in the analysis (for detail see section 5 Results).

Chapter 4

Methodology

4.1 Motivation

Following Skuhrovec (2019), I offer another perspective of how to view the data. As mentioned in the previous section, the most frequently identified tax haven in the sample is Switzerland, a European non-EU country. The reason behind this can, however, most likely be the companies' real physical economic activity based in Switzerland rather than profit shifting behaviour or a tendency to hide the ultimate beneficial owners. Furthermore, in some countries, such as Bahamas or Cayman Islands, it seems that legitimate reasons of why a government procurement supplier is based in such territory are extremely rare, but in reality there are some factors that may cause an increased procurement supply, e.g. historical colonial links, common currency, or certain trade agreements. In order to provide more detailed view of such transactions, I apply gravity models of trade to account for determinants which could naturally increase the procurement supplied by such countries. Using available listings (EU blacklist, EU greylist, OXFAM list) I exclude the countries suspected of being a tax haven from the data and I find a fitted model which describes the EU procurement market and the transactions between selected countries without the havens disturbances. Following the estimation, the obtained parameters are applied in a prediction to the entire dataset. The fitted values predicted by the model are then be compared to the actual observed values of procurement supplied between the respective countries. Based on the assumption that abusive profit shifting behaviour, with the intention to avoid taxation or hide the beneficiaries, does not have legitimate grounds of why the company is based in the territory, I expect the tax havens to be identified as outliers and exceed the

values predicted by the model. In my analysis I also separately examine European tax havens, namely Cyprus, Ireland, the Netherlands, Malta, Switzerland and Luxembourg.

As the public procurement market is set to follow globalisation and is gradually expanding, it offers opportunity to further analysis by employing the gravity equation model. There is a substantial interdependence between the countries and individual economies that adopts the globalized ecosystem of trading and it becomes apparent that public contracts are beginning to display comparable characteristics. Even though, the public procurement market has certain restrictions, the gravity principle is undeniably still present. Thus, the gravitation theory is therefore used for modelling and examination of the public contracts within the area of the European Union. The objective of modelling the public tenders supplied to EU countries is to estimate the theoretical volume of flows determined by the established and corroborated factors which affect trade such as GDP of both countries, distance between them weighted by population, or existence of potential trade barriers. The residuals predicted by the model should reveal outlying high volume flows that do not have grounds in any physical economic activity, i.e. sign of potential profit shifting to tax havens.

4.1.1 Gravity Model of Trade

Gravity model of bilateral trade flows is frequently employed when researchers attempt to estimate and reveal the key determinants affecting the patterns in international trade market. The model relies on gravity economic forces between the respective countries and provides estimated elasticities of specified determinants. Most frequently the model is used for identifying the trade potential and drawing subsequent predictions in the bilateral trade behaviour of countries under scrutiny. Rather than investigating the trade potential, this paper exploits the gravity principle and aims to identify the opposite case, when countries report significantly greater volumes of public procurement supplied than predicted by the fitted model. If applied correctly, this suggests that the procurement supplied above the predicted values is not underpinned by real economic activity, could therefore indicate profit shifting behaviour and the presence of so-called tax havens. This section provides both the theoretical and empirical context of the gravity equation economics mentioning evolution of

the model as well as discussing potential drawbacks associated with individual estimation methods.

Early Gravitation Theory

The first foundations of the traditional gravity model were laid out by the extensive research conducted by Jan Tinbergen (1962). Other researchers who attempted to apply the model and enhance the early theory basis include Pöyhönen (1963) and Linnemann (1966). They all provide description how the magnitude of the mutual flows of goods, services, and other resources can be estimated by a model which foundations lie within the Newton's gravitation theory. While the Newton's law of universal gravitation explains the mutual forces within the universe and provides us with description how individual masses are attracted to each other (Cohen and Whitman, 1999), Tinbergen (1962) states that the identical pattern is followed by international trade. He provides theoretical foundation for the first gravity equation of trade which models the forces that illustrate mutual attraction between individual economies which is proportional to their capacities and distance. He proposes a simple equation for cross-sectional data describing flows, denoted X_{ij}, from country i to country j given by following table.

Table 4.1: Gravity Equation

Gravity Model of Trade	Newton's Law of Gravitation
$X_{ij} = \tilde{G}\frac{Y_i E_j}{T_{ij}^{\theta}}$	$F_{ij} = G\frac{M_i M_j}{D_{ij}^2}$
where:	where:
X_{ij}: exports from countries i and j	F_{ij}: gravitation between i and j
$\tilde{G}$: inverse of world production $\tilde{G}=1/Y$	G: gravitational constant
Y_i: country i's domestic production	M_i: object i's mass
E_j: country j's aggregate expenditure	M_j: object j's mass
T_{ij}^{θ}: total trade costs between i and j	D_{ij}: distance between i and j

Source: Yotov et al. (2016)

The fundamental gravity theory suggests that countries trade in proportion respectively to their GDPs and mutual proximity. The traditional gravity equation proposed first by Tinbergen is focused on a simple specification to Newton's Law of Gravity and provides the bilateral trade flow in form of a log-linear function of the two countries GDPs, their bilateral distance and a series of bilateral dummy variables, which together with the former reflects

trade costs as a proxy. The Classical Gravity Model as it is known today is described as:

$$\ln(X_{ij}) = \beta_0 + \beta_1 \ln(G_i) + \beta_2 \ln(G_j) + \beta_3 \ln D_{ij} + \epsilon_{ij} \tag{4.1}$$

where G_i, G_j are respective country's GDPs, D_{ij} is their mutual distance and ϵ_{ij} is the error term. The most frequent approach includes estimation of the unknown β coefficients in Equation 4.1 by Ordinary Least Squares (OLS) on the aggregated trade cross-sectional data. The log-linear form of the model then delivers elasticities of trade in terms of country GDP and distance.

The OLS estimation of the gravity model has been considerably popular among economists (e.g. Linnemann, 1966; Baldwin and Nino, 2006; Linders and De Groot, 2006; Westerlund and Wilhelmsson, 2011; Martin and Pham Cong, 2008; Shepherd, 2013) as it offers a simple and intuitive solution. However, while it may be very effective when rough estimates are desired or as a benchmark model, the log-linear form of gravity is connected to several basic statistical drawbacks (Baldwin and Taglioni, 2006). Thus, since 1962 the model has experienced several modifications, and has evolved as researchers followed Tinbergen's model and attempted to correct for various forms of misspecification and errors from which the traditional model suffers.

The most apparent issue concerning most researchers is that the simple log-linear model neglects the relativity of trade flows to the rest of the world, namely their economic sizes as well as prices of their goods. The first researcher to address this issue after Tinbergen was James Anderson (1979) by whom the early theoretical basis of the gravity equation models was provided. While his work clearly presents a method of gravity models estimation offering a simple solution to the problem, it principally relies on the assumption that all goods are differentiable by country of origin and can be only imperfectly substituted for each other which in most cases cannot hold. As several contemporary authors (Leamer and Levinsohn, 1995) have pointed out in the past, although the theoretical framework delivered by Anderson (1979) introduced a conventional economic gravity model, it was perceived as lacking everyday practicality for its complexity and did not rise in popularity among trade economists at that time.

Recent Developments in the Gravity Research

It was not until 2003 when Anderson and van Wincoop properly set out the theoretical micro-foundations of the gravity equation. The basic theory used in their study is derived from Anderson (1979); in their research they present evidence that controlling for the third-countries' effects is essential for a correct specification of the gravity model. Their analysis shows that both bilateral and multilateral resistance are important determinants of trade and they take endogeneity of prices into consideration when estimating the model. Their study Gravity with Gravitas (2003) has become a major source in the current trends in estimating the gravity equations, and provided substantial material in the evolution of the original gravity model from 1962. While the traditional conception of the model suffers from misspecification as the effects outside of the bilateral relationships are frequently omitted, Anderson and van Wincoop (2003) offer a rationale where trade costs relative to other countries' conditions need to be applied in order to build the Structural Gravity Model. Multilateral trade resistance terms (MRT), as they proposed, account for the resistance created by the pressure of other economies in the world trade market and correct for the omitted variable bias in the Classical Gravity Model. According to several respected papers, including Anderson and van Wincoop (2003) or WTO published Bacchetta et al. (2012), a specification correction for the MRT can provide a sufficient modification of the traditional log-linear model and yield consistent estimates if the other classical linear assumptions hold. The common and widely recommended approach (e.g. Rose and van Wincoop, 2001; Baldwin and Taglioni, 2006) is to use the fixed effects estimation; however, as this would result in elimination of time-invariant variables or effects of variables with relatively minor changes over time it is not a desirable direction for the purposes of this paper. As we want to obtain the coefficients in order to apply them later to another dataset containing only data on countries classified as tax havens, the elimination of such fundamental variables may result in insufficient predictions. This does not necessarily mean that such model would yield inaccurate estimates as the approach is promoted by many trade economists and is widely recommended; however, it does not ideally serve the purpose of this paper. Another method by which the MRTs could be accounted for is to simply calculate them for each country and replace the distance variable with the so-called remoteness variables for respective countries. This method is widely used and recommended as it provides the desired specification correction for the

traditional log-linear OLS model which has been frequently criticized for neglecting the exogeneity of prices and the third countries' effects. This approach is strongly supported by current researchers, e.g. a book series published by the World Trade Organisation in cooperation with the United Nations Conference on Trade and Development (Bacchetta et al., 2012; Yotov et al., 2016).

