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MASTER'S THESIS

Factors Determining Czech Export on Different Aggregations with Focus on Electrical Engineering: Gravity Model Approach

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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, May 11, 2015

Signature

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Abstract

The thesis provides a quantitative analysis of the Czech export with a further focus on the electrical engineering and on the electric motors and generators. The tool used for the analysis is the gravity model of the international trade, and the estimation method employed is the PPML estimator. The novelty of the research lies in a one country export analysis, and in a comparison of the export functions on three different aggregations and for two states (the Czech Republic and France). The panel data analysis of the period between 1995 and 2013 reveals that the Czech Republic was more export-driven than France, an unanticipated fact about a dissimilarity of the total and the machinery and transport equipment export functions of the Czech Republic, and a statistically nonsignificant influence of the euro on the Czech export. The one year analyses of 1995 and 2013 reveal an increasing importance of the distance and the partner's GDP on both countries' exports, and a non-importance of the partner's EU membership and of the geographic location in the CEE on the Czech export.

JEL Classification	C13, C23, F10, F12, F14
Keywords	determining factors of export, gravity models of trade, Czech Republic, electrical engineering

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Abstrakt

Práce se zabývá kvantitativní analýzou českého exportu se zaměřením na elektrotechniku a na elektromotory a generátory. Analýza je provedena pomocí gravitačního modelu mezinárodního obchodu, parametry modelu jsou odhadnuty metodou PPML. Inovativnost práce spočívá v analýze exportu pro jednu domovskou zemi a ve srovnání funkcí exportu na třech různých agregací a pro dva státy (Českou republiku a Francii). Z dat mezi lety 1995 a 2013 je možné Českou republiku ve srovnání s Francií označit za více exportně orientovanou zemi. Za povšimnutí dále stojí významně se lišící funkce celkového exportu a funkce exportu strojů a dopravních prostředků České republiky a statisticky nevýznamný vliv eura na český export. Průřezová analýza exportní funkce

pro roky 1995 a 2013 ukazuje rostoucí význam vzdálenosti a HDP partnera na celkový export České republiky i Francie. Členství v EU a geografické umístění zemí ve střední a východní Evropě nejsou významné faktory, které by ovlivňovaly vývoj českého exportu.

Klasifikace JEL	C13, C23, F10, F12, F14
Klíčová slova	determinanty exportu, gravitační modely obchodu, Česká republika, elektrotechnický průmysl

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Résumé

La thèse repose sur une analyse quantitative des exportations tchèques avec un accent sur le génie électrique et sur les moteurs et générateurs électriques. L'outil d'analyse utilisée est le modèle de gravité du commerce international, et la méthode d'estimation est l'estimateur PPML. L'originalité de ce travail réside dans une analyse de l'exportation d'un pays seulement, et dans une comparaison des fonctions d'exportation sur trois agrégations différentes et pour deux Etats (la République tchèque et la France). L'analyse des données de panel entre 1995 et 2013 révèle que la République tchèque était plus axée sur les exportations que la France, un fait inattendu basé sur la différence de la fonction d'exportation totale, de celle des machines et de celle des équipements de transport de la République tchèque. Ceci s'explique également car l'euro a une influence non significative sur les exportations tchèques. Les analyses de section transversales (année par année) de 1995 et 2013 révèlent une importance croissante de la distance et du PIB du partenaire sur les exportations des deux pays, alors que l'adhésion à l'UE du partenaire et l'emplacement géographique dans la CEE n'ont pas d'influence sur les exportations tchèques.

JEL Clasification	C13, C23, F10, F12, F14
Mots clés	facteurs déterminants de l'exportation, modèles de gravité du commerce, République tchèque, ingénierie électrique

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Acronyms

CEB Czech Export Bank

CEE Central and Eastern Europe

CEPII Centre d'Etudes Prospectives et d'Informations Internationales

CMEA Council for Mutual Economic Assistance

CZK Czech Koruna

CZS Czechoslovakia

CZSO Czech Statistical Office

EGIC Export Guarantee and Insurance Corporation

EMU European Monetary Union

ERDI Exchange Rate Deviation Index

EU European Union

EU28 European Union 28

EUR euro

FE fixed effects

FSU former Soviet Union

GDP gross domestic product

GDP PPP gross domestic product at purchasing power parity

IMF International Monetary Fund

NATO North Atlantic Treaty Organization

NEG new economic geography

NLS non-linear least square

OECD Organization for Economic Co-operation and Development

OLS ordinary least square

PML pseudo-maximum likelihood

PPML Poisson pseudo-maximum likelihood

SITC standard international trade classification

UN United Nations

USD United States Dollar

USSR Union of Soviet Socialist Republics

VIF variance inflation factor

WTO World Trade Organization

Master's Thesis Proposal

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Motivation: The thesis focuses on the analysis of Czech export and the determination of different factors influencing its volume. The analysis, evaluation and recommendations are based on the comparison with France. France was chosen because of its geographical proximity and similarity to some extent on one hand, on the other hand, because of its relatively large market in comparison with the Czech one. The thesis concentrates on the electrical engineering; special attention is given to the electric motors. The gravity model of international trade is used for the trade flow estimations. The analysis is done using data on 60 countries from period between 1995 and 2014.

The data, methodology and current state of the economies and the sector is described before the analysis is done. The analysis firstly concentrates on the whole economies, after, on the electrical engineering, and finally on the specific product, the electric motors. Based on the results from the models, the evaluation of the export is done and further the indication of opportunities for the Czech exporters as well.

Hypotheses:

1. There is statistically significant and positive effect of regional trade agreements on the trade between the states.

2. There is statistically significant and positive effect of the real interest rate on the trade between the states. This is an important difference

between France and the Czech Republic in connection with the European Monetary Union (EMU) states. (The real exchange rate is included in the same way as Martinez-Zarzoso & Nowak-Lehmann (2003) included it.)

3. There is statistically significant and positive effect of the trade flows in the previous year on the current trade between the countries.

4. In spite of the fact that both states, France and the Czech Republic, share borders with Germany, the volume of trade flows between France and Germany is larger than between the Czech Republic and Germany. This might be caused by the size of French market and the length of common borders.

Methodology: The analysis consists of three models. The first one is the most general and it is connected with the economy as a whole, after the model including electrical engineering follows, and the last one is the most detailed, it considers the specific product. The gravity model of international trade is used to estimate all the previously mentioned models. All the estimations are done using the Poisson pseudo-maximum likelihood estimator.

Some more variables are added to the general gravity model, where the trade flow between the two countries depends on GDPs and their distance. The additional variables are the membership in some international organizations or existence of some international agreement between the states, real exchange rate, trade flows in the previous year, common borders, etc. Based on the particular coefficient (its sign and statistical significance) all the above mentioned hypotheses are tested.

The main guideline for the empirical part is the theoretical base that is relatively wide. Van Bergeijk & Brakman (2010) described the development of the model, its challenges and possible applications. Silva & Tenreyro (2006) recommend the Poisson Pseudo-maximum likelihood estimator to be the most suitable estimation technique for the gravity model of international trade.

Outline:

1. Introduction
2. Theoretical Background and the Review of World Literature
3. Description of the Sector in Both States
4. Methodology Description

5. Data Description
6. An Analysis of Exports Using the Gravity Model
   (a) General Analysis of the Economies
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7. Evaluation of the Results
   (a) Comparison of the Theoretical and Real Results
   (b) Comparison between the States
   (c) Recommendations for the Czech Exporters
8. Conclusions
9. References / Bibliography

Expected Contribution: Many authors have been using gravity model as a tool for analysis of the international trade. Many authors were dealing with the influence of trade agreements in general (Carrere (2003)), many others investigated the EU influence from many different points of view (Fink (2009)), Dascal et al. (2002)), and some others investigated consequences of new member entrance into some organization (Gencer (2012)). However, there is not so much literature evidence dealing with comparison of two states, which will be one of challenges for the thesis. Another challenge follows Bergeijk & Brakman (2010), who highlighted the need for sectoral and product group analysis.

The French-Czech comparison gives new insight from two sides. From the comparison side, as the comparison of two states is not so common in the gravity model analysis, and from the states choice side. Both states have been mentioned in context of European Union (Fink (2009)). Moreover, the Czech Republic has been analysed as a part of Central and Eastern Europe and transition (Bussière et al. (2005)), or as a part of 2004 enlargement (Paas (2002)). However the analysis of the states as individuals is missing.

