

Charles University in Prague

Faculty of Social Sciences
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MASTER'S THESIS

**A Gravity Approach to Modelling German
Exports: The Role of Institutions**

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, July 24, 2015

Signature

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Abstract

The purpose of this thesis is to implement the gravity model approach to identify and quantify determinants of bilateral trade flows of Germany and its trading partners, while focusing on the effect of institutions. Based on various gravity model techniques (clustered pooled OLS, Poisson Pseudo-Maximum Likelihood estimation, Hausman and Taylor estimation and Instrumental Variables regression), we have confirmed that the quality of institutions have a significant and positive effect on German exports. Depending on model specification and estimation technique, some institutions seem to effect German export more than others. We see the Hausman and Taylor estimator advisable for addressing endogeneity of institutions.

JEL Classification	C13, C23, F10, F14
Keywords	Bilateral trade, German trade, Gravity equations, Institutions, Institutional quality
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Abstrakt

Cílem této práce je pomocí gravitačního modelu určit a kvantifikovat faktory ovlivňující bilaterální obchodní toky mezi Německem a jeho obchodními partnery, přičemž hlavním zaměřením je vliv institucí. Na základě různých odhadujících technik gravitačního modelu (klastrovaná metoda náhodných čtverců, Poissonovský druh odhadu, Hausman – Taylorova metoda a metoda instrumentálních proměnných), můžeme potvrdit významný a kladný vliv institucí na německý export. V závislosti na specifikaci modelu a použité techniky odhadování mají některé instituce větší vliv na německý export než jiné. Hausman Taylorův odhad se jeví jako vhodný pro řešení problému endogeneity institucí.

Klasifikace	C13, C23, F10, F14
Klíčová slova	Bilaterální obchod, Německý obchod, Gravitační rovnice, Instituce, Kvalita institucí
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Master's Thesis Proposal

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Defense Planned:	September 2015

Proposed Topic:

A Gravity Approach to Modelling German Exports: The Role of Institutions

Topic Characteristics:

The classical conception of gravity model was originally reported by Tinbergen in 1963 and it was inspired by the Newton’s law of universal gravitation. Gravity model for international trade describes the patterns of bilateral trade flows based on economic size (proxied by GDP) and the distance between the two countries. Standard gravity equation also incorporates factors such as population or trade policy. This thesis attempts to identify and quantify determinants of bilateral trade flows of Germany and its trading partners, while focusing on the effect of institutions. We have chosen Germany as it serves as a good representative for Europe. More specifically, we will test whether institutional homogeneity and its quality have an independent impact on the trade volume between two countries. We expect that having a similar institutional framework promotes bilateral trade. The main purpose and contribution of this thesis is to determine a proper estimation method to cure both non-linearity and endogeneity of institutions.

Hypotheses:

1. Institutional quality has an independent and positive impact on trade volume between two countries.
2. The large economic dimensions (GDP) increase bilateral trade and unitary elastic relationship between GDP and bilateral trade holds.
3. Population has negative effect on trade (higher number of population means that the economy is more closed to trade).
4. Bilateral trade increase when two countries are geographically close.

Methodology:

As for the empirical analysis, we will use panel data for the estimation which allows taking into account more general types of heterogeneity. We will start with the pooled OLS framework. We will work with the non-linear modification of Poisson's equation to account for the endogenous change in the price levels and we will use the logarithmic transformation as a bench mark. There is a strong assumption that institutions are endogenous which may lead to inconsistent estimation. Therefore, we will search for a more proper methodology, e.g. the Hausman-Taylor approach.

Outline:

1. Introduction
2. Position of Germany in Global Trade
3. Literature Overview
4. Gravity Model Issues
5. Data and Methodology
6. Empirical Analysis
7. Conclusion

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1 Introduction

Decisions to import or export goods and services bring a lot of uncertainties due to many factors such as different languages, different currencies, different jurisdiction or different institutional environments of the two partner countries. In a frictionless economy, any country trades more with a bigger country, smaller countries are naturally more open, and faster growing pairs of countries have increasing world trade share. However, the evidence of frictions has several implications to trading volumes. First, trade falls sharply with increasing distance of partner countries. Second, crossing a border further reduces trade. Other factors such as tariffs on trade affect the trading volumes of each country. Moreover, trading flows between countries A and B affects as well trade between countries B and C, simply because the more A trade with B, the less remains for C to trade with B. Obviously, frictions between two countries affect not only their bilateral trade flows, but also trade flows of each of them with other countries. (Anderson, 2014).

The gravity model of trade became one of the most commonly used tools in empirical trade research. The classical conception of gravity model was originally reported by Tinbergen (1962) and it was inspired by the Newton's law of universal gravitation, which explains the gravity between two objects to their masses and distances between them. Gravity model for international trade describes the patterns of bilateral trade flows based on economic size (proxied by GDP) and the distance between those two countries. Standard gravity equation also incorporates factors such as population or trade policy. Such models are also used in sociology or urban geography, e.g. to estimate the degree of integration between two locations (level of migration or traffic flow).

The objective of this thesis is to extend this type of analysis and focus on a role of institutional environment. The impact of institutional quality has already been reported by some economists. However, they usually study the effect of one type of

institution or they use the overall index. Anderson and Marcouiller (2002) explain that imperfect contract enforcement and corruption reduce trading volumes. Linders (2004) uses the single institutional indicator to explain the differences on the markets with homogeneous and differentiated products.

We study the effect of various institutions on bilateral trade flows, using a gravity model approach on a data set for Germany. We have chosen Germany as it serves as a good representative for Europe. More specifically, we test whether the institutional quality have an independent impact on the trade volume between two countries. We assume that having a similar institutional framework promotes bilateral trade by lowering the transaction costs. The main focus of this thesis is the correct estimation of the institutional parameters. We reaffirm the theoretical justification for using the gravity model approach in the analysis of bilateral trade flows. Specifically, we focus on the endogeneity problem and the problem of log-transformation in gravity models, which we try to address with using proper estimation methods. We compare results yielding from different approaches, such as the pooled OLS, the non-linear modification of Poisson's equation, the Hausman-Taylor approach or the instrumental variable regression. The main contribution we see in discussing the best possible estimation method which accounts for both endogeneity of institutions and problem with log-transformation.

The thesis is structured as follows. Chapter two provides description of German trade and its global position. Chapter three summarizes relevant literature on the gravity model of international trade. Chapter four describes the main issues associated with gravity models. Finally, chapter five describes the data, variables, and methodology that is used to analyze our data set. Chapter six provides the empirical analysis including the discussion of the results and chapter seven concludes the main findings and contributions of this thesis.

2 Position of Germany in the Global Trade

2.1 Global Trade Patterns

Understanding the trade flow is mostly important to firms, which can use the scanning of markets in order to utilize their resources effectively. There are several sources where one can obtain trade flow data, such as the World Trade Organization or the International Trade Centre.

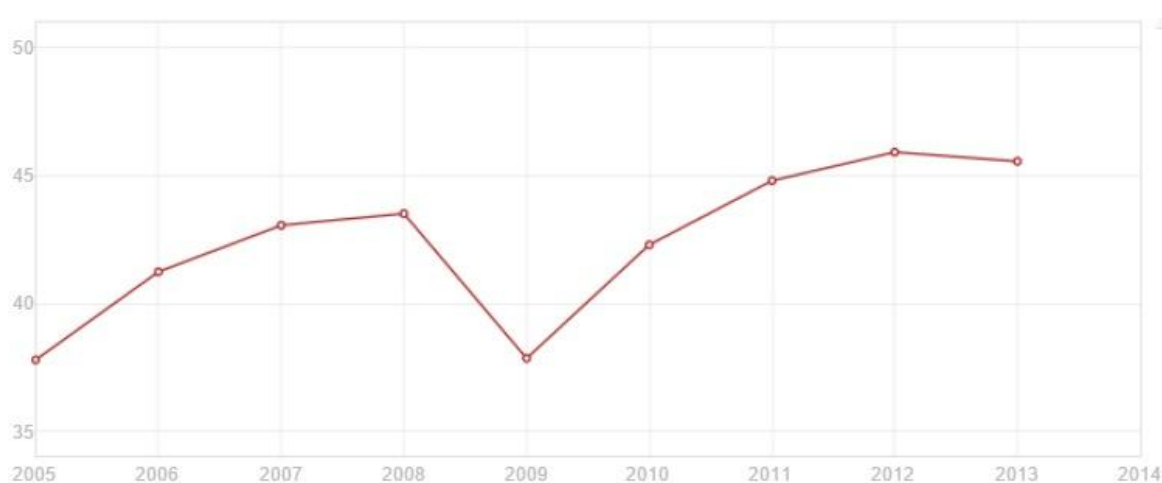
Several patterns have occurred in the past years that have changed the global economy. The creation of blocks, such as the European Union or NAFTA, has led to a trade creation, where countries among the block have better conditions to trade with each other. On the other hand, non-members of the block suffer from a trade diversion, which is cost-inefficient comparing to rest of the world. Trade diversion may not only cause economical losses for the non-members, but it may as well harm politically due to potential strained relationship between a member and a non-member country. Another pattern causing a change in a global trade flow structure is deindustrialization, which is a process of economical and social change caused by the reduction of industrial capacity leading to less national output generated by the manufacturing sectors. On the other hand, newly industrialized countries, like China and India, have increased their share of world trade, as well as their share of manufacturing exports. China has increased its trade share in all areas (for example the China's share in high-tech goods went up from 3% in 1995 to 15% in 2005). The overall export of goods and services in China has risen from 20.1% in 1996 to 39.1% in 2006, but has decreased again to 26.4% in 2014. China has surpassed the UK, Germany or Japan in terms of the world trade share in recent years. Another pattern is

a collapse of communism. Many of the former-communist countries have opened-up, which has led to an increase of their share of global trade by taking advantage of their low wage levels and other production costs. (Bussière and Mehl, 2008) and (The World Bank, 2014).