The multilateral resistance terms for the exporter and importer, in our case supplier and contracting authority respectively, are accounted form with a proxy variable. The remoteness terms are most frequently calculated as:

$$Rem_i = \sum_j distance_{ij} \frac{GDP_j}{GDP_W} \tag{4.2}$$

The formula describes a country's average distance from its trading partners weighted by the partner country's share of the world GDP (i.e. GDP_W in Equation 4.2). Furthermore, the original method of calculating the multilateral resistance terms (Anderson and van Wincoop, 2003) has been subjected to a few modifications, for example Head and Mayer (2000) suggest applying the square root of the country's area multiplied by 0.4 to specify its distance from itself. Most recently, as Bacchetta et al. (2012) note in their methodological paper, Baier and Bergstrand (2009) offer a linear approximation with a first order Taylor series expansion to avoid using a non-linear procedure in the log-linear model, their resulting gravity equation is described as:

$$\begin{aligned} \ln Trade_{ij} = {} & \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j - (\sigma - 1) \ln t_{ij} \\ & + (\sigma - 1) \left[\sum_j \theta_j \ln t_{ij} - \frac{1}{2} \sum_i \sum_j \theta_i \theta_j \ln t_{ij} \right] \\ & + (\sigma - 1) \left[\sum_i \theta_i \ln t_{ij} - \frac{1}{2} \sum_i \sum_j \theta_i \theta_j \ln t_{ij} \right] \end{aligned} \tag{4.3}$$

where θ denotes GDP shares as suggested in Equation 4.2 and t overall trade costs, rather than only simple distance. The terms in square brackets represent the linear approximation of remoteness term and the world trade costs respectively. Furthermore, Head (2003) suggests an alternative form, given by:

$$Rem_i = \sum_j \frac{distance_{ij}}{GDP_j / GDP_W} \tag{4.4}$$

which is a minor modification of the formula in Equation 4.2 proposed by Anderson and van Wincoop (2003). In the early stages of my research I tested

all of the methods mentioned above and the formula proposed by Head (2003) yields the best results in terms of additional percentage points of R-squared. As indicated in Bacchetta et al. (2012), accounting for these multilateral resistance terms can solve for the most frequent mistake in the traditional approach identified by Baldwin and Taglioni (2006). As these are strongly correlated with the trade costs, the OLS estimation yields significantly biased results when MRTs are omitted. Later on in this paper, I use the traditional log-linear model for rough estimates and a benchmark, thus Head's (2003) approach is applied in the estimation.

Treatment of Zero-Observations

Another issue which has been frequently discussed since the first introduction of the gravity model are different approaches of how to handle zero trade flows between a given pair of countries. These observations are often omitted in the OLS estimations due to the logarithm specification. As many researchers point out (e.g. Bacchetta et al., 2012; Yotov et al., 2016; Baldwin and Taglioni, 2006; Anderson, 2011; Brakman and Begeijk, 2010; Silva and Tenreyro, 2006), dropping such observations in the trade data does not affect the estimation as far as the zeros simply represent missing unreported observations and follow a random distribution. However, if these are true zero trade flows in reality they carry important information, and thus excluding them from the model can yield biased results. An alternative model was proposed by now influential and respected paper of Silva and Tenreyro (2006). They suggest using the Pseudo Poisson Maximum-Likelihood (PPML) estimator in order to solve for the zero-trade flows. Moreover, the log-linear form of the gravity equation alters the property of the error term, and yields inconsistent results in the presence of heteroskedasticity, which is typical for trade data. The Pseudo Poisson Maximum-Likelihood model offers a viable non-linear solution to several issues raised in the OLS estimation. It has proven to be robust to various heteroskedastic structures, and as Silva and Tenreyro (2006) highlight, it is the best available approach if no further information on the form of heteroskedasticity is accessible. They modify the log-linear form in Equation 4.1 and provide an equation[1] for the PPML Gravity Model, given by:

$$Trade_{ij} = exp(\beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln Distance_{ij}) \times \eta_{ij} \quad (4.5)$$

[1] A basic reduced form of the equation is presented for clarity, in further estimations additional variables are applied as proxies for trade costs.

where the disturbance with common properties is denoted by η_{ij}. As Silva and Tenreyro (2006) show that PPML delivers significantly less biased estimates than OLS, the model estimating equation in Equation 4.5 has penetrated the consciousness of trade economists in recent years, and has risen in popularity in the gravity research. Following papers successfully employ the procedure: Westerlund and Wilhelmsson (2011); Martin and Pham Cong (2008); Kucharčuková et al. (2012); Cipollina and Salvatici (2010).

Alternative Models

Since 1962 there have been several modifications of the gravity equation and different estimation methods introduced. Cross-sectional analysis has been widely popular among trade economists when using traditional OLS approach or Pseudo Poisson Maximum-Likelihood estimator (e.g. Frankel and Rose, 2000; Nilsson, 2000). Others preferred pooled cross-sections (e.g. Cheng and Wall, 2005), though the method did not rise in popularity. Recently, many authors have successfully employed panel data methods (e.g. Rose and van Wincoop, 2001; Bacchetta et al., 2012; Yotov et al., 2016; Cheng and Wall, 2005).

Many different estimation techniques were discussed over the past decades; however, there is no single general estimator that strictly dominates the gravity research. Pooled OLS, Fixed Effects, and Random Effects have frequently been used as a benchmark in the past. In 2006, Silva and Tenreyro introduced a very effective solution to heteroskedastic errors in the Classical Gravity Model and has been regarded as a new benchmark since then (Kucharčuková et al., 2012). Less frequently, Mundlak Model is employed (Mundlak, 1978); its basis lies within the random effects regression theory, which uses the group-means of variables differing within groups as additional set of regressors. The model relaxes the classical endogeneity assumption in the random effects regression. For more details see Mundlak (1978), and Chapter 10 in Wooldridge (2010). Very similar to the Mundlak model, Hausman-Taylor model with instrumental variables was introduced by Hausman and Taylor in 1981. The model obtains consistent estimates of the time-invariant variables and similarly to the previous model, it deals with potential endogeneity in the independent variables. See also Hausman and Taylor (1981); Egger and Pfaffermayr (2004) for applications and more details. Other researchers employ Tobit estimation (Silva and Tenreyro, 2006; Martin and Pham Cong, 2008), Heckman two-step model (Martin and Pham Cong, 2008; Linders and De Groot, 2006), Nonlinear

Least Squares (Silva and Tenreyro, 2006), Feasible Generalised Least Squares or Gamma Pseudo Maximum-Likelihood (Márquez-Ramos et al., 2007). These offer several options for comparison; however, this is beyond the scope of this paper.

4.2 Baseline Model

The database provided by DIGIWHIST project reports public procurement data in 47 countries, these include European countries with a reliable number of observations as well as rather deficient non-European countries' data which appear to have been incorrectly included in the dataset. Such deficient figures may create a significant disturbance in our data; thus, countries reporting less than 5 observations in the original database were dropped from our dataset (e.g. Bangladesh, Belarus, Benin, Bolivia, Cambodia, Chad, etc.).

As DIGIWHIST is a successful ongoing project, the database is continuously updated with new figures, thus, the most recent data appear to be reporting missing values for supporting variables such as last year's GDP or countries' population. As these variables are essential for the gravity analysis, the data was manually filled in with International Monetary Fund's (IMF) financial statistics to complete the dataset (2018).

The most apparent transformation in the structure of the data was elimination of the time dimension. In the early stages of my research, I attempted to form a panel and then apply panel data estimation methods as it is the most frequently recommended approach. Nevertheless, I have soon come to following issues which prevented me from using a panel for further analysis. The data form a strongly imbalanced panel in terms of both country-pairs and inconsistent number of observations over the available time period. As mentioned earlier, the quality of the data is not consistent across countries, for some countries the data are rather deficient. For example as discussed in Chapter 3, Croatian data are unavailable until its joining the Union in 2013. Overall, the data appear to be unfit for panel data estimation.

In addition to this approach, I also performed Pooled Cross-Section; however, the distribution of the regression residuals has proven to be unsuitable for further analysis in terms of grouping the data by supplier countries. To properly exploit the finest granularity of the data, for further research using gravity models I suggest dividing the data and perform the analysis separately for each contracting country in the sample and also clustering by supplier countries, po-

tentially even dividing the data by industrial sectors. This would certainly help to achieve desired homogeneity and reduce unwanted disturbances across the European procurement market. However, this is beyond the scope of this paper; as discussed further in the empirical results, individual elasticities and effects of independent variables in the model are not subjected to the scope of my research as the key interest lies rather within the fitted values of the model as a whole. Furthermore, as I am particularly interested in the residuals in terms of individual supplier countries, applying cross-sectional methods on grouped data appears to be far more suitable for my analysis than working with the original granularity.