Further, the topic focuses on one of van Bergeijk & Brakman (2010) challenges, the need for the analysis on the disaggregated level, both on the firm level and on the product group level. This kind of analysis is not so common, but it enables the gravity model to keep pace and to answer current issues. Our aim is to determine whether and how the elasticities differ on particular aggregations (total, industry and product) and try to find possible explanations.

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Author Supervisor

Chapter 1

Introduction

What have been the main factors influencing the Czech export in the recent years? How did these factors change when focusing on a specific industry or even further on a specific group of products? Are we really able to better describe export on more aggregated level? What does the comparison of the Czech export function with the French one corroborate? Had the European Union (EU) membership comparable influence on the Czech and on the French export? What about the euro, was it more influential for the French export (as differently from the Czech Republic, France is the eurozone member)? And finally, how did the factors influencing the export differed between 1995 and 2013? All these questions, and not only, will be quantitatively analyzed in our research.

The thesis deals with the Czech export analysis on three different aggregations, the total, machinery and transport equipment and electric motors and generators export. The research is enriched by the same analysis for France, which enables us another means of comparison. The main part of the research lies in the panel data analysis of the period between 1995 and 2013. In the very end, we add also one period estimations. We focus on the first and on the last year of our analysis, which we suppose to give us interesting results mainly for the Czech Republic (because of the communist history and other changes).

The tool selected for the analysis is the gravity model of the international trade. The model has been used for decades to describe flows between any two transacting agents based on their masses, and the distance between them. Differently from the commonly used approach, we apply the model on a one

country's data, and we obtain the results for the export function valid only for that single home country. Generally, the model is applied on the bilateral trade flows of all the participating countries, and the result is the trade function valid on average for all the participants.

We begin with the review of the world literature in Chapter 2 (Review of World Literature). We discuss the new economic geography (NEG), a useful tool for the real economic distance approximation. After, we move to the Poisson pseudo-maximum likelihood (PPML) estimator and, both, authors supporting and criticizing it as the most appropriate estimation tool. After, we reveal another trend in the gravity model estimation, the panel data use. We also add few comments on the microeconomics foundation of the gravity model and especially on the multilateral resistance. As last but not least, we focus on one country analysis in the gravity equation.

Chapter 3 (Czech Position: International Trade and Industry) provides a very extensive and detailed description of the Czech industry and international trade, which helps us to better understand our later results. The Czech Republic is a small open economy located in the Central Europe. It is an export driven economy with a large share of the export going to Germany. It has gone through a rich history influencing its industrial orientation and international trade. Recently, it has been influenced mainly by the EU entrance and membership.

In Chapter 4 (Model), we focus on the gravity model from the theoretical point of view; its origin, history and an appropriate estimator. The gravity model of the international trade was mathematically formulated in 1962 by Tinbergen. However, the idea of the trade between two clusters being determined by the economic sizes of the clusters and their distance is much older. Initially, there was a problem with not sufficient economic foundation of the model, which is, however, no more actual. Further, we show the theoretical inappropriateness of the ordinary least square (OLS) estimator for the gravity equation. It is not able to deal with zero trade values and with heteroscedasticity. PPML estimator shows up to be an advisable method in general. Moreover, in the very beginning of Chapter 6 (Results), we show that the choice of the estimator matters (speaking of the Poisson and the linear estimation). We estimate the same export function by the linear and by the Poisson estimator. We do it for the total Czech export and for the total French export. Both comparisons detect noticeable differences depending on the estimator.

In Chapter 5 (Empirical Framework), we describe the data, variables and

concrete models and estimation methods of our research. The research covers period of 19 years between 1995 and 2013. To be able to compare the export functions on different aggregations, we estimate three models for both countries (the total, machinery and equipment and electric motors and generators export function). The one period models (of 1995 and 2013) were estimated only on the total export level in order to maintain our research uncluttered. Concerning the choice of the variables, we follow the approach of the endogenous theory of growth. We try to incorporate all the factors possibly influencing the trade including traditional economic and geographic factors of the gravity models taking into account also the less common ones, the institutional variables or the recession dummy.

Chapter 6 (Results) reveals the estimation results, comments them, compares the differences between the countries and aggregations and tries to find possible causes. However before all that, statistical assumption violation tests are run, and depending on their results respective adjustments are done. Moreover, for the panel data analysis, the Hausman specification test is run to decide between the fixed and the random effects model.

After the short note on the linear and on the Poisson estimator, we move to the core part of our estimation. The main part of our research lies in the comparison of the export functions on the total, machinery and transport equipment and electric motors and generators levels of the Czech Republic and of France. We use the character of our data, and the estimation is done using the panel data analysis. The Hausman test indicates to use the fixed effects model. By clustering the standard errors in states, we obtain results indicating the generalized driving factors behind the decisions of the exporters (the Czech Republic and France).

For the French export, the results reveal common trend. We are more able to predict the results on the higher aggregation. R-squared is decreasing with the disaggregation, and moreover, we have less statistically significant variables and some of them had an opposite effect we would expect for the electrical motors and generators export model (the lowest aggregation of our research). For the Czech Republic, we did not expect such a similarity of the export functions for the total and electric motors and generators (the highest and the lowest aggregation of our research), and the difference of the machinery and transport equipment export function. Machinery and transport equipment represents a large share of the Czech export, so we would expect it to be determined by similar factors as the total export.

The Czech export was more influenced by its own gross domestic product (GDP) than France, revealing that Czech GDP was much more export-driven than the French one, pointing to a possible reversed causality between the Czech GDP and the exports. On the other hand, French export was more sensitive to the partner's GDP changes.

Factor having had a similar influence on the both countries' export was the partner's market size (approximated by its population). In the Czech Republic, it was becoming unimportant with the disaggregation. In France, its influence was becoming even statistically significant and negative. In connection with the EU and euro, we anticipated them to be statistically significant in more cases. The EU membership was significant only for the French electric motors and generators export, and for the Czech machinery and transport equipment export. We see a possible reason in an existence of a special agreement. Euro was significant only for the total French export, and moreover, it had an opposite effect we would have expected (negative). For the negative effect we see possible reasons in the recent euro crisis, the tendency to diversify, or the trade with EU members not having the euro or with countries having colonial ties with France (that are not the EU members). For the nonsignificance on the future disagregations and for the Czech Republic we see possible reasons in the specificity of the product (the export depends rather on specific conditions and agreements than common currency), and on France being more influenced by the eurozone (as the Czech Republic is not a member)

In the very end, we add one more comparison. We estimate the total export functions for 1995 and 2013 for the both countries, and we try to see whether the variables influencing the trade differed between the years.

In contrast to our anticipations, we do not see as many differences between the Czech Republic and France as we would expect. The trend of the core variables, partner's GDP and distance, was similar, their importance increased. The effect of the partner's market size decreased between 1995 and 2013, specific needs of the market might have become more important than its size. Some cultural, geographic and institutional distance variables had a larger effect we would have expected. The EU membership had a statistically significant effect only in the French export model for 1995, we found several possible explanations. The nonsignificance of the EU membership for the Czech export might have been caused by a closer French relationship with the EU from the beginning. Possible cause for the nonsignificance in 2013 in France is the euro crisis or the tendency to diversify. Finding that undoubtedly worth highlight-

ing is the unanticipated statistical significance of the Austro-Hungarian Empire dummy in 1995, and at the same time, the nonsignificance of the Central and Eastern Europe (CEE) in any of the years in the Czech Republic.

In Conclusion we review the results and the research as a whole. Further, we highlight the main contribution our thesis, namely its novelty in one country export function analysis, and in comparison of the function between countries and aggregations. We also admit the existence of alternative estimators for the gravity model. However, we suppose a detailed analysis of possible estimation methods to be beyond the scope of our research.

The detailed study of literature and quantitative analysis of the Czech export bring us interesting and sometimes unexpected results about its functioning. Thanks to that, we were able to uncover facts and implications that are far beyond the intuitive outlook we had before we started with the research. Gravity model of the international trade shows up to have a large explanatory power, and to be simply applicable and explicable. Moreover, it shows up to be much more than a simple tool for the export determination.

Chapter 2

Review of World Literature

Gravity model of the international trade is a widely used tool for the international trade analysis. Many authors appreciate its explanatory power, it is able to describe up to 70% of variation in the international trade flow (Bergeijk & Brakman (2010), Linders & Groot (2006)), and flexibility. Many of them suppose the gravity model to be the workhorse for the international trade analysis (Bergeijk & Brakman (2010)). As you will see later on, the tries to improve the estimation quality have led to often discussions and different opinions on the appropriate estimation tool and a way of estimation.