2.2 German Trade

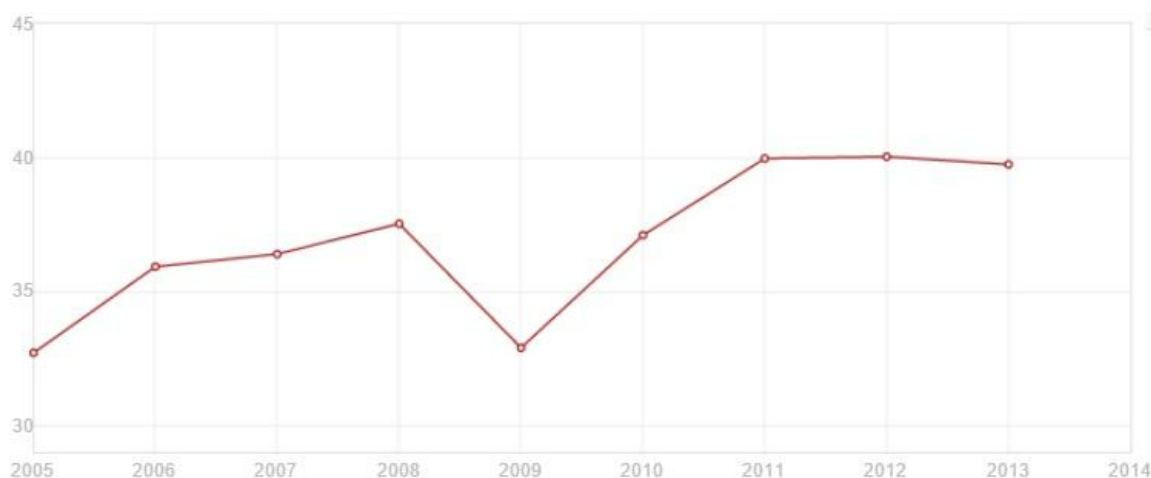
Currently, Germany ranks number four in both net exports and net imports in the world. Moreover, it ranks number three in terms of an Economic Complexity Index (ECI), which explains an economic system as a whole rather than the sum of its parts. Germany's export of goods and services as a share of GDP has increased from 19% in 1980 to 46% in 2013 and import of goods and services as a share of DGP has increased from 23% in 1980 to 40% in 2013. There was a drop in both exports and imports in 2008 - 2009 period due to the Global Financial Crisis. Since 2009 both exports and imports have been steadily increasing. (The World Bank, 2014). See the graphs below.

Figure 2.1: Exports of goods and services (% of GDP) for Germany in latest years



Source: The World Bank

Figure 2.2: Imports of goods and services (% of GDP) for Germany in latest years



Source: *The World Bank*

Top five products exported by Germany are: vehicles (11.22%), vehicle parts (4.12%), packaged medicaments (3.64%), planes, helicopters and/or spacecraft (2.44%) and refined petroleum (1.33%). Top five products imported to Germany are: crude petroleum (5.62%), petroleum gas (5.19%), cars (3.79%), vehicle parts (2.97%) and refined petroleum (2.79%). Top five export destinations of Germany are: France (8.81%), United States (8.14%), China (6.35%), United Kingdom (6.21%) and Netherlands (5.84%). Top five import destinations of Germany are: Netherlands (8.93%), China (8.59%), France (7.2%), United States (5.48%) and Italy (5.2%). Overall 68% of exports of goods made in Germany were shipped to European countries and 71% of imports came from Europe (Observatory of Economic Complexity, 2014). The top trading countries of Germany are countries that are either geographically close, or are large economies.

3 Literature Overview

3.1 Theoretical Basis of Gravity Model

Professor Jan Tinbergen is the first recipient of the Nobel Memorial Prize in Economics in 1969. Among many achievements, Tinbergen is the first economist to propose so called “Gravity model of international trade” in his paper from 1962. Tinbergen states that the volume of trade flows between two countries is proportional to the gross national products of those countries and inversely proportional to the distance between them, similarly to Newton’s law of universal gravitation, where two objects are attracted to each other with a force proportional to the product of their masses and inversely proportional to the square of the distance between them. However, the gravity equation suffered from a lack of theoretical basis, despite its extraordinary stability and its power to explain bilateral flows of trade and Tinbergen’s work was laid out of the mainstream for a long time period mainly because this theory was viewed more as physics than economic analogy. Over time, Tinbergen’s approach has been equipped with theoretical underpinning and improved estimation techniques. (Xiong and Chen, 2012). Since then, gravity model for international trade has been a useful econometric tool for testing hypothesized influences on trade flows between pair of countries, with country (market) size and distance as core variables. Standard models of international trade until then were the Heckscher-Ohlin model, relying on differences in factor endowments among countries as the basis for trade, and the Ricardian model, relying on differences in technologies across countries in order to explain patterns in trade. However, these two models were not capable of providing sufficient foundation for the gravity model of international trade. (Bacchetta et al., 2012).

Anderson (1979) provided a first important attempt to deliver a theoretical foundation of gravity models. In his work he proposed that all countries trade and all goods are traded. More specifically, a country consumes at least some of every good from every country, while the goods are differentiated by the country of origin (each country is fully specialized in the production of one good) and the preferences of consumers are defined over all the products. In such setup, national income is the sum of home and foreign demand for good produced by each country and as a consequence, larger countries trade more. Bergstrand (1985 and 1989) proposed that a gravity model is an implication of Krugman's monopolistic competition based model of trade, where consumers have a preference for variety and identical countries trade differentiated products. In this scenario, countries are specialized on different sets of products and the location of firms is determined endogenously. Couple years later, Deardorff (1995) demonstrates that a gravity model may arise from a traditional factor-proportions explanation of trade. A gravity-type equation can also be derived from Ricardian type of model, as Eaton and Kortum (2002) suggest.

The simplest multiplicative form of gravity model, as formulated by Professor Tinbergen (1962), is determined by following equation:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} D_{ij}^{\beta_3} \quad (3.1)$$

Where the trade flow from country i to country j is denoted by X_{ij} , Y is the economic size of each country and D_{ij} is the distance between the two partner countries. β_0 , β_1 , β_2 and β_3 are unknown parameters. The model shows that while economic growth increase the absolute trade flow, the increase is not proportional with the rate of national growth.

Over the years, the standard gravity equation was extended by many authors to capture the effects of relevant variables, such as infrastructure, exchange rate, or institutional variables, on bilateral trade.

3.2 Empirical Research Literature

A nature of German trade-foreign direct investment (FDI) is explored by using a system of gravity equations in a paper by Mitze et al. (2009). The authors adopt a Hausman and Taylor Instrumental Variable (IV) approach and a non-IV method to explain the links between German trade flows and FDI activity. Mitze et al. find substitutive links between the outward FDI and flows of trade and they extend their analysis with checking the sensibility of German data on a region level sub-sample. Based on a panel data set, patterns of 16 German federal states are analyzed. After presenting regional differences relative to the German average, authors point out an importance of taking into account regional dimension while analyzing linkages of trade and FDI.

Zarzoso et al. (2008) use the static and dynamic gravity model approaches to study the link between German development aid and German exports to the recipient country. The authors investigate that each US dollar spent on development aid promotes German exports to the recipient countrz by 0.83 USD. However, the magnitude of the effect differs across sectors. Sectors that gain the most from the development aid are: machinery, electrical equiplment and transport equipment.

The gravity model of international trade can be applied to explain the overall trade frows or to explain a flow of a specific types of goods or services. Kavallari et al. (2008) study the factors that explain the olive oil imports to Germany, the biggest EU importer of the olive oil (traditional Mediterranean commodity). Using the Random Effects (RE) approach, authors conclude that the trade volume to Germany is positively correlated to tourism and to existence of direct marketing channels. Kavallari et al. suggest that there is potential for further market creation between Germany and Mediterranean partner countries.

Jansen and Nordas (2004) study the impact of the quality of institutions on international trade. The authors use three indicators as a measure of institutional

quality – government effectiveness (measure of the quality of government inputs), rule of law (including enforceability of contracts or effectiveness of the judiciary), and control of corruption (measured as the exercise of public power for private gain). Jansen and Nordas estimate the impact of domestic institutions on bilateral trade flows by using gravity equations, while controlling for the quality of domestic infrastructure as well as the domestic trade policy. They find out that the quality of institutions has a positive and significant effect on a country's level of openness and therefore on bilateral trade flows, but the parameter of institution variables might turn insignificant and is reduced by almost a half when the quality of domestic infrastructure is included in the regression.

Anderson and Marcouiller (2002) address a problem of trade reduction due to the imperfect contract enforcement and corruption in their paper. Using the gravity approach, they estimate relative import demands to deal with the specification errors. The authors argue that inadequate institutions affect trade in the same way as tariffs. The trade reduction is caused by hidden transactions associated with the insecure international exchange environment (bribes, hijacking or contract enforcement issues), causing a price markup. The authors develop a model that is accounting for such insecurities. They show that trade expansion is connected to a strong institutions, e.g. a legal system that is capable of enforcing contracts or a transparent implementation of government economic policies. More specifically, a *ceteris paribus* 10% increase in a country's index of transparency raises its import by 5%.

Linders (2004) combines the elements of formal trade barriers and transport costs to investigate bilateral trade flows, while distinguishing between differentiated and homogeneous product groups. Using OLS, he estimates the gravity equation to study how are patterns of bilateral trade flows affected by variation in the effectiveness of institutions. Linders uses six institutional indicators (such as rule of law, control for corruption, or political stability) and composes a single indicator by calculating a simple arithmetic average. The author also adds institutional distance variable, which reflects the adjustment costs and trust in exchange. Linders confirms that institutions matter the most for trade in products that are differentiated.

Moreover, he suggests a different sectoral disaggregation in order to take into account comparative advantages among countries.

A paper by Bojnec and Ferto (2009) use gravity models to focus on a quality and similarity of institutions in order to address the variation of agriculture and food exports among the OECD countries. The authors confirm the separate effects of a quality and similarity of institutions, while relying on probit model estimation. Moreover, the effect of quality varies among institutions as some have a greater effect on food and agriculture exports than others.

The gravity-based analysis is used by economists all over the world. Prasai (2014) works with the gravity model to estimate the trade patterns of Nepal. Based on his analysis, the author suggests that Nepal should negotiate a free trade agreement with China and redirect its trading activities there in order to reduce its trade dependence with India. The author proposes that Nepal needs to concentrate on improving trade relations with China (e.g. by constructing railway links and removing tariffs on Nepalese goods entering the Chinese market).

Inefficient institutions can lead to serious barriers. Bingsten et al. (2000) explain why foreign firms find it difficult to trade with partners missing an efficient legal system (e.g. African firms) and why those partners have such a hard time breaking into export markets. The authors use survey data of six African countries - Burundi, Cameroon, Côte d'Ivoire, Kenya, Zambia, and Zimbabwe. They state that the reason behind this is the unpredictable behavior of such firms (e.g. contractual delays or calls for contractual renegotiation). Long-term relationships of the firms with their partners lead to dealing through negotiation. Lawyer and courts are only used by large companies and when negotiation fails. Bingsten et al. prove that a flexibility of contracts is not necessary for market exchange to take place, and that firms only seek the protection of a legal institution, only when a confidence in the partner is lost. The authors conclude that large firms often face more problems, because of the fact that the occurrence of problems is lower when legal institutions are less advanced and the manufacturing sector is not so sophisticated.