4.2.1 Log-linear OLS model

The biggest advantage of the traditional OLS log-linear approach is that the model is simple and quite intuitive; however, it can yield biased coefficients under heteroskedasticity and can cause loss of information if zero trade flows are present. For it can still provide good approximation, the log-linear model is used as a benchmark regression results. As Baldwin and Taglioni (2006) and many others emphasise, the original OLS model suffers from misspecification as it neglects multilateral relationships with third-countries. As follows from Anderson and van Wincoop (2003) and supported by the WTO research (Bacchetta et al., 2012; Yotov et al., 2016) adding a proxy remoteness variable which accounts for the unobserved effects in the original model is sufficient. Thus, altogether, I arrive at model:

$$\begin{aligned}\ln(pp\_value_{ij}) = {} & \beta_0 + \beta_1 \ln(GDP\_contractor_i) + \beta_2 \ln(GDP\_supplier_j) \\ & + \beta_3 \ln(distance_{ij}) + \beta_4 RTA\_wto_{ij} + \beta_5 pta\_bb_{ij} \\ & + \beta_6 contig_{ij} + \beta_7 comlang\_off_{ij} + \beta_8 comlang\_ethno_{ij} \\ & + \beta_9 comcol_{ij} + \beta_{10} tdiff_{ij} + \beta_{11} conflict_{ij} \\ & + \beta_{12} colony_{ij} + \beta_{13} comrelig_{ij} + \beta_{14} smctr_{ij} \\ & + \beta_{15} remoteness\_supplier_j + \beta_{16} remoteness\_contractor_i \\ & + \epsilon_{ij}\end{aligned} \tag{4.6}$$

where $\ln(pp\_value_{ij})$ is the logarithm of the public procurement supplied by country j to country i over 12 years (2007-2018). In an ideal situation, bilateral trade flows should be estimated; however, discrepancies in the data frequently

cause an imbalance as trade data typically consist of export and import from country i to country j, and vice versa. Most authors work with the average of these four measurements; nonetheless, in order to avoid Silver Medal Mistake as indicated in Baldwin and Taglioni (2006) and Bacchetta et al. (2012), the common practice suggests that trade flows should be treated seperately each way. Thus, in my model I use public procurement supplied by country j to country i only. Furthermore, following example of Anderson and van Wincoop (2003); Bacchetta et al. (2012); Silva and Tenreyro (2006) remoteness variables were calculated for country i as well as for supplier country j using formula in Equation 4.4 in logarithm. The intuition behind remoteness indexes is to account for effects that multilateral relationships (remoteness towards third countries) may pose on the bilateral trade flow, i.e. procurement supply. As Silva and Tenreyro (2006) note in their study, controlling for remoteness allows for examining the hypothesis that greater remoteness with respect to third countries might increase bilateral trade between two countries. This hypothesis is supported by Poisson regression in their results, in our case both OLS and Poisson regression demonstrate that both the supplier's and the contracting authority's remoteness increase bilateral procurement relationship (see Table 4.2 and Table 4.3).

GDPs of both countries are taken into the regression as natural logarithms ($\ln(GDP\_supplier_j)$, $\ln(GDP\_contractor_i)$); in addition to the key variables, bilateral dummies for regional trade agreements (fta_wto_{ij}), WTO membership ($gatt\_d$), contiguity ($contig_{ij}$), common language official ($comlang\_off_{ij}$), common language by ethnicity ($comlang\_ethno_{ij}$), common coloniser ($comcol_{ij}$), time difference ($tdiff_{ij}$), conflict ($conflict_{ij}$), colonial relationship ($colony_{ij}$), common religion ($comrelig_{ij}$), and a dummy for domestically supplied procurement ($smctr_{ij}$) is used.

Alternatively, I perform the common traditional OLS regression using only the simple distance in logarithm ($\ln(distance_{ij})$) without the remoteness variables. For individual details and comparison see Table 4.2.

Table 4.2: OLS Regression Outputs

Non-zero dataset	OLS1	OLS2	OLS3
No. of obs.	806	806	806
R-squared	.4653	.5830	.6038
Dependant variable	ln(pp_value)	ln(pp_value)	ln(pp_value)
ln(distance)	***-1.1689		***-1.0091
ln(gdp_contr)	***.4299	.0371	.1042
ln(gdp_supp)	***.9733	***.5099	***.4981
fta_wto	-.1900	.2564	-.1636
gatt_d	***1.2819	.3003	*.5441
contig	*.8797	***1.5941	*.6022
comlang_off	.2192	-.2634	.0871
comlang_ethno	-.0344	.5121	.4545
comcol	***3.0200	***3.1895	***3.2442
tdiff	.0824	***-.1958	.0172
conflict	-.2540	.3358	.07504
colony	*1.1801	.4207	.5310
sibling	.5196	.7912	.0638
comcur	-.2396	*-.5110	-.4256
comrelig	*.9940	**.9024	*.7441
smctr	***4.3052	***6.5685	***4.2274
remoteness_contr		***.3706	***.3872
remoteness_supp		***.4639	***.4374
constant	***-12.2047	***-7.4569	-1.3073

$* \; p < 0.05, \; ** \; p < 0.01, \; *** \; p < 0.001$

Regression output using the traditional Ordinary Least Squares approach with simple distance variable (OLS1), remoteness variables one for each country in the pair (OLS2), and distance together with both remoteness indexes as performed in Silva and Tenreyro (2006) (OLS3) on a non-zero dataset. *Source:* Author's calculations

4.2.2 Poisson Pseudo Maximum-Likelihood Estimator

The log-linear model provides a good approximation for identification of the supplying countries as potential tax havens. However, as mentioned in the gravity theory overview, the OLS model tends to yield biased estimates under heteroskedasticity and report several other issues which were discussed earlier. Therefore, as follows from influential paper Log of Gravity (Silva and Tenreyro, 2006) and several later studies, I propose the Pseudo Poisson Maximum-Likelihood estimator; the procedure is said to be robust to various forms of heteroskedasticity and can treat even misspecification errors. In further anal-

ysis, I use this approach to estimate the equation given by:

$$\begin{aligned} pp\_value_{ij} = exp\Big[&\beta_0 + \beta_1 \ln(GDP\_contractor_i) + \beta_2 \ln(GDP\_supplier_j) \\ &+ \beta_3 \ln(distance_{ij}) + \beta_4 RTA\_wto_{ij} + \beta_5 pta\_bb_{ij} \\ &+ \beta_6 contig_{ij} + \beta_7 comlang\_off_{ij} + \beta_8 comlang\_ethno_{ij} \\ &+ \beta_9 comcol_{ij} + \beta_{10} tdiff_{ij} + \beta_{11} conflict_{ij} \\ &+ \beta_{12} colony_{ij} + \beta_{13} comrelig_{ij} + \beta_{14} smctr_{ij} \\ &+ \beta_{15} remoteness\_supplier_j + \beta_{16} remoteness\_contractor_i \Big] \times \eta_{ij} \end{aligned} \tag{4.7}$$

Alternatively, according to Fally (2012) the multilateral resistance terms can be neglected if Poisson estimator is employed; thus, simple distance alone is used in the same equation instead of the MRTs for comparison:

$$\begin{aligned} pp\_value_{ij} = exp\Big[&\beta_0 + \beta_1 \ln(GDP\_contractor_i) + \beta_2 \ln(GDP\_supplier_j) \\ &+ \beta_3 \ln(distance_{ij}) + \beta_4 RTA\_wto_{ij} + \beta_5 pta\_bb_{ij} \\ &+ \beta_6 contig_{ij} + \beta_7 comlang\_off_{ij} + \beta_8 comlang\_ethno_{ij} \\ &+ \beta_9 comcol_{ij} + \beta_{10} tdiff_{ij} + \beta_{11} conflict_{ij} \\ &+ \beta_{12} colony_{ij} + \beta_{13} comrelig_{ij} + \beta_{14} smctr_{ij} \Big] \times \eta_{ij} \end{aligned} \tag{4.8}$$

For the sake of comparison I estimate both the OLS and the Pseudo Poisson model with and without using remoteness terms as proxies for multilateral relationships, which are not directly observable, on the original data without adding zero observations for completeness. While the OLS can yield biased estimates, Poisson should solve for several issues which arise in the linear model (Baldwin and Taglioni, 2006). I suspect both should converge in the countries identified as potential tax havens; however, divergence in the magnitude of the individual effects and size of residuals is most likely. Detailed overview is provided in the next sections. Furthermore, using the original dataset without the zeroes for both the OLS and the Poisson estimation may not seem to be ideal, but as illustrated in Log of Gravity omitting the zeros has reasonably small consequences (Silva and Tenreyro, 2006).

Additionally, I suspect that in the context of the procurement data, not including the zeros would have an even smaller impact than for the regular trade, simply because the restricted public procurement market is significantly smaller in terms of participating countries and cannot reach the same high level of globalisation as international trade in the private sphere. Furthermore, this implies the zero procurement supplied by certain countries is not caused by e.g. their small production or remoteness, rather they imply the fact that such countries have never even entered the EU's public procurement market. In the original DIGIWHIST dataset zero observations are not included; I suspect that including zeros with the intention to obtain complete data with all pairwise combinations as advised by Bacchetta et al. (2012) would not only be incorrect but could also strongly bias the overall estimates downwards. Thus, in this paper, I use the traditional OLS approach as a reference point model and to obtain rough estimates for identification of the suspected tax havens with the original data without the zero observations, to be able to report more accurate and reliable results I apply the Poisson estimator. For the regression results of the method applied see Table 4.3.

It can be observed that the Pseudo Poisson model is far more successful in describing the data than does the traditional OLS model. R-squared for the log-linear OLS model is around 58% compared to 87% for the Poisson. Given that the exact same independent variables are applied in both of the approaches, the significant improvement in R-squared is a result of a different choice of estimation method and it is suggested that the Poisson model is most likely to note significant features in the data causing heteroskedasticity which violates the consistency of OLS estimates. Additionally, both distance and remoteness coefficients are notably smaller under the former estimator. Silva and Tenreyro (2006) describe this as the heteroskedasticity effect in the OLS model.

Due to its popularity in current research and the fact that Poisson yields consistent estimates regardless the data distribution, the pseudo-maximum likelihood estimator seems to be the best available option (Shepherd, 2013).