In the following paragraphs, we discuss the choice of the independent variables, the most appropriate estimator, panel data and microeconomics theory behind the model. In the very end, we add few comments on the novelty of our research.

2.1 New Economic Geography

As Bergeijk & Brakman (2010) highlighted, economics is not physics and the physical distance is not able to capture the economic distance. Very useful tool for the economic distance approximation is so called new economic geography. Paas (2002) even denoted the NEG to be one of the sources of the theoretical foundation of the gravity model (next to the microeconomics foundation and the trade theories).

New economic geography is a concept describing "the intra-regional relationship and their influence on the behavior of individual units" (Paas (2002), pg. 7). NEG in the international trade is not a recent concept. For illustra-

tion we can name Reilly (1929), Steawart (1948), Isard (1954), or Fujita *et al.* (1999), who used it.

The importance of the distance approximation is more than apparent, so the question is not the inclusion or non-inclusion of the new economic geography. The question is the fit of the gravity model and the NEG into some economic theory, and the variables used for the NEG inclusion. Bergeijk & Brakman (2010) provided different approaches to the gravity model covering different ways of inclusion of the new economic geography.

The variables used for the NEG inclusion differ with author, and consist of both, variables of economic and non-economic character. There are variables that are used very often and by the vast majority of the authors. There are also variables that are not so often used, because they are specific for some particular region (state), or are not supposed to be so important. As you will see hereinafter and in more details in Empirical Framework (Chapter 5), we include both.

The European Union (or any other organization, depending on the geographic location) membership is undoubtedly one of a very common and very often used NEG variable. It is one of the variables that serves not only as one of the factors influencing and determining the trade flow. The gravity model and the trade agreement existence can be used for an analysis from a slightly different perspective. The original purpose of the gravity model is the volume of trade in the center of attention, and the determination of all the factors influencing it. However, we can put the trade agreement existence in the center of our attention, and determine only whether the introduction of the agreement influence the trade. Carrere (2003) analyzed the influence of the trade agreements in general, GOV.UK (2013) focused on the EU membership, and Fink (2009) investigated the EU Single Market Program influence on a deeper integration.

Also the cultural variables resulting from the common history are common and usually significant. We can name a common language variable (that is used mainly in connection with Spanish, French or English, which is also partially connected with the colonial history), or directly the colonial history inclusion (Melitz (2007)).

History can be accounted for by different variable as well (which is useful mainly for states with no colonial history), for example using common political history with some group of states. Common communist history seems to be interesting from this point of view, there are many researchers interested in the

CEE integration. Bussière *et al.* (2005) commented on the rapid integration of the Central and Eastern Europe in 1990s, and analyzed and judged its future integration with the European Union. Paas (2002) focused directly on the eastward EU enlargement. Blürhart & Kelly (1999) were more specific and analyzed the trade flows between the Central and Eastern Europe and Ireland.

Other commonly used independent variables are the common currency existence (for example Glick & Rose (2002)), or borders sharing, and landlockness.

Variables that are not so common but have had a rising importance are for example the institutional variables (Groot & Linders (2004) or Baltagi *et al.* (2003)), and the recession variable (Bobková (2012) or Davidová & Benáček (2014)).

2.2 Poisson Pseudo Maximum Likelihood Estimator

Traditional base for the gravity model estimation is its log-linearized version and a simple OLS estimation. However recently, many authors have been highlighting its inability to deal with zero trade values and heteroskedasticity. Unfortunately, both problems are very typical and common for the trade data (Herrera & Baleix (2009)).

The inability to deal with the heteroskedasticity is an implication of a well known Jensen's inequality, $\mathbb{E}(\ln y) \neq \ln \mathbb{E}(y)$. This was in details shown by Westerlund & Wilhelmsson (2009) or by Silva & Tenreyro (2006). Shepherd (2013), moreover, added that we are not able to remove this kind of heteroskedasticity by simple model adjustments.

The second problem, the inability of the log-linearized model to deal with the zero trade values, is caused by the fact that the logarithm of zero is not defined. While estimation, the zero values are usually automatically dropped, which, as highlighted by Shepherd (2013), causes a sample selection bias. There are alternative ways how to treat it, use the Tobit estimator or modify all the flows in a same way (for example add 1 to all of them). However, according to Silva & Tenreyro (2006) or Linders & Groot (2006), there is no reason to believe that this bring us a consistent estimator.

In connection with the above mentioned shortcomings, discussions about the most suitable estimator has been arising. Undoubtedly, one of the most influential researchers in this field is Silva & Tenreyro (2006), who introduced

the PPML estimation of the multiplicative version of the gravity model to be the best choice in general.

They were not comparing only the OLS and the PPML, they also added other possibly suitable estimates. Basically, they found the multiplicative form of the gravity model to be much more advisable than the log-linearized version, and were trying to find the most suitable estimator for it. By comparing the non-linear least square (NLS), the gamma pseudo-maximum likelihood (PML) and the PPML, the PPML estimator turned out to have low demands, and to be consistent under a wide range of heteroskedasticity. As they pointed out, the gamma PML gives an excessive weight to the observations prone to the measurement errors, and the NLS focuses more on the noisier observations. In 2009, ao Santos Silva & Tenreyro (2009) confirmed their previous findings (from Silva & Tenreyro (2006)) under even less restrictive conditions, under assuming a frequent presence of the zero trades values.

On the contrary, Martínez-Zarzoso (2013) or Martin & Pham (2008), suggested alternative estimators that were in their opinions able to better deal with both problems, the zero trade values and the heteroskedasticity, than the previously mentioned PPML estimator. From the alternative estimators we can name the Tobit models, the truncated OLS or the Heckman selection estimator.

However, Silva and Tenreyro insisted on the PPML suitability, and seem to have a relatively strong support from researchers. Siliverstovs & Schumacher (2007), Bobková (2012) or Westerlund & Wilhelmsson (2009) confirmed the PPML from the theoretical point of view, and many others have continued using it in the application (Davidová & Benáček (2014)).

2.3 Panel Data

Panel data analysis has been recently raising popularity among researchers for the gravity model estimation. As Wooldridge (2010) indicated, the panel data analysis, that evolve measurement of several characteristics over time, is suitable for the data that are both cross-sectional and time series. The panel data analysis is able account for a heterogeneity among countries (Bobková (2012)), and provides us a wider and a less restrictive view (Mátyás & Harris (1998)). The two dimensions (cross-sectional and time series) also provide more observations, which together with the previously mentioned advantages ensures less biased estimates (Wooldridge (2008)).

The crucial issue we have to take in mind in the panel data modeling,

is that there is no reason for observations to be independent across time (as Wooldridge (2008) highlighted). In the other words, unobserved factors that were influencing the export in 1995, might have influenced the export in 2013 as well. To deal with the time-constant unobserved attributes, we can employ fixed or random effects.

There are both, researchers employing the fixed effects model (Westerlund & Wilhelmsson (2009) or Rose & van Wincoop (2001)), and researchers employing the random effects model (Peridy (2005) or Carrere (2003)) in the panel data analysis of the gravity model. However, the theory is more prone to the fixed effects (at least in general). Wooldridge (2008) highlighted that the data on states cannot be supposed to be randomly selected, so the unobserved effects are rather to be estimated (for example by using different intercepts) than supposed to be outcomes of a random variable. Westerlund & Wilhelmsson (2009) added an argument supporting the fixed effects model use in the multiplicative form of the gravity model (which is the main form of the model in our research). They pointed out that the unobserved effects are generally correlated with the explanatory variables in the multiplicative form. However, as you will see, the choice is not the matter of theory but the matter of the testing on the specific data.

2.4 Microeconomics behind the Gravity

Not only the estimation itself but also the theory behind the gravity model has been recently (and not only) widely discussed.

The early stage of the model, its mathematical formulation by Tinbergen (1962), was followed by the waves of criticism. That time, the model was based rather on a common sense than on the economic theory as Bergeijk & Brakman (2010) highlighted. The model was very general as well, which allowed different interpretations of the results, Bergeijk & Brakman (2010) gave an example of the Iron Curtain fall and connected trade predictions.