Institutions have also been studied in a context of their effect on economic growth. Many studies have proven their positive effect on economic growth but until 2012 none of them specified which institution matters the most. Siddiquai and Ahmed (2012) use the Index of Institutionalized Social Technologies (IIST index), while further distinguishing between its three components - anti-rent seeking technologies (factor of institutional and policy rents and factor of political rent) and factor of risk reducing technologies. The authors determine that institutions of Institutional and policy rents substantially affect long-run economic growth, whereas institutions that reduce risk and inhibit political rent are not always statistically significant. The authors test the role of institutions on economic growth in the empirical analysis using pooled OLS and GMM dynamic panel estimation methods, which are more robust compared to the ones used by other authors before this study. They conclude that if government's behavior furthers corruption, predatory rents for privileged or inefficiency, then all the people who do not possess those privileges cannot enter into similar contract which will greatly diminish long-run growth perspectives. Moreover, the authors suggest that if all institutions improve concurrently their individual effect will be more distinct, which revealed a high degree of complementarity among institutions. The suggested policy implementation is to focus on strengthening all form of institutions.

Acemoglu and Johnson (2003) search the importance of property right institutions and contracting institutions, using a strategy of multiple instrumental variables to isolate the property rights and contracting channels. The authors use two alternative measures to proxy the property rights institutions - constraint on the executive (which is closely related to the security of property rights) and political risk services' assessment of protection against expropriation by the government. On the other hand, the contracting institutions are proxied by the number of formal legal procedures essential to settle a simple case congregation on an unpaid check or expelling a non-paying occupier (greater level of legal formalism is associated with higher costs of enforcing simple contracts). Acemoglu and Johnson find a strong support for the significance of property rights institutions on current economic outcomes. The results of this study show that countries with a higher protection of

expropriation and greater limitations on elites and politicians tend to have a higher per capita income, as well as greater investment rates, or more developed stock market. On the other hand, the importance of contracting institutions seems to be more limited. Apparently, countries with greater legal formalism suffer from less developed stock markets. However, if controlled for the effects of property rights institutions, legal formalism do not seem to have an effect on per capita income. The authors conclude that legal formalism and contracting institutions in general matters less than property institutions.

Persson and Tabellini (2003) estimate an influence of political institutions on productivity and growth, while using instrumental variables. The authors conclude that in well established democracies with the presidential systems, compared to the parliamentary systems, are more growth-oriented. Contrary, in weak democracies, tend to be more growth-oriented the parliamentary systems. For such analyses, they used the Frankel and Romer (1999) instrument of trade openness, derived by the authors only from the country's geographic characteristics (does not depend on their incomes or actual trading patterns). Frankel and Romer compose this instrument while studying the impact of trade openness on income per capita. Their methodology includes an estimation of first-stage gravity equation of bilateral trade flows.

Hall and Jones (1999) are other economists to use instrumental variables in their analysis. They study an effect of social infrastructure on income per capita. To measure the social infrastructure, they combine an index of government anti-diversion policies together with the fraction of years in which a country's openness held according to the index proposed by Sachs and Warner (1995). Hall and Jones also use the above mentioned Frankel and Romer (1999) instrument as a measure of trade openness to suggest that a country's economic performance over a long-run is determined mainly by the institutions and government policies.

Felbermayr and Gröschl (2011) use the gravity model to address a question, whether openness to trade results in higher per capita income. Moreover, they use the instrumental variable method to overcome the joint openness and income

endogeneity. They use natural disasters as an instrument for openness. Their explanation of the instrument validity is following: when a country is hit by a major natural disaster, its productive capacity is temporarily reduced and if an economy has access to the international market, the imports increase. When the capacity is restored, imports decline but exports have to increase so that the economy meets an intertemporal budget constraint. This suggests that *ceteris paribus* an economy is more open after a disaster. Moreover, the geological allocation and timing of disasters are exogenous. Authors confirm the validity of this instrument and conclude, that countries that are more open to trade tend to have a higher income per capita in the long-run. However, the instrument varies over time and works well in panel framework. Therefore, they suggest using this instrument in various setups to understand the effect of trade openness on macroeconomic outcomes.

Gravity-type models were as well used by Borrmann et al. (2005) to explain the position of German foreign direct investment (FDI), operationalized as production value of foreign affiliates, in Central and Eastern Europe. They point out that when gravity-type models are applied to explain the FDI, some differences occur in the mode of operation of the two core variables (distance and economic size) so that the interpretation may become uncertain. The reason of this uncertainty is in the fact that the market size can exceed the host country and also the distance can be an incentive, as well as an obstacle to FDI (as opposed to the original idea of gravity models where distance is generally view as an obstacle to trade). The purpose of this paper is to answer a question, whether the rapid growth in recent years has already led to a normal level – whether there was a backlog, or whether an overshooting has taken place. Besides the two core variables, the authors include other variables, such as endowment-related variables and market potential of neighboring countries. The authors conclude that the actual FDI values of the core four CEE countries (Poland, Czech Republic, Slovakia and Hungary) have clearly exceeded the normal values. However, it is not relevant to interpret this as overshooting, mainly due to the extreme wideness of confidence intervals and a fact, that FDI decisions are also based on future growth prospects and not only on a past performance. The high estimates of German FDI should be rather interpreted as “already above average”.

The same modeling instruments that yield gravity equations for international trade may as well be applied to other types of flows in different areas. Gravity models of trade are comparable with gravity models of immigration. Lewer and Van den Berg (2008) study the comparability of those two implications of the gravity model. According to the authors, the gravity model of immigration is likely to respond in a similar fashion as the gravity model of international trade, and can be used to test the marginal influence of additional variables to immigration. Using gravity models of immigration, researches may test empirically that the current immigration is positively linked with past immigration flows (because the cost of adapting to a new society is lower due to the presence of compatriots), where the immigration flow is greater, when the language and culture in the destination country is well known.

Based on the literature review one can conclude that gravity equations have been a dominant tool used by economists to determine various effects on bilateral trade flow or even economical growth. However, the role of gravity equations has been prominent not only in the area of international trade. The accuracy of gravity equations estimates and their interpretation has been a key to successful use in various branches of empirical literature. There is some evidence of the effect of institutions on a trade flow. However, most studies estimated the impact only of a certain type of institution, which we see as an opportunity to use the gravity-based models and provide an empirically broader analysis of an influence of institutions on a trade flow by estimating a wider range of institutional indices. Moreover, we will focus on a proper estimation technique.

4 Gravity Model Issues

Three common errors have been identified by Baldwin and Taglioni (2006) in the traditional gravity models literature. First, the traditional gravity equation omits so called multilateral resistance terms (MRT), which are correlated with trade costs. This leads to biased estimators¹. Second mistake is to average the reciprocal trade instead of treating the trade flows each way (from country A to country B and vice versa). Third, inappropriate deflation (typically by the US aggregate price index), which most likely creates bias through spurious correlation. Baldwin and Taglioni call these errors the gold, silver and bronze medal mistakes, respectively.

4.1 Zero Trade Flows

One of the most discussed issues is how to treat zero flows between two countries that do not trade with each other. The problem arises especially in the log-linearized form of gravity model when the zero trade flows are dropped out of the estimation as the logarithm of zero is not defined. Traditional concepts that have been being used in order to correct for the zero trade are: (a) dropping the zero value observations, (b) substitute the zero value with a very small negligible constant, or (c) estimating the model in levels. However, the first concept is not advisable due to dropping valuable information. Both (b) and (c) methods are as well incorrect when using an OLS estimation framework, yielding to inconsistent estimates.

¹ MRT refers to the barriers faced by each country while trading with all trading partners. (Bacchetta et al., 2012) suggest replacing the MRT with country dummies to control for country-specific characteristics.

Traditional gravity equations use data on country pairs with a non-zero trade volume in at least one direction. Helpman et al. (2008) are the first to develop a model of international trade which included as well data on countries that do not trade with each other, but according to the authors such data include important information and disregarding them produce biased estimates. In addition, Helpman et al. argued that the standard specifications of gravity equations impose symmetry which is inconsistent with the data and therefore another source of biased estimates. In order to correct these biases, the authors developed a theory that predicts not only positive, but as well zero trade flows between countries. Based on this theory, they derived estimation approach that uses the information contained in the data set including both trading and non-trading sets of countries. The robustness check was performed to assure that the estimates are not sensitive to the estimation method (parametric, semi-parametric or non-parametric).

The correct choice of estimation method is dependant on what we believe is the reason for a zero trade flow (e.g. firms' decision not to export, missing values that were wrongly recorded or the result of rounding errors). The Tobit model framework reflects a situation when some observations are not observable (censored) and recorded as zero. Linders and de Groot (2006) note that such framework is not appropriate in terms of explaining why some trade flows are missing.

Santos Silva and Teneyro (2006) derive a gravity model specification, which cure the biased estimates yielding from the log-linearized gravity equation when heteroskedasticity is present. The estimator is equaled to Poisson pseudo-maximum-likelihood (PPML) estimator, which is proved by the authors to be more robust.

When zero trade flow results from firms' decisions not to trade, a Heckman approach is advisable. The appropriate estimation involves modeling such decisions and correcting the trade volume estimation for a selection bias. (Bacchetta et al., 2012).

4.2 Problem of Endogeneity

Second issue that has been widely discussed when it comes to gravity model estimation is endogeneity. Such problem often arises while studying an impact of trade policies, when the trade policy variables are correlated with an error term due to unobserved characteristics. The source of endogeneity issues may be a reverse causality as well as omitted variable bias. Generally, fixing endogeneity is not an easy task.

Fixed effects (FE) in a panel might correct a part of the omitted variable bias endogeneity problem, while time-varying omitted variables still remain a problem. There is other downside to the FE method. All time-invariant (such as bilateral distance) variables are dropped from the model and it is not possible to estimate their parameters. The instrumental variable (IV) technique is an option here. However, it is challenging to find an instrument that is correlated with the endogenous dependent variable and uncorrelated with trade. In any case, such procedures ignore the time-invariant characteristics of the unobserved effect. (Bacchetta et al., 2012) and (Hausman and Taylor, 1981).

Egger (2004) is the first to propose using a Hausman and Taylor (1981) 2SLS error components approach, which allows accounting for possible correlation of some of the regressors with the unobserved effects and provides consistent parameter estimates of the time-invariant variables (even in a setting with bilateral and time effects). The model proposed by Hausman and Taylor can be written as:

$$\begin{aligned}
 Y_{it} &= X_{it}\beta + Z_{it}\gamma + \varepsilon_{it} \\
 \varepsilon_{it} &= \alpha_i + \eta_{it}
 \end{aligned}
 \tag{4.1}$$

Where β and η are coefficients of time-varying and time-invariant variables (X and Z , respectively), disturbance η is assumed to be uncorrelated with X , Z and α , and has a zero mean, and α is the unobserved time-invariant random variable potentially correlated with X and Z . This model may as well be used with unbalanced data, when data are missing at random.