Table 4.3: PPML Regression Outputs

Non-zero dataset	PPML1	PPML2	PPML3
No. of obs.	806	806	806
R-squared	.8128	.8666	.7953
Dependent variable	pp_value	pp_value	pp_value
ln(distance)	***-.7750		**-.6374
ln(gdp_contr)	.0678	***-.2704	**-.1896
ln(gdp_supp)	***.4724	.0973	*.1907
fta_wto	***.9087	***1.1118	**.8416
gatt_d	.9647	.6549	.5693
contig	.4202	***.9019	.3810
comlang_off	**-.8298	***-.9016	**-.7377
comlang_ethno	*.7179	***1.2933	***1.126248
comcol	.0646	.5017	.4567
tdiff	***.2199	.0516	*.1709
conflict	.0240	.3637	.2886
colony	***1.0729	.6490	*.6441
sibling	.7159	.7300	.5722
comcur	-.0546	.0855	.0109
comrelig	.3418	-.1237	.1140
smctr	***4.3565	***5.5348	***4.2192
remoteness_contr		***.3056	**.2571
remoteness_supp		**.3698	**.3929
constant	***9.1720	***14.0585	***14.5073

$* \; p < 0.05, \; ** \; p < 0.01, \; *** \; p < 0.001$

Regression output using Pseudo Poisson model approach with simple distance variable (PPML1), remoteness variables one for each country in the pair (PPML2), and distance together with both remoteness indexes as performed in Silva and Tenreyro (2006) (PPML3) on a non-zero dataset. *Source:* Author's calculation

4.2.3 Poisson Pseudo Maximum-Likelihood Estimator Treating Zero-Observations

As most researchers point out (e.g. Baldwin and Taglioni, 2006; Silva and Tenreyro, 2006; Drzewoszewska, 2014; Yotov et al., 2016; Bacchetta et al., 2012), omitting zero-observations can lead to loss of important information, if the zeros are not randomly distributed and represent, in fact, zero trade or no procurement supplied in our case. There are no zero-observations present in the original dataset, but for the sake of comparison it is appropriate to add the

zero-observations using the STATA command *fillin [varlist]* to complete for all possible combinations of countries (Bacchetta et al., 2012).

It is still useful to compare the elasticities estimated using OLS and Poisson model both of which omit the zero-observations (see Table 4.2 and Table 4.3) with the estimates using the simple gravity model Poisson model (PPML1) and OLS (OLS1) where the zero procurement supply is explicitly treated as a no procurement situation (Table 4.4). The regression model including the zeros demonstrates results more or less consistent with the previous models (see Table 4.4 for comparison of regression outputs).

Table 4.4: PPML Regression Output with Presence of Zeros

Non-zero dataset	OLS1	OLS4	PPML1	PPML4
No. of obs.	806	2204	806	2204
R-squared	.4653	.5325672	.8128	.8472
Dependant var.	ln(pp_value)	ln(pp_value+1)	pp_value	pp_value
ln(distance)	***-1.1689	***-2.9236	***-.7750	***-.9496
ln(gdp_contr)	***.4299	***.7794	.0678	.0737
ln(gdp_supp)	***.9733	***1.5870	***.4724	***.5265
fta_wto	-.1900	***2.9634	***.9087	***1.3148
gatt_d	***1.2819	***2.0844	.9647	*1.3222
contig	*.8797	**2.08449	.4202	.3292
comlang_off	.2192	.6884	**-.8298	**-.7447
comlang_ethno	-.0344	-.3797	*.7179	*.6470
comcol	***3.0200	2.3002	.0646	-.3015
tdiff	.0824	***.4324	***.2199	***.2868
conflict	-.2540	-1.3096	.0240	-.0800
colony	*1.1801	***4.7650	***1.0729	***1.2361
sibling	.5196	-1.277403	.7159	.6517
comcur	-.2396	1.005907	-.0546	-.0399
comrelig	*.9940	***2.2302	.3418	.4366
smctr	***4.3052	***6.6653	***4.3565	***4.5770
constant	***-12.2047	***-32.9479	***9.1720	**7.8894

$* \; p < 0.05, \; ** \; p < 0.01, \; *** \; p < 0.001$

Regression output using both OLS and Pseudo Poisson model with a non-zero dataset (OLS1, PPML1) and data where unreported procurement flows are treated explicitly as zeroes (OLS4, PPML4). *Source:* Author's calculation

Inclusion of zero-observations seemingly presents a better fit in terms of additional (Pseudo) R-squared and reports greater elasticity of trade in terms of distance and supplying country's GDP. Consistently with previous research

(Felbermayr and Kohler, 2010; Helpman, 2006) I also find that including unrecorded procurement supply flows in gravity equations shows that trade agreements (see *fta_wto* in Table 4.4) has a strong and significant positive effect on procurement using Poisson model. Additionally, same applies to WTO membership, which shows a significant positive effect on procurement, this is also in line with the fact that EU promotes openness in public procurement and has committed to award EUR 1.3 trillion worth of public contracts under the WTO's Agreement on Public Procurement (see Section 2.3 for detail).

4.3 Comparison of the Models

When estimating Equation 4.6, some diagnostic tests were conducted. When applying log-linear regression problems arise if the explanatory variables are highly correlated (Wooldridge, 2010). Such issue may result in a significant change in the regression coefficients if a predictor is added or excluded, and the estimated errors of the fitted coefficients may appear not be statistically significant even though there is a strong statistical relation between the explained and explanatory variables as a whole. In order to check for the presence of multicollinearity, I calculate the variance inflation factors (VIF) and tolerances for each regressor. According to (Chatterjee and Hadi, 2012), there is evidence of multicollinearity if the largest VIF is larger than 10 or the mean of all the VIFs calculated is considerably larger than 1. When using both remoteness and distance variables as performed by various respected papers (Silva and Tenreyro, 2006), the test reports a strong collinearity in the remoteness variable (Table 8). Hence, for further analysis I proceed with the remoteness variables or distance, but not both. For the models using only remoteness variables, performed multicollinearity test reports no VIF greater than 10 and the average factor exceeds the threshold set at 1 only by a minor amount (Table 9). However, intuitively, some of the independent variables, especially the ones representing overall trade costs, will necessarily be correlated, for example common colonizer can be expected to affect the countries' language. If further examining the individual effects, this should be considered. Furthermore, a simple Breusch-Pagan[2] test was conducted, and the presence of heteroskedasticity was confirmed in line

[2]Breusch-Pagan Test for Heteroskedasticity: The test involves regressing the squares of the OLS residuals on a set of the original variables in an auxiliary regression. If the homoskedasticity assumption holds, such regression should have no explanatory power. The Breusch-Pagan test can be computed with a simple STATA command *estat hettest* after *reg [depvar][varlist]* (Wooldridge, 2010).

with our expectations. Thus, a non-linear method was also used to obtain viable consistent estimates, I applied a Pseudo Poisson Maximum-Likelihood model as proposed by Silva and Tenreyro (2006), the approach has proven to be effective and robust to various forms of heteroskedasticity.

Table 4.2, Table 4.3, and Table 4.4 report the regression outcomes for all used methods. As intuitively expected, all approaches yield negative elasticity with respect to the distance variable and strong positive statistically and economically significant effects of countries' GDPs. Both OLS and Poisson show that supplier's and contractor's remoteness to third countries increase bilateral procurement supplied consistently with Silva and Tenreyro (2006); Márquez-Ramos et al. (2007). In addition to the key regressors, WTO membership and regional trade agreements mostly show a small statistically and economically insignificant effect in models using non-zero dataset and strongly significant positive effect when including the zeros in case of the WTO membership. While in the OLS approach shared border appears to be statistically significant and positively affecting procurement, for the Poisson model the variable is not significant. Although the previous results were expected, some of the obtained coefficients are rather surprising, namely all of the models applied report a significant negative elasticity of common official language and negative effect of a currency union. Even though these effects seem to be rather unexpected, the results are somewhat consistent with the previous research. For example Frankel and Rose (2000) report +235% effect of sharing a currency, but the multilateral relationships are neglected in their paper, after correcting for the gold-medal mistake, as Baldwin and Taglioni (2006) call it, the estimated coefficient is -0.38 (Glick and Rose, 2001), significantly smaller and negative.

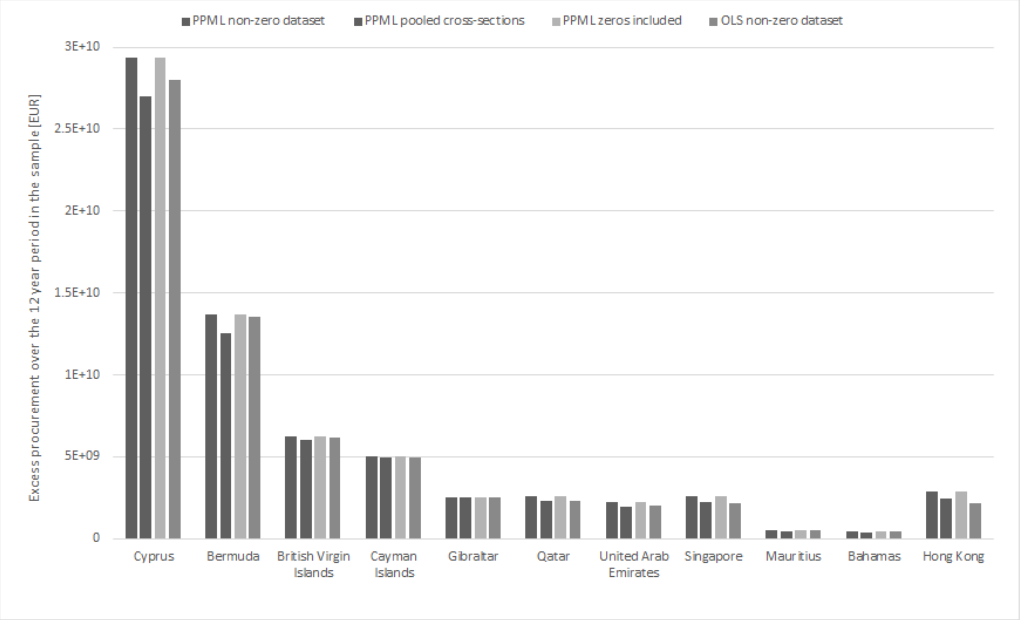
For identification of countries supplying procurement to the EU as potential tax haven, residuals are subjected to further analysis. Countries with the greatest outliers, i.e. the largest difference between fitted values predicted by a gravity model and the observed values in terms of both nominal figures and percentage.