These events contributed to the tries to give the gravity model a proper theoretical foundation. Anderson (1979) explained the gravity model using the Armington preferences, Bergstrand (1985) and Bergstrand (1989) derived the model from the monopolistic competition model, Helpman & Krugman (1985) and Helpman & Krugman (1990) used the increasing returns to scale, and Deardorff (1998) used the approaches based on the Heckscher-Ohlin model.

Even recently, as Davidová & Benáček (2014) stressed, there have been

many authors trying to derive the gravity equation from various theories. So the fear about a not sufficient theoretical foundation is no more actual.

One of the most influential extension of the recent years is the multilateral resistance inclusion. The idea was introduced by Anderson & Van Wincoop (2003) and further by Shepherd (2013) or by Head & Mayer (2013). In the intuitive model (the basic one), we solely rely on the inverse relationship between the trade and the distance, and the direct relationship between the GDPs and the trade (and possibly on the influence of some other factors like the NEG variables). However, the intuitive model totally ignores a possibility of the trade between a country and its partner to be influenced by changes in the trade cost between the country and any other partner, the relative price effect. If the trade between country A and B becomes more expensive, it can enhance the trade between country A and C, even if the trade cost between A and C remains the same. As Anderson & Van Wincoop (2003) stressed, the non-inclusion of the multilateral resistance terms (as in the case of any other relevant variable), can lead to the omitted variable bias problem.

To solve the problem Anderson & Van Wincoop (2003) derived the gravity model including the multilateral resistance variables. They used the basic idea of the gravity relation modeled as a demand function with the constant elasticity of substitution and the utility increasing in variety and volume. Considering production, each firm produced a single unique product (which ensured variety), it was enjoying the increasing returns to scale, and the number of the firms was supposed to be large enough to ensure the competitive environment. Producer could sell goods both locally (with no transport cost) or internationally (with transport costs).

Using these assumptions and the aggregation of the separate firms, they got a model with two new terms, the multilateral resistance terms. They included the outward multilateral resistance, capturing the fact that the export from the country i to the country j depends also on the trade costs in all other countries (possible importers), and the inward multilateral resistance, capturing the fact that the import from the country i to the country j depends also on the other possible importers (where i stands for the home country and j stands for the partner).

Regarding the recent trends and increasing popularity of the panel data in the gravity models estimation, Baldwin & Taglioni (2006) extended the previous idea for the panel data use (as the previous version was applicable only on the cross-sectional data). Using the example of a currency union trade

effect, they showed the inclusion of the multilateral resistance by importer and exporter dummies interacted with time dummies.

2.5 One Country Focus

Differently from our analysis, the gravity models are more commonly applied on a bilateral data of all the trading partners. The estimated model is then valid for all the participants. Our model is estimated from a one country point of view, and valid only for this country. Basically, we have the home country and the data on exports from this country to the rest of the world.

Exactly the same was analyzed by Davidová & Benáček (2014), who applied this approach on the data on the Austrian export. They also provided a short explanation why the suppose this attitude to be "more concrete and realistic, and less misleading in interpretation" (Davidová & Benáček (2014), pg. 6). By analyzing the export function valid for all the participating countries, we get an idea about the export on average. However, the impact of for example the distance on the Czech export might be different than the impact of the distance on the French export. Moreover, when interpreting the coefficients, we are not able to focus on details with the general function. When interpreting an export function valid only for a one country's export, we can take into account its political, historical or economic background.

Egger (2002) or Fidrmuc (2009) focused on the problem more from the econometric point of view. They showed that mixing all the heterogeneous countries together might cause the estimate to be biased.

One more additional note is that by analyzing the export by this approach, and so by having the data we have, we are not able (and it is also not necessary) to include the multilateral resistance. The idea of the multilateral resistance is the influence of the factors affecting the trade between a pair of states on the trade between one of these states and some other partner. This problem is beyond the scope of our analysis, as we are having the data on a one country's export.

Chapter 3

Czech Position: International Trade and Industry

The Czech Republic is a small open economy located in the Central Europe. In the past 150 years, it has gone through the Austro-Hungarian Empire era and its fall, the era of the Soviet Union influence, and the two world wars. Industrial production has been an important sector of the Czech economy since the first industrial revolution, and the international trade a crucial factor for the Czech development. This chapter points out intensive structural changes in the industry and trade that the Republic has experienced. These qualitative changes culminate in factors and changes we analyze by the gravity model in the following sections.

3.1 International Trade

The aim of this section is to describe the factors that has been influencing the Czech international trade. The section is very extensive, however, the proper understanding of the trade background will help us when describing the results of the gravity model.

The Czech international trade is strongly affected by its geographic location and recent history. The fact that the Czech Republic is an export-driven economy together with a huge share of the export going to Germany, might cause a great vulnerability. Fortunately, in the last years, the Czech export has seemed to diversify.

3.1.1 From Communism to the European Union

The Czech Republic is a small open economy located in the central part of Europe. It has been strongly influenced by its recent history. During the period between 1948 and 1989, the Czech Republic was under the domination of the communist Soviet Union, which was associated with a centrally planned economy and with a strongly restricted orientation of the trade on the Soviet Union and other communist states. However, after the fall of communism, the Velvet revolution, November 17th 1989, the Czech Republic was able to profit from its geographic location and historically favorable position. According to Michalopoulos (1999), the Czech Republic together with Slovenia were considered to be the most successful in dealing with all the consequences of transition, and to be the fastest ones in the integration. The Czech success lay in its export industries that were growing at a real rate of over 10% between 1992 and 2008.

As Janda *et al.* (2010) suggested, important steps focusing on the promotion of the Czech export were done, and important institutions supporting the international trade were created during the nineties. The first Czech (Czechoslovak) institution of such a character in 1992 was the Export Guarantee and Insurance Corporation (EGIC) providing an insurance of commercial and political risks connected with the Czech export. In 1995, it was followed by the Czech Export Bank (CEB) focusing on the financial services related to the export. The system supporting the Czech export was completed in 1997, when the Czech Trade (Czech Trade Promotion Agency) was established. The Czech Trade is

an official contact partner for the companies looking for the Czech suppliers of products, providers of services or investors.

An important moment for the Czech international trade came in 2005, when the export started to excess the import. Current account surplus has been rising since 2005 with exception of 2009, the recent crisis. In 2013, the current account surplus achieved its maximum value so far (351b Czech Koruna (CZK)). Compared to 1993, the international trade with goods rose seven times in 2013 (as CZSO (2014) reported).

The Czech Republic takes an advantage of a membership in numerous international organizations; this undoubtedly simplifies negotiation on the international level, and improves its position in the international trade. Michalopoulos (1999) supposed the international organizations membership to be a crucial factor in states development. He denoted the World Trade Organization (WTO) membership to be "an essential element, perhaps even a necessary condition for full integration in the world trading system" (Michalopoulos (1999): pg. 1); and the EU membership as an important challenge for the CEE states. In 1993, the Czech Republic became a member of the WTO; in 2004, it was a part of the first eastward enlargement of the EU. More details on the Czech Republic membership in selected international organizations are visible in Table 3.1.

3.1.2 What do the data say?

Connected with the earlier mentioned transition process, we consider the data from 1995, as from this date the Czech economy is supposed to be stabilized and the data relevant for the analysis.

Between 1995 and 2013 the Czech GDP PPP per capita grew by more than 110%, and based on the IMF estimation, it is supposed to further grow, by more than 170% between 1995 and 2019 (which might however not be very reliable).