Alternatively, a Generalized Method of Moment (GMM) estimation method, where lagged levels are used as IVs, can be applied. Arrelano and Bond (1991) derive a consistent GMM estimator, which treats the model as a system of equations and uses lags of the dependent variable as instruments in the dynamic panel data estimation. This estimator has one-step and two-step alternatives. Few years later, Arellano and Bover (1995) and Blundell and Bond (1998) estimator is derived to address a problem of the original estimator - lagged levels are often weak instruments for first differences. The AB/BB estimator uses additional moments: lagged differences are used as IVs for the level equation and lagged levels are used as IVs for the differenced equation. The drawback is that the GMM estimates tend to be sensitive to the number of lags that are being used. (Bacchetta et al., 2012).

Another common way to address endogeneity of explanatory variables is to use their lags as instruments. Villas-Boas (1999) use lagged prices as their instruments. This strategy is called the lag identification.

A recent study by Wooldridge (2014) suggests using a quasi-maximum likelihood estimation (QMLE) framework to address endogeneity of either continuous or binary explanatory variables in nonlinear panel data.

5 Data and Methodology

5.1 Data, Variables and Their Expected Effects

We obtained the data set from my supervisor at no charge. We were provided with the panel data set of gravity model for German trade in years 1995-2011. The list of variables together with their original source is provided in a table below and the description follows.

Table 5.1: List of variables and their sources

	VARIABLE	SOURCE	REMARK
xgjt	German Exports	Eurostat	in millions EUR
yjt	Partner's GDP at PPS	Eurostat, IMF	in millions EUR
ygt	German GDP at PPS	Eurostat	in millions EUR
dgj	Weighted Distance	CEPII	In km
pjt	Population partners	IMF	in millions
cijt	Currency union dummy	Own estimation	<1-3>
tijt	Trade barriers dummy	WTO, UNCTAD & Own	<1-9>
gjt	Gov. effectiveness	World Bank	per cent
erijt	ERDI index	IMF, World Bank	Exchange Rate Deviation Index
edu	Education index	United Nations	<0-100>
pro	Property Rights	Heritage Foundation	<0-100>
cor	Freedom Corrupt	Heritage Foundation	<0-100>
fis	Fiscal Freedom	Heritage Foundation	<0-100>
gov	Government Spending	Heritage Foundation	<0-100>
bus	Business Freedom	Heritage Foundation	<0-100>
mon	Monetary Freedom	Heritage Foundation	<0-100>
tra	Trade Freedom	Heritage Foundation	<0-100>
inv	Invest-ment Freedom	Heritage Foundation	<0-100>
fin	Financial Freedom	Heritage Foundation	<0-100>
y95-y11	Dummy for year 1995-2011	Own estimation	{0;1}
AF-ZW	Dummy for countries	Own estimation	{0;1}

The dependent variable is volume of German export to a country j in millions of Euros. The rest of variables are explanatory. The list of all partner countries of Germany is listed in Appendix.

Both partner's GDP and German GDP (based on Purchasing Power Standards) are measured in millions of Euros and should result unitary elasticities, as suggested in existing literature. (e.g. Bacchetta et al., 2012).

The distance of the two partner countries is measured as weighted distance using city-level data to assess the geographic distribution of population inside each nation. The basic idea is to calculate the distance between two countries based on bilateral distances between the biggest cities of those two countries, those distances being weighted by the share of the city in the overall country's population. Distance between two countries can also be measured as a simple distance (not weighted). For more details including the general formula used for calculating the distance between two countries see Mayer and Zignago (2011). According to Bacchetta et al. (2012) the elasticity of trade to distance lies usually between -0.7 and -1.5 . Egger (2004) measured even greater effect of distance on trade (parameter -1.7) when using the Hausman and Taylor estimation technique. Distance is used as a proxy for transportation costs.

The population variable serves as a proxy for the "openness" factor. Alesina and Wacziarg (1998) provided cross-country empirical evidence that a country size is negatively related to trade openness. Openness is a parameter of the income absorption on the side of aggregate domestic demand. Small countries tend to be more open. However, big countries appear to trade more as far as the volume of traded goods due to their self-sufficiency.

The currency union dummy can score between 1 and 3, where 1 is a non-member of Eurozone with floating exchange rate to Euro, 2 is a country with a fixed exchange rate to Euro and 3 is a member of the Eurozone. Rose (2000) have proposed that an effect of common currency on trade is large. Andrew Rose

estimated that two countries using the same currency trade over three times as much as comparable countries with their own currencies. Havránek (2009) studied the so-called Rose effect, using meta-regression methods, applied on the Euro area. The results of his studies are not as optimistic as Rose's estimates – Havránek concluded, that the effect of Euro on trade is much smaller than what Rose presented in his work. Moreover, the effect of Euro differs from country to country and from industry to industry. We expect a small, if significant, effect of this variable on German export.

The trade barriers dummy variable can score values between 1 and 9, where 1 is an EU member and 9 is a country without any special institutional barriers. The full list of the values paired with what they stand for can be found in a study by Paulus et al (2014). The expected influence on trade is negative.

The government effectiveness variable is measured in per cents. A country with a better governance rating obtains a higher score. The effectiveness is measured as a quality of public and civil governance and their independence from political pressures as well as a quality of formulation and implementation of policies. This measure was constructed using many individual variables, such as bureaucratic quality, quality of primary education or quality of public administration. (Kaufman et al., 2010). Naturally, we expect a positive sign.

The Exchange Rate Deviation Index (ERDI) is measured as the deviation of a real exchange rate from its purchasing power parity (PPP). Naturally, we expect an adverse effect of ERDI on trade, as we believe that Germany would trade more with a country with less deviated (more stable) exchange rate.

The Education Index is measured in per cents. This index is, together with the Life Expectancy Index and Income Index, a component of the United Nations Human Development Index. The Education Index is calculated from the Mean years of schooling index and the Expected years of schooling index. The highest score (100%) indicates a perfect education attainment. A positive effect on trade is expected.

The data contains as well a set of Heritage Foundation institutional variables. We expect a positive effect, believing that Germany would trade more with countries with better institutions. The descriptions of each of them follow.

The role of institutions is connected to the Index of Economic Freedom. Economic freedom is a basic right of every human being to control his/her labor and property and it brings healthier societies, cleaner environments, democracy, human development, poverty elimination and greater per capita wealth. This index shows how much are people free to work, consume, produce, and invest in the way they desire. In a society which is economically free, the government allows a free movement of capital, labor and goods. The index covers 10 equally important freedoms: business freedom, trade freedom, fiscal freedom, government freedom, monetary freedom, investment freedom, financial freedom, property rights and labor freedom. These institutional variables were collected from the Heritage Foundation. Each of the institutional freedom variables is graded on a scale from 0 to 100. The overall Index of Economic Freedom is derived by averaging each of the ten freedoms, with equal weight given to each. (Miller and Kim, 2014). Now let us take a look on each of the freedom components of the Index of Economic Freedom and the way they are measured by the Heritage Foundation. An explanation of each of the freedom components is provided below, as these variables are of the main interest of this thesis.

The property right component measures the ability of individuals to accumulate private property and wealth with a security of clear laws that are fully enforced by the state which allows the citizens to make long-term plans. It is understood to be a key motivation for workers and investors in a market economy. The enforcement of contracts is proven to be the key aspect of property rights protection. Independence, transparency and effectiveness of the judicial system serve as key determinants of a country's prospects for a long-term economic growth. This index measures a degree to which the laws in a country protect private property rights and the degree to which those laws are enforced by its government – the greater the chance of government expropriation of property and the less certain the legal

protection of property, the lower its score is. A country's score can vary between 0 for "Private property is outlawed, and all property belongs to the state. People do not have the right to sue others and do not have access to the courts. Corruption is endemic", and 100 for "Private property is guaranteed by the government. The court system enforces contracts efficiently and quickly. The justice system punishes those who unlawfully confiscate private property. There is no corruption or expropriation". (Miller and Kim, 2014).

Corruption can be understood as a failure of integrity of an economic system where individuals can gain at the expense of the whole. Freedom from corruption is another index connected to economic freedom. The score for this index is derived mainly from Corruption Perception Index (CPI) measured by the Transparency International. The freedom from corruption index is measured as a 10 times the CPI (which is on a scale from 0 to 10 which makes the freedom index on a scale from 0 to 100). (Miller and Kim, 2014).

A tax burden imposed by the government is measured by the fiscal freedom index which includes direct taxes in terms of the top marginal tax rates on incomes of an individual, the top marginal tax rate on corporate income, and overall taxes (direct and indirect) as percentage of GDP. The fiscal freedom index is determined by those three numerical variables which are equally weighted (each as one-third of the component). The data for each factor are converted to 0 – 100 scale using a formula which can be easily found on Heritage Foundation webpage but which is beyond the intention of this thesis. The higher the score, the lower the tax burden imposed by the government is. (Miller and Kim, 2014).

The government spending component considers the government expenditures, including consumption and transfers, as a percentage of GDP, which account for the entire score. This component includes all levels of government, such as federal, state and local. The scale is non-linear, meaning that expenditures close to a zero benchmark are just lightly penalized, while expenditures that exceed 30% of GDP lead to a much worse score. The score equation can be as well found on the Heritage

Foundation webpage but is not of our interest. In general, the higher the score, the smaller the government spending as a percentage of GDP is. (Miller and Kim, 2014).

Business freedom serves as an indicator of the efficiency of government business regulations. The score is derived based on 10 equally weighted factors and varies between 0 and 100, with 100 equaling the freest business environment. The 10 factors consist for example of a cost of starting and closing of a business, number of procedures of starting and closing a business, cost and number of days necessary for obtaining a license, and some other factors. (Miller and Kim, 2014).

The monetary freedom component measures price stability together with an assessment of price controls. The ideal state for a free market is price stability without microeconomic interventions. The score of this component is derived based on two factors – the weighted average inflation for the most recent three years and price controls. The first factor serves as the primary output into a score equation, which can be found on the Heritage Foundation website. (Miller and Kim, 2014).

The trade freedoms serves as a measure of absence of tariff and non-tariff barriers to trade that affects exports and imports of goods and services and its score is determined based on two factors – the trade-weighted average tariff rate and non-tariff barriers. The precise equation together with possible penalties of 5-20 points is listed on the Heritage Foundation website. The trade freedom index scores from 0 to 100 with 100 being the freest trade environment. (Miller and Kim, 2014).

The investment freedom index evaluates a variety of constraints on the flow of investment capital. The ideal score in an investment free country is 100. Points for variety of investment restrictions are deducted from the ideal score of 100. The list of points to deduct can be found on the Heritage Foundation website. Categories of such restrictions leading to score deduction include national treatment of foreign investment, restrictions on land ownership, capital controls or foreign exchange controls. (Miller and Kim, 2014).