The coefficients resulting from the models applied are estimated on data from which countries classified as tax havens were excluded (using EU Black List, Grey List and OXFAM). Fitted values are then compared to the observed figures for the entire dataset. The results are expected to report significant differences between the predicted values and the actual values for the tax haven countries in comparison to others. These differences represent the taxable

revenue from supplied tenders that may be shifted to tax havens above the theoretical trade relationship established by the mutual economic gravity forces and pose a risk in terms of tax evasion as well as conflict of interest if financially secretive regimes are used.

Finally, as discussed in the previous sections (see Subsection 4.2.2), adding the zeros does not shift the fitted values significantly downwards as expected. Figure 1 illustrates that all the methods applied are somewhat consistent, and thus, any deviations caused by the selected approach in terms of the form of dataset or chosen estimation method are minor in line with Silva and Tenreyro's claims (2006). For identification of tax countries I use both OLS and Poisson model, but for the reasons stated previously and following recommendations of previous studies, I primarily use the Poisson model without the zero-observations (PPML2) for further analysis and treat the excess procurement estimated as a certain lower bound.

Figure 4.1: Sensitivity to Different Choice of Dataset and Method



Comparison of residuals in PPML model using a grouped non-zero dataset, grouped data where unreported flows are treated explicitly as zeros, original pool of cross-section with yearly breakdown, and OLS on a non-zero dataset showing that the analysed residuals are robust to a different choice of dataset form and estimator. *Source:* Author's calculations

Chapter 5

Results

The traditional log-linear approach is applied in order to obtain rough estimates and to provide benchmark estimation for further analysis. A gravity equation based on Anderson and van Wincoop (2003) model is used with and without the multilateral resistance terms defined in Head (2003) for comparison. In the following section, I use the methods applied to identify high risk countries as tax havens by the magnitude of residuals estimated.

5.1 Identified Countries

The intuition behind the analysis is that if the estimation is performed on data excluding the tax haven jurisdictions (EU Black List 2018, EU Grey List 2018, OXFAM listing 2018) any potential disturbances are eliminated and coefficients of determinants of the overall natural level of public procurement supplied are obtained. Then when these coefficients and the model is applied on the entire dataset, outliers as potential tax havens are identified. The difference between fitted values predicted by the gravity equation and the observed figures is calculated cumulatively by individual suppliers, i.e. the amount of procurement predicted to be supplied by a country and how much it in fact supplied.

Based on both the OLS and Poisson approach (using OLS2 and PPML2), following countries are identified as top outliers in terms of the magnitude of residuals by both the nominal figures and per cent (for individual quantities and further analysis see Section 5.2).

Table 5.1: Top 13 outliers identified by the OLS model

No.	OLS [nominal]	OLS [%]	No.
1	Cyprus	British Virgin Islands	1
2	Bermuda	Bermuda	2
3	British Virgin Islands	Angola	3
4	Cayman Islands	Marshall Islands	4
5	Angola	Cayman Islands	5
6	Gibraltar	Mauritius	6
7	Japan	Gibraltar	7
8	Qatar	Seychelles	8
9	Hong Kong	Sao Tome and Principe	9
10	Singapore	Cyprus	10
11	United Arab Emirates	St. Kitts and Nevis	11
12	Australia	Barbados	12
13	Mauritius	Bahamas	13

Source: Author's calculations

Table 5.2: Top 13 outliers identified by the PPML model

No.	PPML [nominal]	PPML [%]	No.
1	Cyprus	Angola	1
2	Bermuda	Bermuda	2
3	British Virgin Islands	Gibraltar	3
4	Angola	British Virgin Islands	4
5	Netherlands	Cyprus	5
6	Cayman Islands	Mauritius	6
7	Gibraltar	Cayman Islands	7
8	Qatar	Qatar	8
9	Mauritius	United Arab Emirates	9
10	United Arab Emirates	Seychelles	10
11	Seychelles	The Netherlands	11
12	Sao Tome and Principe	Barbados	12
13	Barbados	Luxembourg	13

Source: Author's calculations

Table 5.1 and Table 5.2 report countries determined by the gravity model as potential tax havens after excluding a small number of suppliers which are recognised due a few of noisy observations. These falsely reported countries are in the majority of cases identified by the OLS model, but not by the PPML estimator which further demonstrates the more accurate performance of the latter method; both of them are conducted on a cross-sectional dataset where data are grouped across the years. For further diagnosis I analyse the original dataset and examine the tenders broken down by individual years and pairs using Pooled Cross-Sectional forms of the model to investigate countries in which the two estimation methods seem to diverge. Selected countries are dropped from the analysis as they supplied a single government or created a noise by a small number of outlying flows. These for example include Liberia supplying Spain exclusively, Guina, Georgia, Costa Rica, Uruguay with a single supply in 2006 to Italy worth EUR 185 million, Dominica disturbing the sample with a connection from Czech Republic in 2017 only, and Belize as a Polish supplier. An interesting disturbance in the data is caused by Czech Republic and Slovak Republic both of which show an excessive procurement supply; however, after closer examination it is obvious that the excess is caused by mutual flows between these two countries solely. Although it is not picked up by the gravity model, increased trade flows between these two countries can be explained by their close historical relationship. For further analysis, these countries are also dropped.

If the results from four methods applied to recognise the risky countries are compared, it is apparent that the countries tend to repeat in the listings. I divide them into two separate tables by the applied model and two following sorting procedures; the first one to be by the nominal difference between the overall procurement predicted to be supplied and the actual observed procurement supplied, and the second one by the relative excess value of public tenders in percentage points.

Japan and Australia are excluded from further analysis as they are identified by the OLS estimation only and only in terms of nominal numbers. Due to the size of these economies and very rough estimates provided by the less preferred model these are omitted in further discussion assuming insignificant risk is posed by them. Furthermore, what appears to be unexpected is that Angola is identified by all the methods and approaches applied, including those not selected in the end for this paper; however, if procurement supplied from the country is examined by contracting governments and individual years, a

deviation can be found in Hungary in 2008 when an incredibly unusual procurement worth 1.534 billion EUR was awarded to a company linked to or based in Angola.

Following countries are extracted from the listings and identified as the most frequently reported or highly suspicious as they are often being listed as notorious havens: Cyprus, Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, Qatar, Hong Kong, Singapore, United Arab Emirates, Mauritius, Marshall Islands, Seychelles, Sao Tome and Principe, St. Kitts and Nevis, Barbados, and Bahamas. Netherlands, Luxembourg, Cyprus and other potential European havens will be further discussed later in this section. When the selected countries are subjected to closer examination in terms of their common features, evidence of suspected harmful tax regimes can be found.

Except for Luxembourg, all of these countries rank among the most financially secretive jurisdictions by both the Financial Secrecy Index (FSI) value and the Secrecy Score (The Tax Justice Network, 2018). This further supports presence of the risk identified by Skuhrovec (2019) that when public procurement is supplied from tax havens, secretive territories may shelter potential undisclosed conflict of interest. For example, in 2018 Cayman Islands are ranked as the third most secretive territory in the world in terms of FSI value. The highest Secrecy Score is reported to be 84 for Bahamas and United Arab Emirates, nine of these selected countries have Secrecy Score above 70 points, and the remaining above 60. For Qatar and Sao Tome and Principe the score is not available. It can be seen that identified countries and the excess procurement they supply is strongly connected with increased financial secrecy.

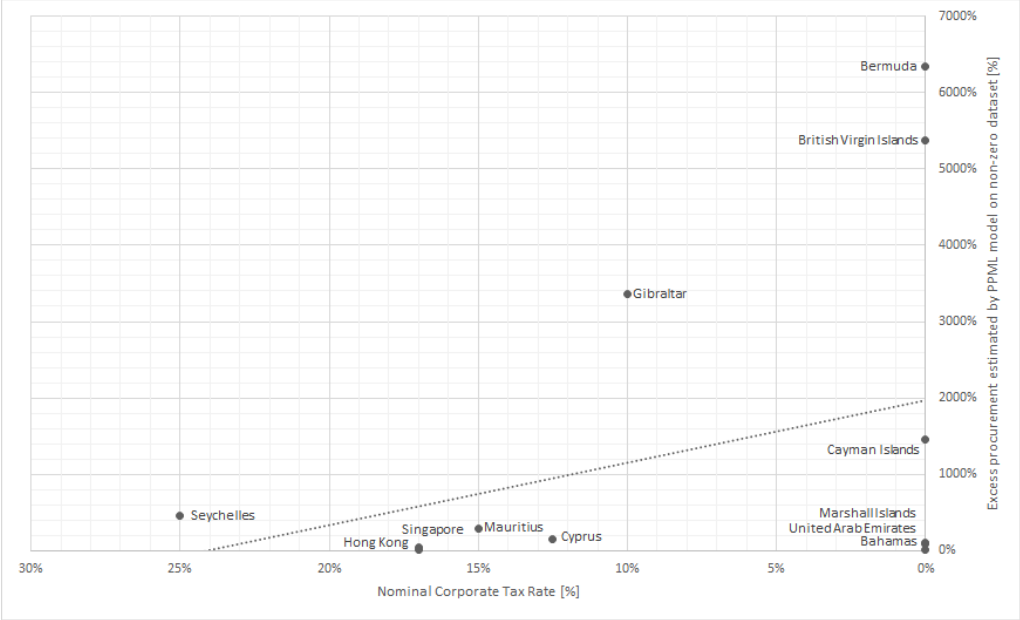
Table 5.3: Level of Financial Secrecy and Nominal Corporate Tax Rates