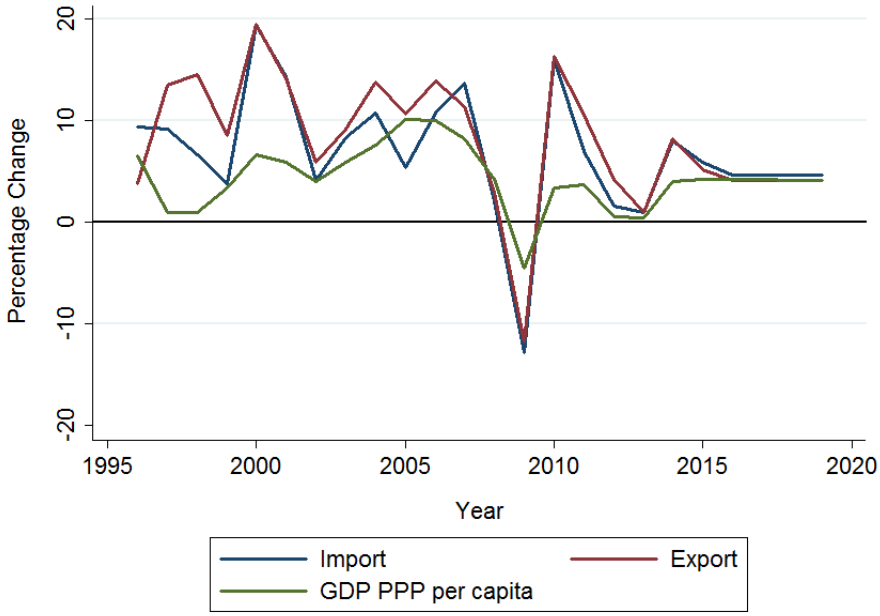
However looking closer, we have to highlight the recent crisis and the recent development that has not been so optimistic. The first highlight is the 2009 drop in GDP PPP per capita by nearly 5% (in all the other years between 1995 and 2013 GDP PPP per capita was growing). Second, we have to realize that GDP PPP per capita grew by nearly 40% between 2000 and 2005. While between 2005 and 2010 (period including the crisis), the growth slowed down to 22%. Also the IMF estimation for the following 5 years (till 2019) suggests a similar trend, the growths between 2010 and 2015 and between 2015 and 2019 are

Table 3.1: **International Organizations Membership of the Czech Republic:** Table showing selected international organizations membership of the Czech Republic (valid for 2013)

Organization	**Year of Entrance**
Asia-Europe Meeting, ASEM	2004
Asia-Europe Foundation, ASEF	2004
Bank for International Settlements, BIS	1993
Council of Europe, CE	1993
European Union, EU	2004
International Bank for Economic Co-operation, IBEC	1993
International Bank for Reconstruction and Development, IBRD	1993
International Development Association, IDA	1993
International Finance Corporation, IFC	1993
International Investment Bank, IIB	1993
International Labor Organization, ILO	1993
International Maritime Organization, IMO	1993
International Monetary Fund, IMF/WB	1993
Multilateral Investment Guarantee Agency, MIGA	1993
North-Atlantic Treaty Organization, NATO	1999
Organization for Economic Co-operation and Development, OECD	1995
Organization for Security and Cooperation in Europe, OSCE	1993
UN Industrial Development Organization, UNIDO	1993
United Nations, UN	1993
World Trade Organization, WTO	1993

Source: Ministry of Foreign Affairs of the Czech Republic.

Figure 3.1: **Czech Potential:** Figure showing percentage changes in the Czech export, import and GDP PPP per capita between 1995 and 2019, data between 2014 and 2019 are the estimates of the IMF.



Source: IMF.

estimated to be around 15%. Again, the estimation might not be correct, but the slowdown was visible also between 2010 and 2013.

The export/import trend is more or less similar. Year-on-year both of them have been growing (with the exception of the recent crisis). However, the global view indicates rather slowdown in the recent years.

More detailed information on the GDP PPP per capita, export and import of the Czech Republic are visible in Figure 3.1.

3.1.3 Top Trading Partners

Considering the Czech top trading partners, factors such as geographic distance, common history, economic prosperity of the partner or the EU membership (that ones traditionally used in the gravity model of international trade) seem to have a major influence on the Czech export. Since 1995, the Czech top 15 trading partners have consisted of the current EU member states and Russia, Switzerland, Ukraine and the United States. For better illustration see Table 3.2, showing the top 15 trading partners for 2013.

One of the main highlights from the Table 3.2 is a huge part of the export

Table 3.2: **Top 15 Trading Partners of the Czech Republic:** Table showing the Czech export to its main trading partners in 2013 in thousands of euros

Export Partner	**Export Volume**	**Share in Total Export**
Germany	38 246 890	31%
Slovakia	10 775 324	9%
Poland	7 331 091	6%
France	6 036 170	5%
United Kingdom	5 908 587	5%
Austria	5 545 806	5%
Russian Federation	4 474 242	4%
Italy	4 418 678	4%
Netherlands	3 413 633	3%
Hungary	3 177 407	3%
Belgium	3 086 940	3%
United States of America	2 660 461	2%
Spain	2 622 761	2%
Switzerland	890 474	2%
Sweden	826 217	1%

Source: Czech Statistical Office (CZSO).

going to Germany. The export allocation is not exceptional for 2013; Germany has traditionally been occupying a huge part of the Czech export, in 2013 it was 31% of the total export. Export to any other country in 2013 did not exceed 10%. Further highlights are the traditionally high share of the export to Slovakia (9% in 2013), this is with high probability connected with the Czech-Slovak common history; and a persistent presence of Russia in the top 15 trading partners (4% in 2013), which was also highlighted by Bussière *et al.* (2005).

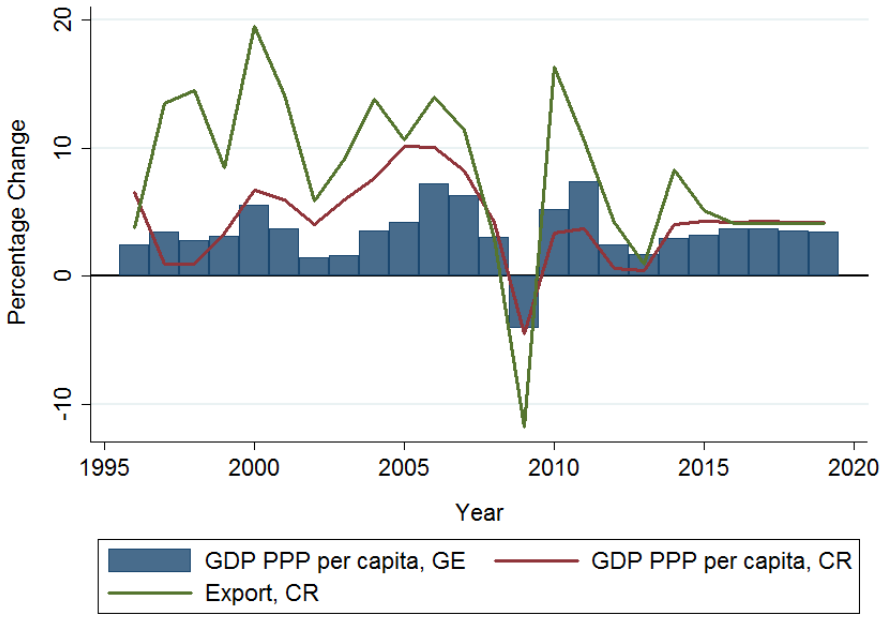
The Czech Republic is a strongly export-driven economy, which can together with the unilateral orientation of its exports lead to a huge vulnerability (the situation has been similar in the other, mainly western European countries, which led to the problems mentioned hereinafter) . During the recent crisis, the Czech Republic was severely influenced by the decrease in demand for its export articles from the western EU countries (including Germany). This consequently led to the decrease in GDP, propensity to consume and aggregated demand and overall economic slowdown. Figure 3.2 illustrates the movement of the German GDP (as the Czech biggest export partner), and of the Czech export and GDP.

Fortunately, in the last years the pattern of the Czech export has been changing in a similar way as the Austrian (Davidová & Benáček (2014)) or the Hungarian (Bussière *et al.* (2005)). The Czech Republic seems to diversify its export partners, and to be more oriented on the emerging markets. With regards to the data reported by the Eurostat, year-on-year declines in Czech export to the European Union 28 (EU28) have been rather random with the exception of the recent crisis and the last two years. This trend might be a sign and a result of the previous "to heavy orientation" of the Czech Republic on the EU market (Bussière *et al.* (2005)). The export to the EU28 declined from 84% to 81% between 2010 and 2013. The diversification is apparent also on the export to the Czech top 15 trading partners, where the decline was from 85% in 2010 to 83% in 2013, and on the export to Germany.

3.1.4 CEE and FSU Nowadays

The Czech Republic has been losing its leading position among the Central and Eastern Europe states and the former Soviet Union states in the last years. Right after the fall of communism, the Czech Republic became one of leading states of the post-communist group. With regards to the trade (export) devel-

Figure 3.2: **CR-GE Correlation:** Figure showing correlation between German GDP PPP per capita and Czech export and GDP PPP per capita between 1995 and 2019, data between 2014 and 2019 are the estimates of the IMF.