Finally, the financial freedom serves as a measure of banking sector efficiency and a measure of independence from government control and intervention in the financial sector. In an ideal environment, credit is allocated on market terms, only minimum government interference exist, government does not own financial institutions, bank can freely extend credit, accept deposits or conduct operation in foreign currencies, independent central bank supervision is limited to preventing fraud, and foreign financial institutions are treated as domestic ones and can operate freely. The index is derived based on various areas such as openness to foreign competition, the extent of government regulation of financial services or the degree of state intervention in financial institutions through direct and indirect ownership. The score of the financial freedom index may vary from 100, “Negligible government interference“, which is an ideal state, to 0, where „Supervision and regulation are designed to prevent private financial institutions. Private financial institutions are prohibited“. (Miller and Kim, 2014).

For the purpose of this thesis we will use concrete freedom variables rather than the overall index to study the effects of particular institutions. We also add year dummies and country dummies which will be used in time effect and country effect estimations.

5.2 Methodology

For the empirical analysis, we will use one-way trade flow panel data of Germany and its partners for the estimation, which allows taking into account more general types of heterogeneity. Several different estimation techniques will be used in order to estimate the gravity equation. We will perform various panel data estimation methods (such as the pooled OLS, Poisson-based method, Hausman-Taylor approach or the IV regression) to estimate the gravity equation using German trade data and compare the results yielding from each of them. We will use the log-linearized transformation, where we take the natural logarithm of the continuous variables. There is a strong assumption that institutions are endogenous referred to export which

may lead to inconsistent estimation. Therefore, we will search for a proper methodology. The main purpose is to find a suitable estimation method in order to cure both non-linearity and endogeneity of institutional variables.

The extended log-linearized gravity model, augmented from the specification by Anderson and van Wincoop (2001), has a following form:

$$X_{jit} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} D_{ij}^{\beta_3} L_{jt}^{\beta_4} e^{(\beta_5 ERDI_{jt} + \beta_6 C_{jt} + \beta_7 T_{jt} + \beta_8 Edu_{jt} + \beta_9 INST_{jt} + \lambda_t + \theta_j)} \varepsilon_{ijt} \quad (5.1)$$

Where X_{jit} is a volume of export from Germany to a partner country j , Y_{it} is GDP of Germany, Y_{jt} is a GDP of a parent country, D_{ij} is a distance between Germany and a partner country, L_{jt} is population of a partner country, $ERDI_{jt}$ is the Exchange Rate Deviation Index of a partner, C_{jt} is the currency union dummy, T_{jt} is the trade barriers dummy, Edu_{jt} is the educational quality index, $INST_{jt}$ is a vector of Heritage Foundation institutional dummies, λ_t is a time effect and θ_j is a time-invariant country effect. Exponents are the parameters to be estimated and ε_{ijt} are the disturbances. This log-linearized specification allows an easy interpretation of the parameters – the estimated logarithms represent elasticities.

The traditional ordinary least square (OLS) approach will be used mainly as a benchmark. In order to control for global economic effects, we will create year specific dummy variables (1995 – 2011). Similarly, we will add time-invariant dummy variables for each country to account for the country-specific patterns. In order to estimate the standard errors consistently, we need to control for serial correlation among observations. Therefore, we will use clustering methods. We will perform fixed effects (FE) and random effect (RE) estimations and the Hausman test will be then used to decide about the preference between FE and RE method. Under the null hypothesis of zero correlation, the random effects model is preferred. If the null hypothesis is rejected, the fixed effects model yields more consistent estimates. Fixed effects method predicts that unobservable effect covered in the error term is

constant for a group, leading to omitting time-invariant variables, such as distance. However, we want to estimate the effect of distance on the trade flow as well as we assume a high explanatory power.

Several problems may arise with the traditional log-linear OLS estimation. The interpretation of the parameters of log-linearized model estimated by OLS as elasticities may be misleading when heteroskedasticity is present due to the Jensen's inequality. Moreover, the log-linearized model raises a problem of treating zero-value trade flow observations. Luckily, this is not the case of our model as non-zero flows are not present in our data set. In order to account for the bias caused by the logarithmic form of the gravity model in case of heteroskedasticity in error term, we will move to Poisson-based estimation, as proposed by Santos Silva and Tenreiro (2006). The Poisson regression fits models with count outcomes. Similarly to previous OLS method, we will estimate the model (5.1) using the Poisson Pseudo Maximum Likelihood estimation (PPMLE) method, and then proceed with adding year dummies and country dummies, as well as running a Poisson-based fixed effects regression. To cure the downwardly biased estimator of standard errors, we will use the Poisson fixed effects estimator with bootstrapped standard errors, as suggested by Westerlund and Wilhelmsson (2009).

In the next step we want to focus on the endogeneity problem in non-linear pooled data. There is a strong assumption that institutions are endogenous, when export affects institutions and vice versa. Endogeneity among explanatory variables in a non-linear model is not an easy task. Egger (2004) proposed to estimate gravity equations with endogenous unobserved effects by using a Hausman-Taylor estimation framework. The H-T estimation is based on instrumental variables and it fits panel data RE models when a correlation of some of the covariates with the unobserved effect is present. Moreover, the H-T estimator distinguishes between the time-varying and time-invariant endogenous variables. We estimate two models, when in the first one we will treat the institutional variables as endogenous, and in the second one we will assume endogeneity in both institutions and GDPs. This method allows a

consistent estimating of parameters of time-invariant variables, such as bilateral distance.

The instrumental variable (IV) regression method has been used to deal with the possibility of endogeneity of independent variables and the correlation between the error term and the lagged dependent variables. However, the choice of instruments can be tricky as it might be difficult to find a variable that can serve as a proper instrument. Two assumptions need to be fulfilled: an IV has to be uncorrelated with an error term and correlated with the problem variable. The German export affects an institution. However, it should not affect its lags. Based on a correlation analysis we will instrument each institution with its 4 year and 5 year lags (correlation coefficient 0.67-0.81).

The validity of results depends on the statistical diagnostics of the model. We will run the postestimation Ramsey RESET test (Regression Equation Specification Test). The fitted values will be predicted and a second power of the fitted values will be added to the models. If their estimates prove to be insignificant, the model is correctly specified (absence of omitted variables is proven).

5.3 Model Specification

Since there are more institutional variables in the data set, some of them have to be eliminated to avoid the multicollinearity problem. Therefore, based on a cross-correlation matrix, I will choose a set of them to use in the analysis. The purpose is to find a set of institutional variables that do not create multicollinearity. The correlation matrix will be computed² among the HF institutional variables as well as between

² All computations including cross-correlations, regressions, descriptive statistics, etc. are made in Stata/SE 13.0 software.

institutional and traditional gravity variables. The results are shown in the two following tables.

Table 5.2: Cross-correlation matrix among institutional variables

	pro	cor	fis	gov	bus	mon	tra	inv	fin
pro	1,000								
cor	0,859	1,000							
fis	-0,105	-0,123	1,000						
gov	-0,291	-0,400	0,523	1,000					
bus	0,782	0,716	0,032	-0,138	1,000				
mon	0,459	0,491	0,166	0,026	0,443	1,000			
tra	0,433	0,488	0,169	-0,185	0,442	0,384	1,000		
inv	0,705	0,596	0,007	-0,113	0,650	0,447	0,438	1,000	
fin	0,724	0,656	0,061	-0,144	0,671	0,503	0,497	0,760	1,000

Source: Own calculations using the STATA software

Table 5.3: Cross-correlation matrix between institutional and other variables

	xgjt	yjt	ygt	dgj	pjt	cijt	tijt	gjt	edu	erijt
pro	0,305	0,143	-0,114	-0,044	-0,074	0,312	-0,315	0,815	0,384	-0,407
cor	0,321	0,139	0,025	-0,061	-0,083	0,321	-0,341	0,827	0,439	-0,459
fis	-0,212	-0,030	0,232	0,193	0,019	-0,228	0,245	-0,089	-0,056	0,024
gov	-0,286	-0,012	0,041	0,356	0,122	-0,360	0,456	-0,364	-0,221	0,142
bus	0,234	0,126	0,016	-0,019	-0,093	0,240	-0,245	0,723	0,367	-0,387
mon	0,172	0,095	0,214	0,046	-0,003	0,180	-0,211	0,504	0,198	-0,405
tra	0,261	0,101	0,334	-0,125	-0,153	0,296	-0,369	0,484	0,356	-0,281
inv	0,234	0,065	-0,041	-0,067	-0,091	0,309	-0,354	0,625	0,277	-0,303
fin	0,251	0,081	0,043	-0,038	-0,113	0,272	-0,313	0,649	0,381	-0,385

Source: Own calculations usith the STATA software

Based on the previous analysis, I decided to use fiscal freedom (fis), government spending (gov), property rights (pro), and monetary freedom (mon) as institutional variables. These are the four HF institutional variables that are least correlated with other dependent variables.

The augmented gravity model that will be estimated in this thesis is specified as follows.

$$\begin{aligned}
\log X_{jit} = & \alpha_0 + \alpha_1 \log Y_{it} + \alpha_2 \log Y_{jt} + \alpha_3 \log D_{ij} + \alpha_4 \log L_{jt} \\
& + \alpha_5 \log ERDI_{jt} + \alpha_6 C_{jt} + \alpha_7 T_{jt} \\
& + \alpha_8 Edu_{jt} + \alpha_9 G_{jt} + \alpha_{10} Fis + \alpha_{11} Pro_{jt} + \alpha_{12} Gov_{jt} \\
& + \alpha_{13} Mon_{jt} + \alpha_{14} y08 + \alpha_{15} y09 + \alpha_{16} y10 + \varepsilon_{jt}
\end{aligned} \tag{5.2}$$

Where *Fis* is the fiscal freedom, *Pro* is property rights variable, *Gov* is government spending and *Mon* is monetary freedom.

6 Empirical Analysis

In this chapter we will provide descriptive statistics, assumption testing and an empirical analysis based on gravity model approach. The methodology used is described above. The discussion of results will follow.

6.1 Descriptive Statistics

Table 6.1 provides a quantitative description of variables which helps to take a first look at the data before running a regression. There are huge differences in the maximum and minimum values in some of the gravity variables. The maximum value of the explained variable, German exports, is about 101 billion EUR (the partner country was France in 2011), while the minimum value is only 0,5 million EUR (the partner country was Grenada in 1996). The maximum value of a partner's GDP is 11 700 billion EUR (United States), while the minimum value is only about 81 million EUR (Marshall Islands). German GDP variable differs by approximately 1 000 billion EUR, which is due to the increase of the country's GDP over the 25 year period (about 1 500 billion in 1995 and 2 500 billion in 2011). The partner country with the greatest distance, New Zeland, is situated more than 18 000 km from Germany. The HF institutional variable property rights have the lowest mean value – only about 50 %.