Country	FSI value	Secrecy Score	Tax Rate
Cyprus	404.44	61	12.50%
Bermuda	281.82	73	0.00%
British Virgin Islands	502.75	69	0.00%
Cayman Islands	1,267.68	72	0.00%
Gibraltar	107.44	71	10.00%
Hong Kong	1243.67	71	17.00%
Singapore	1081.98	67	17.00%
United Arab Emirates	661.14	84	0.00%
Mauritius	223.47	72	15.00%
Marshall Islands	275.28	73	0.00%
Seychelles	125.26	75	25.00%
St. Kitts and Nevis	152.54	77	0.00%
Barbados	230.95	74	25.00%
Bahamas	429.00	84	0.00%
Luxembourg	975.91	58	18.19%
The Netherlands	598.80	66	25.00%
Qatar	unavailable	unavailable	10.00%
Sao Tome and Principe	unavailable	unavailable	0.00%
Curacao	105.65	75	0.00%
Liechtenstein	240.85	78	12.50%

Source: The Tax Justice Network (2018), OECD (2018), KPMG (2017)

Another aspect to be necessarily considered, and may provide further evidence of incentives to profit shifting behaviour, is the nominal corporate income tax rate applied in a territory. Bahamas, Bermuda, British Virgin Islands, Cayman Islands, St. Kitts and Nevis, and Marshall Islands all employ 0% corporate income tax rate. It appears to be rather unexpected that Luxembourg, the Netherlands, Seychelles, Mauritius, Hong Kong or Singapore tax corporate profits by considerably high rates. The most probable reason behind this is that nominal rates were used in the analysis, as the data for effective rates, which would be far more accurate, are unavailable. These countries usually offer various tax levies; consequently, very little or no tax is required to be paid. Additionally, these countries are also reported as very secretive in return. Table 5.3 shows that the remaining countries offer very low tax rates.

Figure 5.1: Tax Rates and Excess Procurement Correlation



Source: Author's calculations, OECD (2018), KPMG (2017)

Figure 5.1 illustrates how lower tax rates are connected to higher excess of procurement supply identified, with the upward[1] sloping trendline, where the negative effect holds throughout the entire sample (for visual representation of including the rest of the countries see Figure 1).

Overall, listed countries, all of which were identified by both of the models, are reported as highly financially secretive by the Tax Justice Network (2018), they employ very low or no corporate rates, or both in most of the cases. Additionally, all of the territories stated above, were also identified as harmful tax regimes, and they are listed on either EU Black List, EU Grey List, or OXFAM tax havens list (see Table 2, Table 1, and Table 3 for listed countries). So far, as companies linked to notorious tax havens appear to be supplying a non-negligible number of public contracts to the EU, it can be concluded that tax avoidance is present on the public procurement market and risk exposure to possibly hidden conflict of interest or loss of tax revenue connected to government expenditure is not insignificant. For more specific figures see the next subsection.

[1]Note: Values on the x-axis in Figure 2 are in reversed order to better illustrate the negative correlation between increased risk exposure in public procurement and lower tax rates.

5.2 Excess Procurement Supplied

As discussed in the methodological section, both models converge in most of the countries identified as potential destinations for profit shifting consistently with the expectations. While the OLS approach provides very general approximation and can be subjected to some level of error, the Pseudo Poisson model should be more precise in terms of the nominal quantities. Following tables summarise tax havens in terms of the excess procurement they supply in both nominal and relative figures listing the most popular tax havens identified:

Table 5.4: Identified Tax Havens and Unexplained Procurement Flows

No.	Country	Excess [billion EUR]	Excess	Unexplained
1	Cyprus	17.8	155%	60.8%
2	Bermuda	13.4	6347%	98.5%
3	British Virgin Islands	6.1	5380%	98.2%
4	Cayman Islands	4.7	1460%	93.6%
5	Gibraltar	2.47	3361%	97.1%
6	Qatar	2.12	459%	82.1%
7	United Arab Emirates	1.05	87%	46.5%
8	Singapore	0.8	45%	31.2%
9	Mauritius	0.4	281%	73.7%
10	Bahamas	0.2	95%	48.8%

Countries identified by the Pseudo Poisson Maximum-Likelihood estimator (PPML2) and sorted by their excess procurement supplied in nominal figures over the 12 year period. *Source:* Author's calculations

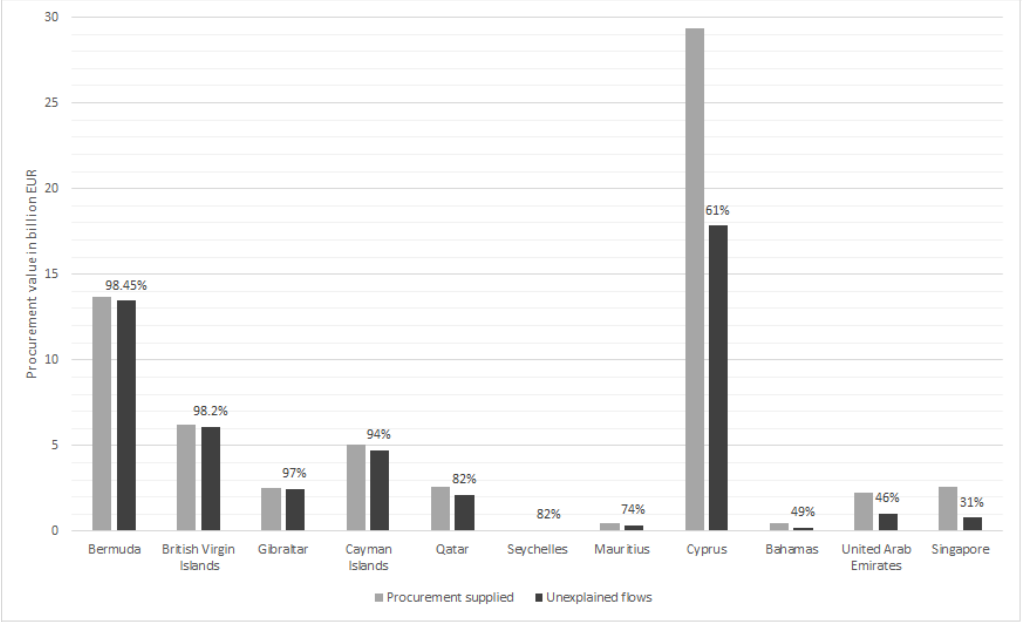
The Pseudo Poisson model is used for analysis as out all of the methods applied it explains the most variance in the sample and reports the lowest possible residuals. This suggests that the model yields a certain minimum lower bound of excess procurement and provides the most optimistic scenario in terms of the immediate risk exposure posed on European governments. This model explains the greatest portion of the procurement for individual supplier countries, i.e. the unexplained share of the tenders value that cannot be linked to any actual activity is most likely significantly more, but definitely not below this threshold. Based on the residuals analysis, it can be safely concluded that the listed countries represent the greatest risk for the European governments in terms of potential loss of tax revenue or conflict of interest when participating on the procurement market. All applied methods consistently identify Cyprus which

supplied the most unexplained procurement over the 12 year period, to be precise 155% above the natural levels predicted by the gravity model and EUR 17.8 billion in nominal figures. However, in relative terms the most unexplained procurement is linked to Bermuda with a minimum 6,347% excess above predicted, the EUR 13.4 billion worth procurement accounts for 98.5% of overall value of tenders it supplied. Table 5.4 summarises the estimated procurement share which cannot be explained by the gravity model for the remaining countries. When incorporating the zero-observations into the dataset, the Poisson model identifies EUR 13.6 billion as a 20,186% excess tender supply linked to Bermuda shedding light upon 99.5% of unexplained flows. As mentioned earlier using the results from the non-zero dataset produces a certain minimum lower bound to work with; however, the model is somewhat consistent across various forms of the dataset (Figure 4.1). Figure 5.2 depicts recognised tax haven countries and the share of tenders they supply which cannot be explained by the gravity model.

Sorted by both nominal or relative figures it can be observed that British Virgin Islands, Bermuda, Gibraltar, Cayman Islands, and Cyprus remain at the top of the list and represent the greatest risk exposure for European governments (see Figure 5.2).

Unfortunately, due to unavailability of gravity data, Curacao and Liechtenstein had to be dropped from the analysis. These two countries supplied an unusual large volume of EU procurement, EUR 3.7 and 0.8 billion over the course of 12 years, Curacao and Liechtenstein respectively. Hence, a simplified gravity model based solely on GDPs is performed in addition to the full gravity equation. Curacao was identified with 7,570% excess and 98.7% of unexplained procurement together with Liechtenstein 1,088% excess and 91.6% of unexplained tenders estimated by a simplified gravity model. However, for the sake of consistent analysis, these are not included in the results.

Figure 5.2: Unexplained Procurement Supplied



Unexplained procurement supplied by firms connected to established tax havens (sorted by the unexplained percentage share). *Source:* Authors's calculation

5.3 EU Tax Havens

Naturally, majority of public procurement in the EU is supplied by companies based in Europe. This could, however, skew the view of notorious European tax havens, such as Switzerland, The Netherlands, Malta, Cyprus, Luxembourg, and Ireland (Langerock and Hietland, 2019). Skuhrovec (2019) identifies Switzerland as the most popular tax haven on the EU procurement market, on the contrary, using the gravity models I find that Switzerland supply of public tenders is not as excessive as it may seem when first examining the data. According to my model most of the tenders supplied from Switzerland are most likely actual Swiss companies physically based in Switzerland. Reasons behind this include its location, economic ties, or size of their economy as a whole. Similar case applies to the remaining countries, where the gravity model accounts for closeness of European countries on the procurement and predicts high values of tenders supply within EU, in fact the European procurement law explicitly forbids any discrimination against other European countries when awarding public contract. However, as seen in the previous

subsection, Cyprus was identified as country with 61% of unexplained procurement flows accounting for almost 1% of the overall EU procurement which in real terms represents roughly about 16 billion EUR annually worth European procurement linked to Cyprus without evidence of any actual activity posing immediate danger.