Source: IMF.

opment, it was extremely successful in transition, and in 2004, it was a part of the first eastward EU enlargement (which was however also a result of its geographic location).

Nowadays, the transition has been finished in the vast majority of the post-communist countries, and a rising part of them (speaking about the European states) was accepted, are candidate countries (Albania, Montenegro, Serbia, the former Yugoslav Republic of Macedonia), or are the potential candidate countries (Bosnia and Herzegovina, Kosovo) for the EU membership. All these factors cause the initially less successful former-communist countries to grow faster nowadays, and to catch up the initially more successful ones.

Speaking in the absolute terms, the Czech Republic is maintaining one of the highest GDP PPP per capita among the CEE and the former Soviet Union (FSU) (and it is supposed to do so also in 2019). However, between 2013 and 2019, the Czech GDP PPP per capita is supposed to grow by less than 30%, in Slovenia it is even less (less than 23%). On the other hand, in Romania or Albania, it is more than 45% (more details are visible in Table 3.3). We have to take in mind that the estimation might not be very accurate, on the other hand, the

gap is relatively huge and the recent events indicate a similar development.

Table 3.3: **GDPs PPPs of the FSU and the CEE in 2013 and in 2019:** Table showing GDPs PPPs in 2013 and in 2019 and its expected change between 2013 and 2019 of the FSU and the CEE (2019 GDPs PPPs are based on the IMF estimation, GDPs PPPs are in current international dollar, Kosovo is not available from the political reasons)

Country	**GDP PPP per capita, 2013**	**GDP PPP per capita, 2019**	**Percentage Change 2013-2019**
Albania	10 596	15 397	45%
Armenia	7 034	9 801	39%
Azerbaijan	17 028	22 969	35%
Belarus	17 623	22 913	30%
Bosnia and Herzegovina	9 563	13 313	39%
Bulgaria	16 518	22 128	34%
Croatia	20 222	24 421	21%
Czech Republic	27 347	34 971	28%
Estonia	26 052	34 588	33%
FYR Macedonia	12 587	17 451	39%
Georgia	7 156	11 005	54%
Hungary	23 236	29 807	28%
Kazakhstan	23 038	31 978	39%
Kosovo	N/A	N/A	N/A
Kyrgyz Republic	3 230	4 561	41%
Latvia	22 832	32 108	41%
Lithuania	25 374	36 062	42%
Moldova	4 666	6 442	38%
Mongolia	9 293	15 002	61%
Montenegro	14 666	19 530	33%
Poland	23 273	32 048	38%
Romania	17 440	25 572	47%
Russia	24 298	29 533	22%
Serbia	12 465	15 395	24%
Slovak Republic	26 616	35 082	32%
Slovenia	28 512	34 983	23%
Tajikistan	2 536	3 530	39%
Turkmenistan	12 863	22 350	74%
Ukraine	8 651	10 959	27%
Uzbekistan	5 176	7 669	48%

Source: IMF.

3.2 Industry

The aim of this section is to provide more details on the Czech industry (its history, current development, relations to the export and description of the electrical engineering separately). Again (as well as the International Trade), the description is very extensive, but understanding of the structural changes that has occurred helps us to understand the gravity model results.

The territory of the current Czech Republic has traditionally been very successful in the industrial production. Not only that the current Czech Republic has been able to take the opportunities (the industrial revolution or the current foreign investments to the Czech Republic). It has also been able to adapt and regain the competitiveness (after the Austro-Hungarian Empire fall or after the fall of communism).

The structure of the Czech economy and industry has been changing. Even if the importance of the tertiary sector has been increasing since the fall of the communism, the Czech Republic is one of the most industrial countries in the world. From the industry point of view, the importance of the particular sectors has been changing as well. There are traditional light industries (porcelain, toys, glass blowing) that has been losing the importance from the volume point of view (the second industrial revolution and the centralization during the communism). On the other hand, they are still important and interesting from the tradition point of view. Regarding the volume of production, the mechanical and electrical engineering, metal processing and chemical industry have been the most important. Even within these industries, the relative importance has been changing. Electrical engineering is supposed to have a rising importance. Growth in this sector has been primarily caused by a growth in the kilogram prices (i.e. increase in products quality and thus in the unit prices). However at the same time the, the share of imported inputs (material) has been sharply increasing as well. Therefore the net exports of value added has been increasing less than a rapidly growing total value of exports.

3.2.1 Review of Industrial History

The origins of the growth and development in the Czech industrial production are dated back to the Austro-Hungarian Empire. The first industrial revolution brought development mainly in the light industry (textile and food industry and glassblowing), that was not demanding for the capital resources and was

ensuring fast returns. The second industrial revolution, new inventions and new energy resources, supported the development of the mechanical and electrical engineering, metal processing and chemical industry. Austro-Hungarian monarchy was highly differentiated, and the Czech lands belonged to the more developed part of the Empire. At the beginning of the 20th century, the Czech lands were the main industrial area accounting for almost two thirds of the total economic potential of the Austro-Hungarian Empire, 52% of industrial plants and 56.9% of workers in the industry were located here (Geršlová & Sekanina (2002)).

After the disintegration of the Austria-Hungary, the Czechoslovak Republic acquired 60% - 70% of the industrial capacity of the Empire, but only 21% of the territory and 26% of the population (Geršlová & Sekanina (2002)). Due to the excess of the industrial production and increasing competitive pressures from abroad, the export became a necessity for the further development of the Republic. After the initial problems with the competitiveness, the Czechoslovak Republic succeeded to revive the market, and to develop the production to be able to compete with the foreign markets. The main steps were modernization, and adaptation of the sectoral compositions to the international requirements, less light industry and traditional manufacturing, and more heavy industries and modern production. The development and rationalization occurred mainly in the mechanical and electrical engineering. The Czech Republic was experiencing a period of the economic boom. Compared to 1913, the GDP rose by 52% and the industrial production by 41% in 1929 (Steiner & Krol (1997)).

In the early thirties (because of the consequences of the Great Crisis), the Republic started suffering again. The Czechoslovak Republic had to face the impacts of the crisis within the domestic economy and on the international level as well. Foreign demand for the Czech goods was decreasing, and thereby the Czech export. The textile industry, glassblowing, and production of porcelain and toys were the most affected.

Paradoxically, the escape from the crisis at the end of thirties, among other things, was the wave of armament. Mining of hard coal, machinery and electrical engineering, chemical industry, textile, footwear, clothing industries and cement production achieved the greatest volume in the history. On the contrary, light industry, that was not associated with armament, remained well below the value of 1929 (Geršlová & Sekanina (2002)).

The war was exhausting for the whole country as well as for the industry separately. Even though the situation of the Republic was the best of all

Central European countries. The non-military production declined by about 50% compared to 1938, and the country received a setback in transiting to its pre-war structure, partially also due to the lack of raw materials.

The advent of the communist era meant that the national economy was based on the Soviet model, which was associated with a high centralization. The industry began focusing on the heavy engineering, and in connection with it on the extension of the fuel, metallurgical and fuelenergetic base. Czechoslovakia was the only country in the CEE (except the Union of Soviet Socialist Republics (USSR)) producing heavy nuclear energy facilities, and has been a supplier of these facilities to the other Council for Mutual Economic Assistance (CMEA) countries. Other traditional products included aircraft, electrical appliances, heavy machinery and precision engineering or vehicles.

In the seventies, problems associated with a lack of innovation, investment, and limiting research projects began showing up, products were unable to compete with the Western European countries.

After the fall of communism, in 1989, basically three transformations connected with the industry occurred.

The first change was the transfer of property to the private owners, privatization. According to Mertlík (2014) there were two types of privatization in the Czech Republic, the voucher privatization, and the sales to the strategic partners.

Secondly, the disintegration of the CMEA naturally brought the problems associated with sales. The Czech Republic could not rely on its earlier partnership within the Soviet bloc. Development of the Western market economies was incomparably higher and the competition was huge. The Czech Republic was forced to innovate and to adapt its production mix (which was closely connected with the third change). However, as was mentioned in the previous subsection, the Czech Republic was one of the most successful states in the integration.

Thirdly, in the transition period, number of employees in the most industries had been reducing. Some workers found an employment in the tertiary sector, but some became unemployed (as it is evident from the increasing unemployment after 1989 shown by Baštová & Toušek (2005)). Fortunately, mainly because of many foreign investments into the Czech industry, the situation has started getting better, and newly created jobs helped to reduce the unemployment. Diversification was not only observed between the secondary and the tertiary sector, but also within the secondary sector (industry). This was

connected with the adaptation to the current needs and restoration and maintenance of the competitiveness, and subsequently also with the structure of foreign investments.