Table 6.1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
xgjt	3009	3963,8	11279,6	0,5	101444,3
yjt	3009	236418,6	876806,8	81,4	11700000,0
ygt	3009	2011267,0	298699,0	1538583,0	2520693,0
dgj	3009	5753,2	3688,6	377,7	18219,9
pjt	3009	35,0	129,6	0,0	1347,4
cijt	3009	1,2	0,5	1,0	3,0
tijt	3009	6,5	2,4	1,0	9,0
gjt	3009	51,2	29,6	0,0	100,0
erijt	2980	2,0	0,9	0,5	5,9
edu	2853	64,0	18,9	11,0	100,0
pro	3009	50,7	25,2	0,0	95,0
fis	3009	69,1	16,5	0,0	99,9
gov	3009	63,8	25,4	0,0	99,3
mon	3009	71,4	18,2	0,0	95,4

Source: Own calculations using the STATA software

For the four chosen Heritage Foundation institutional variables (property rights, fiscal freedom, government spending and monetary freedom) we provide an interesting summary below. The worst score as far as the average value over the time period of our interest belongs to North Korea. At 3 out of 4 freedom indicators, which we decided to take a closer look at, this country ranked among the bottom 5 countries. It had an overall lowest average score in fiscal freedom (9.7) and monetary freedom (9.7), and second lowest in property rights (9.7). North Korea has been ranked as the least free country of the world (rank number 177) not only concerning these 4 indices, but also as far as the overall index. Its neighbouring country, South Korea, ranked number 29. Other freeless countries in overall ranking are Cuba, Venezuela, Zimbabwe or Eritrea. Mostly African, Asian and South American countries ranked at the bottom, but also European Greece ranked 130 out of 178, which is way after countries like Nigeria (rank 120), Senegal (rank 106), or Ghana (rank 71). Surprisingly, France (rank 73) had a lower overall score than countries like Rwanda (rank 65), Turkey (rank 70), or Israel (rank 33). On the other hand, Hon Kong scored number one in an overall index, followed by Singapore, New Zealand, Austria, and Switzerland. Chile or Estonia made it to the top 10 as well. Sweden

ranks as the least free in government spending index, but in an overall score it ranked number 23 (as of 2014). For comparison, the Czech Republic ranked 24th in 2014.

6.2 Testing of Assumptions

Before we start with the estimation of gravity equation, we will perform a test of stationarity to ensure the validity of the gravity equation estimation, the multicollinearity test, the Hausman test to decide between FE and RE method, Breusch-Pagan LM test and overidentification test. These tests will help a better specification of gravity model estimation.

6.2.1 Stationarity

The presence of a unit root can invalidate the results of our estimations, as the probability distribution changes over time. Therefore, we will test for stationarity. There are several tests that can be used, e.g. the Hadri test, Im-Pesaran-Shin test, Fisher-type test, Levin-Lin-Chu test, Harris Tzavalis test or Breitung test. Each of the tests has its benefits and drawbacks. We will perform the Levin-Lin-Chu (LLC) test on following variables: German export (dependent variable), German GDP, partner's GDP, and population. We assume that the rest of the variables cannot possibly suffer from non-stacionarity. The LLC test proposes following hypotheses:

H_0 : Panels contain unit roots

H_a : Panels are stationary

The results are shown in following table. For all tested variables we can reject the null hypothesis if favor of the alternative on a 5% level of significance.

Table 6.2 The Levin-Lin-Chu test of unit roots

VARIABLE	Adjusted t*	p-value
log(Xgjt)	-6.321	0.000
log(Yjt)	-16.03	0.000
log(Ygt)	-6.982	0.000
log(Pjt)	-2.181	0.015

Source: Own calculation using STATA software

6.2.2 Multicollinearity

This Gauss-Markov assumption can be tested using the Variance Inflation Factor (VIF), which measures the degree of multicollinearity between the dependent variable with the regressors. The most commonly used rule of thumb is that the VIF value should be less than 10. When a test exceeds this threshold, it is advisable to drop one or more explanatory variables to escape the multicollinearity problem.

We will use this tool to eliminate some explanatory variables specially in the time effect and country effect specifications. Variables with a VIF above the threshold will be dropped out of the regression. We will not present the VIF test procedure results, as it only serves as a tool for proper model specification.

6.2.3 Comparison of Fixed and Random Effects Estimator

In order to decide between the FE and RE methods, we perform the Hausman test, which is based on the differences of the FE and RE estimates. Under the null hypothesis, the Hausman test assumes that both RE and FE are consistent, but RE is more efficient. Under the alternative hypothesis, the Hausman test assumes that RE is inconsistent and FE is preferred.

The result of the Hausman test used on our gravity models strongly rejects the null hypothesis on a 1% level with $\text{Chi}^2(15) = 139.94$. As a consequence, we will only show results of the FE method.

6.2.4 Breuch-Pagan LM Test for Random Effect

The Breuch-Pagan Langrange Multiplier test can be used to examine the presence of heteroskedasticity and help us to make a preference between the RE and pooled OLS methods. Under the null hypothesis, the test assumes constant variance (no significant differences across countries). Under the alternative, heteroskedasticity is present (error variances are a multiplicative function of one or more variables). Heteroskedasticity itself does not cause unbiased estimators. However, the OLS estimates have no longer the smallest variance among all unbiased estimators.

The result of the B-P LM test on our model strongly rejects the null hypothesis on a 1% level with $\text{Chi}^2(1) = 1674.79$. Therefore, we can confirm heteroskedasticity and we should prefer RE over OLS method.

6.2.5 Overidentification

In the case of the instrumental variable estimation we perform a test of overidentifying restrictions to see if the model is specified correctly. After estimation of the parameters we run the test and obtain Wooldridge's score test of overidentifying restrictions. We fail to reject the null hypothesis (on a 1% level) that our estimates are valid in the linear 2SLS model with robust standard errors (in all three specifications: the traditional, time effect and country effect). Therefore, we can assume that our model is specified correctly. Moreover, we assume the same for the FE IV method (since we have proved it for the country effect specification and the overidentification testing would be beyond the scope of this thesis due to the lack of

postestimation option in STATA). However, we reject the null hypothesis in the case of Poisson IV estimation method on a 1% level.

6.3 Gravity Model Analysis

6.3.1 Pooled OLS Methodology

First, a set of pooled OLS regressions and panel FE estimation of the gravity equation (5.2) were performed. The results are shown below in Table 6.3. The regression is country clustered to approve the accuracy (there is a natural collinearity among each country's different year's data and clustering will cure this problem). Based on the VIF test (variance inflation factors for the independent variables) and a rule of thumb ($VIF > 10$), some of the time dummies in the time effect model, as well as country dummies in the country effect model, have been dropped to avoid the multicollinearity problem.

Approximately unitary elasticity holds in the case of partner's GDP in the traditional, time effect and country effect regression, which is in accordance with what corresponding literature suggests. The German GDP is significant on a 1% level only in the case of fixed effect estimation. The distance variable is very significant with values between negative 0.7 and negative 0.8, which is a slightly smaller effect than expected. The ERDI variable became significant with the fixed effect estimation, while having an expected negative effect on trade. The population variable has an effect on trade of an expected sign (greater population corresponds to more closed economy), but it is not significant. Fiscal freedom is significant on a 5% level in 3 out of 4 specifications. The effect on trade is quite large. An increase of fiscal freedom index by 1% increases German export as high as by 0.73%. Government spending is significant on a 1% level in the case of FE estimation. Again, its effect on German export is quite high, when a 1% rise in government spending index increases the German trade by 0.34%. We expected the currency union variable to only have a

small effect on trade, but it is suprising that its effect on German trade is negative, while being significant on a 10% level in the case of FE estimation. The effect of year 2008 is positive and significant on a 10 % level in the time effect and country effect model. This suggests an impact lag of the global crisis. The effect of the recession year 2009 is negative and significant in some specification, where the German exports declined by about 8%. The OLS models explain the data reasonably high (89% to 94% of model is explained by the dependent variables). OLS specifications proved that the partner's GDP, German GDP and distance are significant variables that explain the German export. A RESET tests suggest that no omitted variables are present in our models (supports the null hypothesis).

Table 6.3 OLS regression

VARIABLES	OLS	Time effect	Country effect	FE
logyjt	1.009***	1.015***	0.950***	0.701***
logygt	0.494*	0.508	0.429	0.858***
logdgj	-0.803***	-0.803***	-0.690***	
logerijt	-0.106	-0.0766	-0.218*	-0.468***
logpjt	-0.0377	-0.0443	-0.0183	0.0826
cijt	0.0699	0.0723	0.0604	-0.0903*
tijt	-0.0408	-0.0407	-0.0954*	-0.00374
gjt	0.00697	0.00665	-0.00250	0.000370
edu	0.00503	0.00519	0.00353	-0.00216
fis	0.00730**	0.00695**	0.00537	0.00375**
pro	0.00825	0.00840	0.0105	0.00443**
gov	0.00133	0.00151	0.000613	0.00338***
mon	-0.00462	-0.00415	-0.00151	0.00124
tdummy08	0.0762	0.0971*	0.0703*	0.00481
tdummy09	-0.0699*	-0.0504	-0.0800**	-0.0763**
tdummy10	-0.0557	-0.0360	-0.0380	-0.0364
Constant	-6.433*	-6.754	-4.780	-14.55***
Observations	2,824	2,824	2,824	2,824
R-squared	0.892	0.892	0.936	0.422
t stats	t = 1.49	t = 1.49	t = 1.18	t = - 1.06
RESET	P> t = 0.137	P> t = 0.138	P> t = 0.241	P> t = 0.292

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

6.3.2 Poisson Based Estimation

In this step we estimate the gravity equation by the Poisson Pseudo-Maximum Likelihood estimation (PPMLE) method and list the results in Table 6.4. The estimates of partner's GDP are close to unitary elasticity, while being significant on a 1% level in all PPMLE specifications. The effect of German GDP on trade became very significant in the traditional, time effect and country effect Poisson specifications, however it is still quite far from the suggested unitary elasticity. The effect of bilateral distance is also close to what literature suggests (negative unitary elasticity). The elasticity of distance is close to a negative one. The currency union estimates are now positive and significant, which supports the Rosean effect, as discussed above. The government effectiveness estimates is positive and significant on a 1% level for all PPMLE specifications. A 1% increase in the government effectiveness index will boost German exports by 1.78% (in the case of time effect specification). We did not expect a significant negative effect of education. The results of the country effect specification suggest that a 1% increase in the education index will cause German export to fall by 0.6%. The recession year 2009 decreases the German export significantly (approximately 10% decline). In two specifications, year 2010 as well reduces the export of Germany, but in a smaller magnitude than the previous year.