While the gravity model accounting for the overall economic closeness of European countries on the public procurement market identifies significantly greater risk in notorious third-country harmful regimes such as Bermuda, Cayman Islands or British Virgin Islands, the presence of European tax havens should not be neglected. European countries in general naturally supply most of the procurement market, and identifying Cyprus only further supports the idea that countries frequently recognised to have aggressive tax practices should be included in any analyses regardless their EU status. While these countries may not pose immediate danger they could potentially undermine any of the EU's future endeavours in fighting tax avoidance, corruption, and increase the taxpayer's burden.

5.4 Findings in the EU Context

Based on the available sample of public procurement I find the most risky countries: Cyprus, Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, Qatar, United Arab Emirates and Singapore. These countries are the most dangerous in terms of the exposure to two risks resulting from potential profit shifting, identified by Skuhrovec (2019); first risk to be the loss of tax revenue and conflict of interest being the second. In order to draw at least some illustrative conclusions on the entire EU procurement market despite the rather complicated structure of the data, I use the real total value of procurement awarded by European countries over the 12 year period, which is about EUR 1,400 billion, and the estimated overall value of EU procurement market, which is roughly about EUR 1,887 billion annually. Based on the unexplained flows estimated, we can conclude that at least 3.6% of overall European tenders cannot be explained by the gravity model even in the most optimistic scenario, which represents a very rough estimate of EUR 67 billion annually of immediate danger of abuse.

Chapter 6

Discussion

6.1 Model Evaluation

Gravity Models in general have considerably risen in popularity among trade economists over the last decades. The econometric model is applicable in number of fields, from policy analysis, impact of agreements and unions, migration flows to examination of FDI between countries, where its recognition in gravity research is certainly underpinned by its high explanatory power, availability of data, and established practices in trade economics. However, as mentioned in the earlier sections, the gravity model is traditionally accompanied by a number of issues which cannot be avoided, and researchers often diverge in delivering solutions.

The most frequently discussed issue are the zero-observations, where most authors drop them or decide not to include them in their dataset using the log-linear OLS method. Silva and Tenreyro (2006) claim that omitting the zero-observations is not always ideal in classic trade data, it should have reasonably minor consequences. This is confirmed in the procurement data in our sample. The reasoning behind including or omitting zero-observations in trade analysis is mostly that all the countries are able to participate, the zero trade flows are considered to be caused by factors such as low production, small economy or high trade costs, and thus such observations are informative. For public procurement data this assumption may potentially not hold, as the market is still restrictive and supplying government tenders is far more complicated than simply exporting goods and services in the private sector; and while the EU promotes openness in public procurement, they are still far from being globalised. There are no zero-observations in our data and I decide not to

include them as adding more countries which may in fact not be part of the market to the dataset would most likely bias the estimates downwards. This is of course merely an assumption, and the analysis confirmed that the difference between used approaches is negligible. However, as there is still an uncertainty about the true nature of the unreported flows, not including the zeros seems to be the safer option. This is even more true in the light of the other models (OLS, PPML with zero-observations included), which estimate greater risk exposure. Additionally, I apply a different method to treat the residuals. Using data coverage in individual contracting countries obtained by Skuhrovec (2019) as weights when obtaining the average per cent excess of procurement supplied yields larger residuals for all methods and all models employed. This further demonstrates that the given PPML model (non-zero dataset) provides a certain lower bound in the best scenario.

Other common issues include the presence of heteroskedasticity, which is easily solved by using the Pseudo Poisson estimator, and multilateral resistance terms which should be included in the model, but are not observable. There are several ways how to more or less treat the problems, but finding an accurate model and estimation method using gravity seems to be inevitably connected with some level of compromise. Drzewoszewska (2014) suggests that a common approach is to use several estimation methods, appropriate to the individual needs of a study, as every estimator has different advantages and disadvantages, and thus the inference based on a single method is not advisable.

I apply several methods, and for the reasons stated earlier, I decide to employ the traditional OLS approach using the correction for MRTs to obtain rough estimates, identify the potential tax havens, and then use the robust Pseudo Poisson estimator for more accurate results. As expected, several issues could not be avoided, such as zero-observations dilemma, accounting for MRTs, inconsistent quality of data across countries or other flaws of the data. Furthermore, exploiting the gravity principle in public procurement may not seem ideal considering how the data was obtained - the value of each contract was allocated to each co-owner country above 10% stake in the supplier company; however, I work with an assumption that if I exclude all potential tax havens from the model most of the disturbances are eliminated, and thus the gravity features can still hold. It offers a different perspective of how to view the data, keeping in mind that actual profits shifted are not subjected to analysis as these data are unavailable, the issue of interest is the risk exposure to taxable revenue outflow that the presence of tax havens may pose.

6.2 Contribution

This paper offers a different perspective on how to view the data. For example the most frequently identified government supplier with aggressive tax practices in the sample is Switzerland. While it certainly creates some level of risk in terms of tax evasion and financial secrecy, the fact it supplies a great portion of European tenders alone is not conclusive. The reason behind this may be the size of Swiss economy, its location in the heart of Europe, or economic ties. The gravity model eliminates the natural level of procurement supply and aims the attention on potential tax havens where reasons for any trade relationship are extremely rare.

The majority of previous research applies the gravity equation theory mostly to examine trade potential, impact of various policies, or migration. I propose to use the gravity model to examine not only trade potential but also the trade excess from the opposite perspective and to investigate the role of offshore companies in various sectors.

This paper confirms the presence of tax havens on the public procurement market and aims to join other studies which support the most frequently debated solution to the harmful tax regimes problem, ban the companies based in or strongly connected to such countries. While in most markets policy makers face a great difficulty to implement the strategy, public procurement market provides the perfect starting ground for any future efforts to fight tax evasion where additional risk in terms of hidden conflict of interest in highly secretive havens. While the situation may be far more difficult in case of European havens listed by OXFAM (Langerock and Hietland, 2019), the current status allows even for the EU blacklisted and greylisted countries to participate in a tender. The European Commission identified the countries; however, these regimes are currently not being penalised in any way. Such ban would not only help to fight financial secrecy and tax avoidance in general, but would also have a highly beneficial and significant effect on governments' budget as the public spending accounts for 20% of GDP on average in the EU (see also Skuhrovec (2019) for further explanation).

6.3 Suggestions for Further Research

If further proceeding in this direction and using gravity models examining this dataset, I propose dividing the data and perform the analysis for individual

contracting countries separately. This approach would enable working with the finest granularity of the data. Additionally, the supplier countries could be divided to clusters, and possibly even industrial sectors. This could reduce disturbances across the heterogeneous dataset and allow for more accurate results and may potentially better investigate European tax havens.

For further investigation of profit shifting and risk exposure to potential loss of tax revenue in different sectors, I suggest the gravity model as a useful tool.

Chapter 7

Conclusion

Corporate income taxation constitutes a significant portion of government revenue on which public expenditure depends heavily, and when multinationals abuse harmful tax regimes to avoid various kinds of taxation, it adds to the average taxpayer's burden. Additionally, when awarding public contracts efficiency of public spending cannot be ensured if tenders are supplied by companies which are connected to notorious havens as a potential conflict of interest can be sheltered by highly secretive countries.

This paper analyses the European procurement market and investigates the presence of companies based in or connected to tax havens. Due to the nature of the topic, it is very difficult to observe the actual profit shifted, thus, the danger is examined using supplier companies' structure measuring the risk exposure that connections to notorious tax havens may pose. In order to account for the immediate risk gravity model is applied to determine the natural levels of public procurement supplied by individual countries.

The model identifies territories where increased risk of abuse is expected, as in some of them up to 99% of their procurement supply cannot be explained by the gravity equation, and thus cannot be linked to any actual economic activity. These include Cyprus, Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, Qatar, United Arab Emirates, Singapore, and most likely also Curacao and Liechtenstein. Suppliers with links to these countries pose about EUR 67 billion of immediate danger of abuse on European governments annually. Additionally, with identification of Cyprus, more light is shed upon countries with aggressive tax practices within the EU's borders, which suggests that even EU Member States should be subjected to monitoring regardless their status as they might potentially undermine any of the EU's future efforts to fight tax

havens and corruption.

It is possible that the gravity model applied in this paper is limited due to the pooling all of the European countries together; thus, for further research, I suggest dividing the data for each contracting authority in the database and performing the estimation separately to fully utilise the finest granularity of the data. This modification in the analysis may allow for more accurate results and possibly be more effective in investigating even European countries. Finally, I suggest the gravity model as a useful tool for further research in tax havens' practices within other markets.

Ultimately, this paper aims to join the existing research on tax havens and further stir debates on potential solutions to the problem, one of which is to ban the countries connected to notorious havens. Public procurement provides the perfect ground for fighting the issue. Current policies do not seem to be sufficient, as not even EU blacklisted countries are penalised, thus more rigorous selection procedures would not only help governments' budgets but would also send a message.