Mechanical and electrical engineering, textile and chemical industry and metal processing remained to be the most important industries. The difference was their relative importance within the secondary sector. There was a rapid development of the electrical engineering, and in comparison with the previous era, the reduction of the employment in the mechanical engineering (Baštová & Toušek (2005)). Currently, the share of the mechanical engineering begins increasing again (Geršlová & Sekanina (2002)).

3.2.2 Czech Industrial Production Nowadays

The industry preserve its importance also nowadays, it remains a major sector of the Czech economy. Among all the GDP aggregates, the industry occupies the highest share, 32 %. The only country with a higher share in the EU28 is Romania, 34%. The EU28 average is much lower, 19%. Similarly, the Czech industry is very important for the employment, it employs more than 40% of the economically active population; and for the international trade, nearly 50% of the Czech industrial products are exported. The main industrial sectors in the Czech Republic are mechanical engineering, chemical and food industry and electrical engineering.

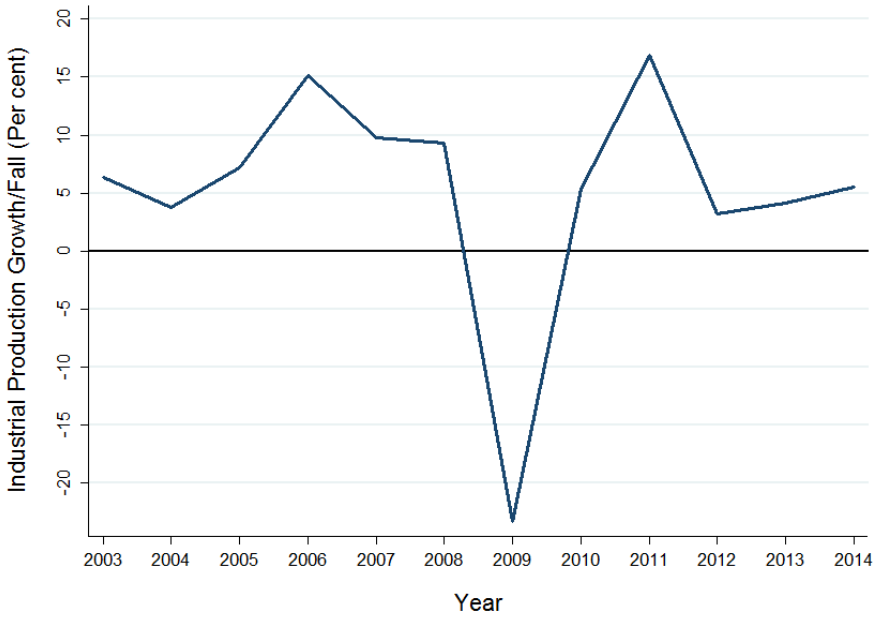
Industrial production has been growing since 2003 (taking into account annual January data), as it is visible in Figure 3.3. The only exception was the recent crisis that caused an enormous drop (34%).

3.2.3 Industrial Production Export, SITC Insight

As mentioned before, the Czech Republic is an export-driven economy, this holds true also for the industry separately. The percentage of the export in the total sales of industrial enterprises has been around 50% since 1995. The main export articles are connected with the Czech main industries, machinery and transport equipment, raw materials and fuel and chemicals.

Regarding the standard international trade classification (SITC) (described in more details in Standard International Trade Classification (SITC) (Appendix A)), the leading export category since 1995 has been the machinery and transport equipment including different kinds of machinery, machine, apparatus and equipment, vehicles and transport equipment. The gap between

Figure 3.3: **Czech Industrial Production Growth/Fall:** Figure showing percentage growth/fall in the Czech industrial production between 2003 and 2014.



Source: CZSO.

the machinery and transport equipment and the others has been really huge, and confirms the machinery and transport equipment to be the leading industrial production and export article in the Czech Republic. In 2013, the machinery and transport equipment export value was more than three times higher than manufactured goods classified chiefly by material (the category with second highest export value), and represented more than 50% of the total Czech export. For more details see (Table 3.4).

The Czech machinery and transport equipment is successful also from the EU28 perspective. Since 2004, the Czech machinery and transport equipment has belonged among the top ten machinery and transport equipment exporters. In per capita terms, the Czech position has been even better, in 2013 the Czech Republic was number 8 in the EU28 (Table 3.5).

Going further in to the disaggregation, to the SITC 716.1, 716.2 and 716.3 (electric motors and generators), we can see the Czech Republic moving even more up. Since 2004, it has been the fourth largest exporter of electric motors and generators in the total terms. However again, in per capita terms the Czech position has been better, in 2013, the Czech Republic was the largest electric motors and generators exporter in the EU28 (Table 3.6). Possible causes for the

Table 3.4: **Czech Export in 2013 according to the SITC:** Table showing the Czech export in 2013 divided according to the SITC (in thousands of euros)

Code	Commodity	Export	Share in Total Export
7	Machinery and transport equipment	65 829 454	54%
6	Manufactured goods classified chiefly by material	21 203 471	17%
8	Miscellaneous manufactured articles	14 395 406	12%
5	Chemicals and related products, n.e.s.	7 792 194	6%
0	Food and live animals	4 465 943	4%
3	Mineral fuels, lubricants and related materials	3 731 559	3%
2	Crude materials, inedible, except fuels	3 266 039	3%
1	Beverages and tobacco	869 126	1%
4	Animal and vegetable oils, fats and waxes	355 443	0 (0.3)%
9	Commodities and transactions n.e.c. in the SITC	277 047	0 (0.2)%

Source: CZSO.

electric motors and generators and electrical engineering success are discussed in the following chapter.

3.2.4 Electrical Engineering

CzechTrade (2014) labeled electric and electrotechnical components as having an increasing importance, i.e. its gains in comparative advantages vis-a-vis the CA in other sectors have been among the fastest. Compared to the car industry (currently the Czech sector number one) it deals much easier with logistics (no strong requirement on territorial proximity, smaller influence of the transport costs), which allows higher flexibility.

The foreign investments to the sector helped to stabilize it, and to increase labor productivity and sector quality. The Czech products are able to compete with the foreign ones, and the sector is attracting new and new investors and research and development centers establishments. CzechTrade (2014) reported the investment in the electrical industry between 1997 and 2007 to be 150 billion CZK; more than 30% of foreign investments went to the electrical industry, which represents the second highest share (after the car industry).

CzechTrade (2014) also labeled certain products of the electrical industry to have a long tradition, experienced workers and a stable position in the Czech

Table 3.5: **SITC 7 Export of the EU28 in 2013:** Table showing the SITC 7 (machinery and transport equipment) and SITC 7 per capita export of the EU28 in 2013 (in millions of euros for the SITC 7 export, in euros for the SITC 7 per capita export)

Country	**SITC 7 Export**	**SITC 7 Export (per capita)**
Germany	519 159	6 362
France	162 070	2 541
Netherlands	140 781	8 312
Italy	133 493	2 174
United Kingdom	126 353	2 025
Spain	76 598	1 618
Belgium	70 732	6 495
Czech Republic	65 355	6 261
Poland	57 516	1 511
Austria	51 819	6 200
Sweden	47 537	5 070
Hungary	42 378	4 242
Slovakia	36 346	6 690
Romania	20 635	977
Denmark	20 122	3 611
Finland	15 139	2 840
Portugal	11 794	1 100
Ireland	9 755	2 151
Slovenia	8 975	4 439
Luxembourg	4 911	9 427
Lithuania	4 384	1 341
Estonia	4 245	3 199
Bulgaria	3 925	529
Latvia	2 311	1 035
Croatia	2 20	497
Greece	2 013	179
Malta	1 125	2 623
Cyprus	339	426

Source: Eurostat, IMF.