Despite the satisfying results, the RESET test suggests that the PPLME models are misspecified, as we can reject the null hypothesis (H_0 : no omitted variables) for each specification on a 1% level. However, while working with the real data we always have to account for a chance of the omitted variables.

Table 6.4 PPMLE method

VARIABLES	Poisson	Time effect	Country effect	FE Poisson
logyjt	0.970***	0.970***	0.989***	1.108***
logygt	0.511***	0.555***	0.544***	0.263
logdgj	-0.879***	-0.879***	-0.890***	
logerijt	-0.141	-0.121	-0.195**	-0.300***
logpjt	-0.141	-0.142	-0.172	-0.129
cijt	0.131*	0.145**	0.110	-0.0173
tijt	0.0406	0.0418	0.0442	-0.0242
gjt	0.0177***	0.0178***	0.0132***	0.00691***
edu	-0.00486*	-0.00458	-0.00626**	0.00198
fis	0.00410	0.00417	0.00310	0.00125
pro	-0.00558	-0.00568	-0.00397	-0.00240
gov	0.000232	0.000359	-0.000397	0.00241
mon	-0.000660	-9.66e-05	0.000536	0.000990
tdummy08	0.00817	-0.0272	0.000956	-0.0187
tdummy09	-0.101***	-0.134***	-0.0970***	-0.133***
tdummy10	-0.0314	-0.0670***	-0.0258	-0.0498***
Constant	-4.800**	-5.515***	-4.945**	
Observations	2,824	2,824	2,824	2,823
z stats	z = - 2.88	z = - 2.82	z = - 2.75	z = 1.73
RESET	P> z = 0.04	P> z = 0.005	P> z = 0.006	P> z = 0.084

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

6.3.3 Hausman – Taylor Approach

Now we move to a Hausman and Taylor estimation technique. We study two different specifications. In the first one (1) only the institutional variables (government effectiveness, education index, fiscal freedom, property rights, government spending and monetary freedom) are considered as endogenous. In the second specification (2), we add the logs of GDPs to the endogenous variables list. Both specifications are estimated in the traditional as well as time effect (TE) H-T approach. However, these 2 approaches yield more or less identical results. The results are listed in a Table 6.5 below. We can notice several patterns. The traditional

gravity equations (GDPs and distance) remains highly significant, and the magnitude of their effects slightly decreased compared to the PPMLE estimation method. Again, the recession year 2009 is proven to have statistically significant and negative effect on German export (about negative 10%). The currency union dummy has an unexpected negative impact, while being significant on a 10% level. The results suggest that a one unit increase of the currency union dummy decreases the German trade by 0.08%. Contrary to previous estimation techniques, the Hausman – Taylor method yields statistically significant estimates of institutions fiscal freedom, property rights, and government spending. The magnitude of their effect is large, as the 1% rise in the fis, pro and gov indices increase German export by 0.3% - 0.5%. When comparing the two H – T model specifications (1) and (2), the results are very similar. The biggest difference in terms of the magnitude of effect on German export can be seen in the German GDP, where the first model suggests that a 1% increase of German GDP boosts German exports by 5%, compared to the second specification, which suggests that a 1% rise in German GDP increases the German export by 6%. Another difference is that the recession year 2010 became significant on a 10% level in the second specification.

Based on the RESET test we can strongly support a null hypothesis of no omitted variables. Our model is well specified.

Table 6.5 The Hausman and Taylor estimation

VARIABLES	(1)	(1) TE	(2)	(2) TE
logyjt	0.876***	0.909***	0.782***	0.821***
logygt	0.500**	0.528**	0.605**	0.620***
logerijt	-0.479***	-0.429***	-0.482***	-0.442***
logpjt	0.0567	0.0327	0.118	0.0910
cijt	-0.0764*	-0.0755*	-0.0753*	-0.0765
tijt	0.000429	0.00278	-0.00568	-0.00186
tdummy08	0.0157	0.0315	0.00907	0.0218
tdummy09	-0.102***	-0.0889**	-0.0975**	-0.0884***
tdummy10	-0.0529	-0.0438	-0.0489	-0.0434
gjt	0.00141	0.00118	0.000777	0.000624
edu	0.00401	0.00488	0.00359	0.00502
fis	0.00344**	0.00318**	0.00336**	0.00319*
pro	0.00503***	0.00528***	0.00478**	0.00507***
gov	0.00282***	0.00307**	0.00302**	0.00324***
mon	0.000590	0.000842	0.000960	0.00113
logdgj	-1.060***	-1.050***	-1.096***	-1.106***
Constant	-2.736	-3.658	-3.021	-3.672
Observations	2,824	2,824	2,824	2,824
z stats	z = - 0.24	z = -0.45	z = - 0.63	z = - 0.84
RESET	P> z = 0.810	P> z = 0.656	P> z = 0.532	P> z = 0.400

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

6.3.4 The IV Estimation

The results of an IV approach follows. We use instruments as described in the Methodology chapter. We proceed with three different IV estimation techniques: linear 2SLS regression with robust standard errors, the panel data FE IV regression and the Poisson IV regression with bootstrapped standard errors. Each technique has its benefits as well as drawbacks.

When it comes to the traditional IV regression model with no time effect or country effect, the results are shown in Table 6.5. In the linear 2SLS approach with

robust standard errors, the s GDPs and bilateral distance are significant with effects corresponding with the literature (unitary and negative unitary elasticity, respectively). Fiscal freedom and property rights are significant on a 1% level and a 1% increase of the indices rise German exports by 1.1% and 1.5%, respectively. On the other hand, monetary freedom has an unexpected negative effect, while being significant on a 1% level. The model suggests a negative unitary elasticity. Trade barriers and the ERDI index have significant negative effects on trade, as expected.

The fixed-effects method confirms the unexpected negative effect of monetary freedom. Government spending has a significant and positive effect, when a 1% increase will boost German export by 2.4%. The elasticity of partner's GDP is 0.8. Moreover, the FE method suggests negative and significant effects of following variables: the ERDI index, population, 2009 dummy and 2010 dummy. These effects are in line with our expectations.

In the case of Poisson IV regression with bootstrapped errors, the core explanatory variables (GDPs and distance) are significant and their effect on trade is of an expected sign. ERDI has a negative effect on German exports. Government effectiveness has a very strong effect on trade: a 1% increase of the index will raise German export by 2%. Fiscal freedom has a slightly weaker, although significant effect: its elasticity is equal to 0.87. Currency union has a positive significant effect. Contrary to what we expected, property rights have a negative elasticity and trade barriers increase exports.

The RESET test suggests a presence of omitted variables in all 3 models.

Table 6.6 IV estimation

VARIABLES	Linear 2SLS	FE	Poisson
gjt	0.00422	-0.00641	0.0200***
edu	0.00125	0.00636	-0.00282
fis	0.0107***	0.0170	0.00873***
pro	0.0145***	-0.0167	-0.00613*
gov	0.00121	0.0237***	0.000462
mon	-0.0104***	-0.0111*	0.00665
cijt	0.0548	-0.152	0.153***
tijt	-0.0479***	-0.0648	0.0290**
logyjt	1.008***	0.803***	0.882***
logygt	0.772***	0.274	0.346**
logdgj	-0.815***		-0.881***
logerijt	-0.190***	-0.338**	-0.117**
logpjt	-0.0359	-0.424*	-0.0420
tdummy08	0.0438	-0.0181	-0.00265
tdummy09	-0.0932	-0.171*	-0.0940
tdummy10	-0.132	-0.132**	0.0161
Constant	-9.974***	-6.214	-2.740
Observations	2,661	2,661	2,661
R-squared	0.887		
t/z stats	t = 4.24	z = - 3.59	z = - 7.76
RESET	P> t = 0.000	P> z = 0.000	P> z = 0.000

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

After including the time effect to the model, the results (listed in Table 6.7 below) remain almost the same. When we compare the estimated parameters and significance of each variable, we can notice only few differences – currency union dummy is now significant in the FE estimation; however its effect is not of an expected sign. On the other hand, monetary freedom is no longer significant in FE estimation.

The RESET test confirms a presence of omitted variables in all cases.

Table 6.7 IV estimation with time effect

VARIABLES	Linear 2SLS	FE	Poisson
gjt	0.00409	-0.0140	0.0202***
edu	0.00106	-0.00103	-0.00314
fis	0.0106***	0.0114	0.00837**
pro	0.0148***	-0.00984	-0.00541
gov	0.00127	0.0239***	0.00002
mon	-0.0111***	-0.00949	0.00399
cijt	0.0506	-0.184*	0.167***
tijt	-0.0495***	-0.0670	0.0325**
logyjt	1.013***	0.901***	0.883***
logygt	0.800***	0.541	0.478**
logdgj	-0.812***		-0.875***
logerijt	-0.186**	-0.361***	-0.101**
logpjt	-0.0409	-0.396*	-0.0438
tdummy08	0.0825	-0.00604	-0.0625
tdummy09	-0.0523	-0.133	-0.150**
tdummy10	-0.0952	-0.114*	-0.0543
Constant	-10.42***	-10.31	-4.494
Observations	2,661	2,661	2,661
R-squared	0.887		
t/z stats	t = 4.04	z = -3.90	z = - 6.36
RESET	P> t = 0.000	P> z = 0.000	P> z = 0.000

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

Last, but not least we add the country dummies to account for the country-specific patterns. The results are shown in Table 6.8 below. Compared to the time effect specification, the statistical significance of each variable remains the same. Moreover, the magnitudes of their effects differ only very little and the signs of their effects remains the same.

Again, the RESET test confirms a presence of omitted variables.

Table 6.8 IV estimation with country effect

VARIABLES	Linear 2SLS	FE	Poisson
gjt	-0.00335	-0.00641	0.0162***
edu	-0.000735	0.00636	-0.00401*
fis	0.0131***	0.0170	0.00763**
pro	0.0200***	-0.0167	-0.00443
gov	-0.00249	0.0237***	0.000581
mon	-0.0110***	-0.0111*	0.00720
cijt	0.0410	-0.152	0.132***
tijt	-0.0559***	-0.0648	0.0313**
logyjt	1.017***	0.803***	0.915***
logygt	0.880***	0.274	0.358**
logdgj	-0.820***		-0.918***
logerijt	-0.269***	-0.338**	-0.171***
logpjt	-0.0585	-0.424*	-0.0644
tdummy08	0.0226	-0.0181	-0.00847
tdummy09	-0.0845	-0.171*	-0.0926
tdummy10	-0.134	-0.132**	0.0172
Constant	-11.09***	-6.214	-2.677
Observations	2,661	2,661	2,661
R-squared	0.898		
t/z stats	t = 3.22	z = - 3.59	z = - 6.52
RESET	P> t = 0.001	P> z = 0.000	P> z = 0.000

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations using the STATA software

6.4 Discussion of Results

Naturally, the estimation results vary across estimation methods and the model specifications. Some specifications suggest a significant effect of an explanatory variable, while others do not. Moreover, the magnitude (and sometimes even the sign) of individual effects differ across estimations.