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Appendix

Table 1: The EU Grey List

Albania	Anguilla	Antigua and Barbuda
Armenia	Aruba	Bahamas
Bahrain	Barbados	Belize
Bermuda	Bosnia and Herzegovina	Botswana
British Virgin Islands	Cabo Verde	Cayman Islands
Cook Islands	Dominica	Republic of Korea
Curaçao	United Arab Emirates	Faroe Islands
Fiji	Granada	Greenland
Guernsey	Hong Kong	Jamaica
Jersey	Jordan	Labuan Island
Macao SAR	Qatar	Macedonia
Malaysia	Maldives	Isle of Man
Marshall Islands	Morocco	Mauritius
Mongolia	Montenegro	Namibia
Nauru	Niue	New Caledonia
Oman	Palau	Panama
Saint Kitts and Nevis	Saint Lucia	St. Vincent and
Serbia	Seychelles	the Grenadines
Swaziland	Taiwan	Thailand
Tunisia	Turkey	Turks and Caicos Islands
Uruguay	Vanuatu	Vietnam

The common EU watch list of tax havens as of December 4th, 2018 - 63 jurisdictions. *Source:* European Commission (2019a)

Table 2: The EU Black List

American Samoa	Guam	Samoa
Trinidad and Tobago	US Virgin Islands	

The common EU Black List of non-cooperative jurisdictions as of December 4th, 2018 - 5 jurisdictions. *Source:* European Commission (2019a)

Table 4: EU Procurement Law Jurisdiction

Threshold	Public authorities
≥ EUR 144 000	contracts for defence (listed in Directive 2014/14)
≥ EUR 221 000	contracts for defence (not listed in Directive 2014/14)
≥ EUR 443 000	supplies and services contracts for water, energy, transport and postal services
≥ EUR 5 548 000	all works contracts

Source: European Commission (2019c)

Table 3: OXFAM Tax Havens Listing

Albania	Anguilla	Antigua and Barbuda
Aruba	Bahamas	Bahrain
Bermuda	Bosnia and Herzegovina	British Virgin Islands
Cook Islands	Cayman Islands	Curaçao
Faroe Islands	Macedonia	Gibraltar
Greenland	Guam	Hong Kong
Jersey	Marshall Islands	Mauritius
Montenegro	Nauru	New Caledonia
Niue	Oman	Palau
Serbia	Singapore	Switzerland
Taiwan	Trinidad and Tobago	United Arab Emirates
US Virgin Islands	Vanuatu	Cyprus
Ireland	Luxembourg	Malta
The Netherlands		

Source: Langerock and Hietland (2019)

Table 5: Identification Rate in the Data Sample

Contractor	Tenders available	Identified supplier	Identification rate
Austria	36855	10959	30%
Belgium	71655	11672	16%
Bulgaria	188115	52	0%
Croatia	137972	24311	18%
Cyprus	11583	27	0%
Czechia	306694	173834	57%
Denmark	54745	18033	33%
Estonia	206856	73701	36%
Finland	69894	12101	17%
France	2894616	133460	5%
Germany	383560	108683	28%
Greece	63222	373	1%
Hungary	134977	49689	37%
Iceland	1853	281	15%
Ireland	32294	365	1%
Italy	222207	25399	11%
Latvia	289694	14974	5%
Lithuania	171616	21980	13%
Luxembourg	10158	933	9%
Malta	3526	101	3%
Netherlands	118762	32516	27%
Norway	93720	18395	20%
Poland	3935984	330851	8%
Portugal	1180408	590069	50%
Romania	497947	26051	5%
Slovakia	81164	49244	61%
Slovenia	323609	64660	20%
Spain	379071	142900	38%
Sweden	101616	35932	35%
Switzerland	24160	12305	51%
United Kingdom	461422	25048	5%

Source: Skuhrovec (2019)

Table 6: List of Countries Supplying Procurement to the EU

Algeria	Congo	Ireland	New Zealand
Angola	Costa Rica	Israel	Nigeria
Argentina	Croatia	Italy	Norway
Australia	Cyprus	Japan	Oman
Austria	Czech Republic	Jordan	Pakistan
Azerbaijan	Denmark	Kuwait	Panama
Bahamas	Dominica	Latvia	Paraguay
Bahrain	Egypt	Lebanon	Peru
Barbados	Estonia	Lesotho	Philippines
Belarus	Ethiopia	Liberia	Poland
Belgium	Finland	Libya	Portugal
Belize	France	Lithuania	Qatar
Bermuda	Gabon	Luxembourg	Romania
Bosnia and	Georgia	Macao	Russia
Herzegovina	Greece	Macedonia	Spain
Brazil	Germany	Malta	San Marino
British Virgin	Gibraltar	Malaysia	Sao Tome and
Islands	Guiana	Morocco	Principe
Bulgaria	Guinea	Moldova	Saudi Arabia
Cameroon	Hong Kong	Marshall Islands	Seychelles
Canada	Hungary	Mauritius	Singapore
Cape Verde	Iceland	Mexico	Slovak Republic
Cayman Islands	India	Namibia	Slovenia
Chad	Iran	Nepal	Somalia
Chile	Iraq	Netherlands	South Africa
China	South Korea	Sri Lanka	Syria
Colombia	St. Vincent and	St. Kitts and	Switzerland
Taiwan	the Grenadines	Nevis	Sweden
Trinidad and	Tunisia	Turkey	Ukraine
Tobago	United Kingdom	United States	Venezuela
United Arab	Uruguay	Uzbekistan	Vietnam
Emirates			

Countries in the sample of government suppliers. *Source:* DIGIWHIST Researchers (2019)

Table 7: Variables Description

Variable	Unit	Source	Description
tot_pp_value_from (also *pp_value*)	EUR	DIGIWHIST	Public procurement value supplied
distance	km	CEPII	Mutual distance
GDP_contractor	EUR	DIGIWHIST & IMF	Contracting authority country's GDP
GDP_supplier	EUR	DIGIWHIST & IMF	Supplier's GDP
fta_WTO	dummy	CEPII	Regional trade agreement
gatt_d	dummy	CEPII	WTO membership
contig	dummy	CEPII	Contiguity
com_lang_off	dummy	CEPII	Common official language
com_ lang_ethno	dummy	CEPII	Common language by ethnicity
com_ col	dummy	CEPII	Common coloniser
t_diff	hours	CEPII	Time difference
conflict	dummy	CEPII	Countries in conflict
colony	dummy	CEPII	Colonial relationship
sibling	dummy	CEPII	Sibling relationship
com_currency	dummy	CEPII	Common currency
com_religion	per cent	CEPII	Common religion
smctr	dummy	generated	Intranational contracts

Table 8: VIF Multicollinearity Test

Variable	VIF	1/VIF
ldistw	16.53	0.060491
remoteness_contr	12.19	0.082044
tdiff	4.45	0.224875
comlang_off	3.35	0.298584
comlang_et o	3.16	0.316689
smctr	2.67	0.375065
fta_wto	2.34	0.426806
colony	2.34	0.427238
conflict	1.91	0.524807
comcur	1.74	0.573943
contig	1.64	0.608330
lgdp_supp	1.59	0.630402
sibling	1.52	0.658858
comcol	1.38	0.722526
remoteness_supp	1.30	0.771763
lgdp_contr	1.28	0.782201
comrelig	1.25	0.800642
gatt_d	1.23	0.813949
Mean VIF	3.44	

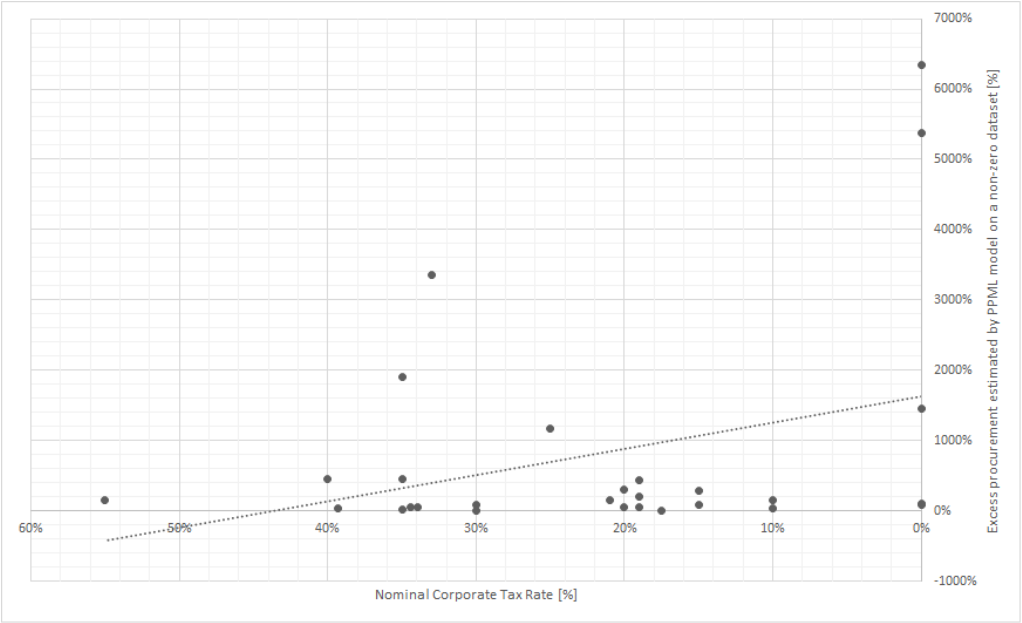
Source: Author's calculations

Table 9: VIF Multicollinearity Test 2

Variable	VIF	1/VIF
remoteness_contr	4.26	0.234607
tdiff	4.05	0.247018
comlang_off	3.84	0.260190
comlang_ethno	3.67	0.272827
fta_wto	2.51	0.398714
colony	2.31	0.433585
conflict	1.95	0.511834
comcur	1.71	0.586482
smctr	1.69	0.592359
sibling	1.45	0.689250
comcol	1.43	0.697359
lgdp_supp	1.41	0.707250
contig	1.34	0.748945
remoteness_supp	1.29	0.775685
lgdp_contr	1.22	0.819782
comrelig	1.22	0.820028
pta_bb	1.14	0.878980
Mean VIF	2.15	

Source: Author's calculations

Figure 1: Correlation between Nominal Corporate Tax Rates and Excess Procurement



Estimated by PPML2 (Table 4.3) model depicting all countries with excess procurement. *Source:* Author's calculations