Table 6.9 shows the minimum and maximum values of the estimated parameters (in case of significance on at least 10% level). The effects of the core gravity variables (GDPs and distance) correspond with the literature. GDP of a partner country has approximately positive unitary elasticity, as suggested by Bacchetta et al. (2012). We expected a slightly larger effect of German GDP, as proposed by the authors. However, 0.88 is close to unitary elasticity. We have proven a negative unitary elasticity of bilateral distance. An adverse effect of the Exchange Rate Deviation Index holds. We have confirmed our expectations that Germany would export more to a country with stable exchange rate. Population serves as a proxy for openness. We have empirically proven that small countries tend to be more open. The Rose (2000) effect suggests that two countries using the same currency trade more than countries with own currencies. On one hand, we have proven a positive effect of the currency union on trade. However, the effect is not as large as Rose (2000) proposed. This finding is in line with the study by Havránek (2014). On the other hand, we are surprised to estimate a negative and significant effect of this variable.

The aim of this thesis is to focus on the effect of institutions. We propose that institutions have a strong effect on German exports. More specifically, we have shown that if a country increases its government effectiveness index or property rights index by 1%, German exports to the country will grow by as much as 2%. When the fiscal freedom index grows by 1%, the exports of Germany may increase by 1.3%. The biggest effect on German export shows the government spending index with the elasticity of 2.4.

Contrary to our expectations, we show that monetary freedom and education index have negative effect on the export of Germany. Year 2008 dummy has a positive effect on German export, while the recession years 2009 and 2010 have negative impacts on exports.

Table 6.9 Summary of results

VARIABLE	MIN	MAX
logyjt	0.701	1.108
logygt	0.346	0.88
logdgj	- 1.106	- 0.69
logerijt	- 0.482	- 0.101
logpjt	- 0.424	- 0.396
cijt	- 0.0903	0,153
tijt	- 0.0954	0.0313
gjt	0.00691	0.0202
edu	- 0.00626	- 0.00401
fis	0.00318	0.0131
pro	- 0.00613	0.02
gov	0.00282	0.0239
mon	- 0.0111	- 0.104
tdummy08	0.0703	0.0971
tdummy09	- 0.171	- 0.0699
tdummy10	- 0.132	- 0.0258

Every method has advantages and distadvantages. The OLS method is simple. It predicts the log of export (in our case) with a set of variables, where the continuous are as well in the log form. This is easy for interpreting the results as the estimated parameters represent elasticities. However, it suffers from the loss of information due to eliminating zero trade flows and yields biased coefficients in the presence of heteroskedasticity (Santos Silva and Tenreyro, 2006). Despite this, we have noticed quite satisfying results in the terms of magnitude and sign of the estimated parameters (those that are statistically significant on at least 10% level). Moreover, the RESET test fails to reject the null hypothesis of no omitted variables. The panel fixed effects method is simple and controls for unobserved heterogeneity. The drawbacks are that it eliminates zero trade flows, it yields sample selection bias and is suffers from the

loss of information due to the drop of variables that are constant over time. Therefore, it is not possible to estimate parameters of time-invariant variables, such as bilateral distance. (Bachcetta et al, 2012). However, the estimated parameters using the panel FE method are quite satisfying in terms of their signs and magnitudes (with one exception, when the effect of currency union is negative and significant). The RESET test fails to reject the null of omitted variables.

The Poisson Pseudo Maximum Likelihood estimation (PPMLE) method deals with the problem of missing trade and provides unbiased estimators in the presence of heteroskedasticity. (Westerlund and Wilhelmsson, 2009) The drawback is that it does not account for endogeneity. As far as the results of our empirical analysis, the PPMLE yields satisfying results. Among other, the Rose (2000) effect has been proven, proposing the positive effect of currency union on trade. A strong and positive impact of government effectiveness was estimated. However, the RESET test rejects the null hypothesis and suggests a presence of omitted variables.

Egger (2004) proposed using the Hausman-Taylor estimation method in the presence of endogeneity. Next to the advantage of taking into account possible correlations of some explanatory variables with the unobserved effects, it is also able to estimate parameters of time-invariant variables. When it comes to our analysis, the H-T estimator yields overall nice results. The parameter of distance is very close to negative unitary elasticity. Moreover it suggests a strong evidence of a positive impact of fiscal freedom, property rights, and monetary freedom institutional variables. Their elasticities vary between 0.28 and 0.58, which is more moderate, yet very significant, than in the case of Poisson estimation (elasticity of government effectiveness is 1.8). Moreover, the RESET test fails to reject the null hypothesis of omitted variables.

We have tried to address the endogeneity of institutions with the IV regression. Moreover, we use the lag identification strategy, where we instrument the endogenous explanatory variables with their lags. We argue that this method has several drawbacks and only few, if any, advantages. We have performed the

overidentification test with satisfying results – the linear 2SLS model is specified correctly. Moreover, we can assume the same for the FE IV model (since we have proved it for the country effect linear 2SLS). However, we reject the null hypothesis that our estimates are valid and realize that our model is specified incorrectly in the case of Poisson IV estimation. We checked the validity of instruments by the correlation analysis with satisfying results (lags of institutions are naturally highly correlated with institutions). Nevertheless, we can only assume that endogeneity of institutions holds. Looking at the results, this method yields the least satisfying estimates of all. Unexpected effects of variables on German exports (such as negative effect of monetary effectiveness, positive effect of trade barriers, or negative effect of property rights), together with the unsecurity of the model specification described above, suggest that lags of explanatory variables are poor instruments.

7 Conclusion

This thesis has analyzed determinants of German trade, based on a gravity model approach. We have provided a theoretical concept for gravity models and discussed several studies that used this concept for explaining trade flows. Moreover, we have shown that the methodology of gravity models can be applied to various research topics, such as international trade or economic growth. We have discussed common issues of gravity models (zero trade flows and the problem of endogeneity) and possible methods to address them. Luckily, our data set does not contain zero trade flows. However, there is a strong assumption that institutions are endogeneous. Based on a gravity model theory, we have derived a gravity equation of German exports enlarged by institutions.

The results of empirical analysis are more or less in line with the literature. We have verified the positive unitary elasticity of partner's GDP. The German GDP has a slightly lower elasticity, but it is also very significant in all types of estimations. The estimated parameters of distance suggest that Germany concentrates its exports with its nearer trading partners.

The main interest of this thesis is to estimate the effect of institutions. Moreover, we have focused on a proper estimation technique. The results are carefully interpreted while using various gravity model approaches. We argue that institutions have a great impact on German export. However, not all types of institutions matter to the bilateral trade in the same way. More precisely, we have proved a significant positive effect of government effectiveness, fiscal freedom, property rights and government spending on German export. Surprisingly, not only we failed to prove a positive effect of education index and monetary freedom, but we have estimated a significant negative effect of these two variables.

We have discussed drawbacks as well as benefits of each estimation approach that we used. Together with the results of empirical analysis, we argue that the Hausman and Taylor method is advisable for addressing endogeneity and the problem of log-linear transformation. Moreover, we argue that lags are possibly poor instruments for endogenous explanatory variables.

The suggestion for a further research would be combining gravity estimates with trade policy experiments in order to calculate implicit welfare changes.

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Appendix: List of partner countries

AFGHANISTAN	EGYPT	LEBANON	ROMANIA
ALBANIA	EL SALVADOR	LESOTHO	RUSSIA
ALGERIA	EQUATORIAL GUINEA	LIBERIA	RWANDA
ANDORRA	ERITREA	LIBYA	SAN MARINO
ANGOLA	ESTONIA	LIECHTENSTEIN	SAUDI ARABIA
ANTIGUA AND BARBUDA	ETHIOPIA	LITHUANIA	SENEGAL
ARGENTINA	FAROE ISLANDS	LUXEMBOURG	SERBIA
ARMENIA	FIJI	MACAO	SEYCHELLES
AUSTRALIA	FINLAND	MACEDONIA	SIERRA LEONE
AUSTRIA	FRANCE	MADAGASCAR	SINGAPORE
AZERBAIJAN	FRENCH POLYNESIA	MALAWI	SLOVAKIA
BAHAMAS	GABON	MALAYSIA	SLOVENIA
BAHRAIN	GEORGIA	MALDIVES	SOUTH AFRICA
BANGLADESH	GHANA	MALI	SOUTH KOREA
BARBADOS	GREECE	MALTA	SPAIN
BELARUS	GREENLAND	MARSHALL ISLANDS	SRI LANKA
BELGIUM	GRENADA	MAURITANIA	ST VINCENT
BELIZE	GUATEMALA	MAURITIUS	SUDAN
BENIN	GUINEA	MEXICO	SWAZILAND
BERMUDA	GUYANA	MOLDOVA	SWEDEN
BOLIVIA	HAITI	MONGOLIA	SWITZERLAND
BOSNIA AND HERZEGOVINA	HONDURAS	MOROCCO	SYRIA
BOTSWANA	HONG KONG	MOZAMBIQUE	TAIWAN
BRAZIL	HUNGARY	MYANMAR	TAJKISTAN
BRUNEI	CHAD	NAMIBIA	TANZANIA
BULGARIA	CHILE	NEPAL	THAILAND
BURKINA FASO	CHINA PR	NETHERLANDS	TOGO
BURUNDI	ICELAND	NEW ZEALAND	TRINIDAD AND TOBAGO
CAMBODIA	INDIA	NICARAGUA	TUNISIA
CAMEROON	INDONESIA	NIGER	TURKEY
CANADA	IRAN	NIGERIA	TURKMENISTAN
CAYMAN ISLANDS	IRAQ	NL. ANTILLES	UGANDA
COLOMBIA	IRELAND	NORTH KOREA	UKRAINE
CONGO	ISRAEL	NORWAY	UNITED ARAB EMIRATES
CONGO, DR	ITALY	OMAN	UNITED KINGDOM
COSTA RICA	JAMAICA	PAKISTAN	UNITED STATES
COTE D'IVOIRE	JAPAN	PANAMA	URUGUAY
CROATIA	JORDAN	PAPUA NEW GUINEA	UZBEKISTAN
CTL AFRICAN R.	KAZAKHSTAN	PARAGUAY	VENEZUELA
CUBA	KENYA	PERU	VIETNAM
CYPRUS	KUWAIT	PHILIPPINES	VIRGIN ISLANDS
CZECH REPUBLIC	KYRGYZSTAN	POLAND	YEMEN
DENMARK	LAOS	PORTUGAL	ZAMBIA
DOMINICAN REPUBLIC	LATVIA	QATAR	ZIMBABWE
ECUADOR			