Table 3.6: **SITC 716.1, 716.2, 716.3 Export of the EU28 in 2013:** Table showing the SITC 716.1, 716.2, 716.3 (electric motors and generators) and SITC 716.1, 716.2, 716.3 per capita export of the EU28 in 2013 (in millions of euros for the SITC 7 export, in euros for the SITC 7 per capita export)

Country	**SITC 716.1, 716.2, 716.3 Export**	**SITC 716.1, 716.2, 716.3 Export (per capita)**
Germany	5 359	66
Italy	1 424	23
France	1 323	21
Czech Republic	1 027	98
United Kingdom	670	11
Austria	606	73
Netherlands	467	28
Finland	434	81
Spain	390	8
Sweden	390	42
Hungary	340	34
Poland	306	8
Slovakia	263	48
Denmark	204	37
Slovenia	192	95
Belgium	128	12
Romania	118	6
Portugal	97	9
Estonia	48	36
Latvia	26	12
Croatia	24	5
Bulgaria	18	2
Ireland	15	3
Lithuania	14	4
Luxembourg	13	26
Greece	4	0 (0.4)
Cyprus	0 (0.4)	0 (0.5)
Malta	0 (0.3)	1

Source: Author's computations, Eurostat, IMF.

industry, namely traditional electric motors, generators and transformers, electrical distribution and control equipment and cables and insulated wires.

Due to the long tradition and ongoing foreign investments and modernization, the Czech products are of a world standard. CzechTrade (2014) highlighted the Siemens Elektromotory company to be an example of a successful company, as it belongs among the top world's suppliers of low-voltage asynchronous electrical motors.

Moreover, because of the favorable investment environment, favorable conditions for development centers establishments, qualified but relatively low waged workforce, ongoing foreign investments and the constant growth in the electrical industry is expected.

The noteworthy development of this sector indicates fundamental shifts in the comparative advantage that occurred in the Czech economy. These shifts were biased to the machinery, electrical engineering and electronics industry. These are industries demanding for the capital requirements, for the medium and high skill requirements, and in particular forthe increasing returns to scale and outsourcing. That means, the Czech export has been changing its structure by adjusting it to Ricardian, Heckscher-Ohlin and "new theories" of the international trade. Gravity model of the international trade can help us to find the casual factors that were/have been driving the changes.

Chapter 4

Model

Model traditionally used for the international trade analysis is the gravity model of the international trade. The model is able to describe the flows between two clusters and influences of the trade agreement existence, sharing borders, history, etc. on that. OLS is the method widely used for the gravity model estimation. However, as you will see in the following chapter, there are estimation methods that are more suitable. Besides the simple OLS method, the Poisson pseudo-maximum likelihood estimation, recommended by Silva & Tenreyro (2006) for the first time, is used for our research, as it is able to deal with the heteroskedasticity and the zero trade values.

4.1 Model History

The tool used for the estimation and subsequent evaluation and comparison of the international trade flows of France and the Czech Republic in the thesis is the gravity model of the international trade flows. The gravity model of the trade flows describes relationship between any two clusters. It is based on the Newton's standard gravity theory. According to the model (in its basic version), the trade flows depends on the distance of the clusters and on their GDPs.

As Bergeijk & Brakman (2010) pointed out, the idea of the trade between the units depending on their distance and weights goes back to the 19th century (early formulation of this relationship by Ravenstein (1885)). Also many theories developed during the 20th century were realizing the importance of both factors (distance and weights), Isard (1954) even included additional factors like politics or cultural factors. Nevertheless, the mathematical formulation

came only in 1962. It was formulated by Tinbergen in his *Shaping the World Economy* (Tinbergen (1962)).

The original model of Tinbergen was based on the idea that the trade is solely defined by the supply potential (exporter's GDP), the market demand potential (importer's GDP) and the transportation costs (distance), which meant no role of prices (Bergeijk & Brakman (2010)). This immediately brought waves of criticism of the model not being sufficient, as there was no convincing microeconomics foundation behind it.

The situation became little bit schizophrenic after the totally opposite criticisms appeared. According to this, the model constituted a threat as it could have been derived from many different trade models, Ricardian models, increasing returns to scale or Heckscher-Ohlin model, which gave an overstated confidence to the police makers in using this model. Moreover, because of numerous possible theories behind the gravity model, the possible interpretation differed. This was proved soon, Bergeijk & Brakman (2010) gave an example of the Iron Curtain fall and connected trade predictions based on the gravity model that gave misleading results.

Searching for the microeconomics foundation remained on the top of the interest of the gravity model researchers. This brought success and the gravity model appeared to be explicable by the basic microeconomics ideas (Anderson (1979), Bergstrand (1985), Bergstrand (1989), Helpman & Krugman (1985), Helpman & Krugman (1990), Deardorff (1998) or the recent multilateral resistance extension by Anderson & Van Wincoop (2003)). More details about the microeconomics foundation behind the gravity model are visible in the Review of World Literature (Chapter 2).

The ability of the model to survive quite a long period, and to proof and show its suitability and credibility again after the waves of criticism is clearly a sign of its quality.

We can see three basic reasons for its success.

The gravity model is able to explain up to two thirds of the variation in the international flows (Bergeijk & Brakman (2010), Linders & Groot (2006)). "The success of the model is its great explanatory power: the equations fit well statistically and give quite similar answers across many different datasets." (Anderson (2010): pg. 71)

The second reason is the rising importance of the international trade over the past years, which was mentioned by (Möhlmann *et al.* (2010)). Moreover,

they labeled the gravity model to be the "workhorse model" for the international trade (Möhlmann *et al.* (2010): pg. 226).

The third reason is its flexibility both in independent variables and in data used.

In the basic version of the traditional model only the GDPs and the distance are included. However, nearly everything can be added as the independent variable, both of the economic and of the non-economic character, depending on the question we are interested in and depending on what is important. We can name variable including diplomatic and politic relations, an influence of various trade agreements, differences in religion, language similarities, colonial ties, environmental agreements, a currency union existence and many others.

Flexibility of the data is easily usable as well. By using the aggregated data, we gain an idea about a country (organization, region, ...) as a whole. We can choose only some part, the data about certain industry or even further, the data about a specific product or firm, which gives us the idea about a disaggregated level.

Both mentioned ways of flexibility (in the independent variables and in the data) are easily applicable, but both of them give us an easy way how to extend the basic gravity model.

4.2 Model Basics

The basic model together with subsequent possibilities of estimation and their pros and cons were in details described by Silva & Tenreyro (2006). According to the traditional form of the gravity equitation (in its simplest version), the trade flow between two countries is proportional to their GDPs, and inversely proportional to the distance between them.

$$T_{i,j} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{i,j}^{\alpha_3} \tag{4.1}$$

Where $T_{i,j}$ stands for the trade flows, Y_i and Y_j stand for the GDPs of countries i and j, $D_{i.j}$ is the distance between the countries and α_0, α_1, α_2 and α_3 are the unknown parameters.

To account for the deviations from the theory, an error factor is included in to the equitation (4.1), and so the stochastic version of the gravity model is gained.

$$T_{i,j} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{i,j}^{\alpha_3} \eta_{i,j} \tag{4.2}$$

Where $\eta_{i,j}$ is an error term with expected value conditional on the independent variables equal to 1: $\mathbb{E}(\eta_{i,j}|Y_i, Y_j, D_{i,j}) = 1$. The error term is supposed as traditionally to be statistically independent on the regressors: $\mathbb{E}(T_{i,j}|Y_i, Y_j, D_{i,j}) = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{i,j}^{\alpha_3}$.

4.3 Traditional Approach. Why not?

According to the traditional way of estimation, we take logarithms of equation (4.2), which leads to the log-linearized form of the model:

$$\ln T_{i,j} = \ln \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{i,j} + \ln \eta_{i,j} \tag{4.3}$$

After the parameters are estimated using the ordinary least squares (OLS) method.

There are two problems of the OLS estimation of the gravity model. The problem when the heteroskedasticity occurs in the model, and the problem with the zero trade values. Unfortunately, both of the problems are very common in the trade data (Herrera & Baleix (2009)).

Westerlund & Wilhelmsson (2009) highlighted the importance of the Jensen's inequality, $\mathbb{E}(\ln y) \neq \ln \mathbb{E}(y)$, in estimating the gravity model. The implication of the inequality is well known but often neglected. Correctness of results obtained from the above mentioned OLS estimation depends on the statistical independence of $\eta_{i.j}$ on the regressors, and therefore on the statistical independence of $\ln \eta_{i,j}$ on the regressors (Silva & Tenreyro (2006)). To understand the problem with the heteroskedastic equitation and the OLS estimation of the gravity model, we have to realize that the expected value of a logarithm of a random variable depends on its mean but also on its higher moments. This causes the inconsistency of the OLS estimations of the heteroskedastic gravity equations (as with the heteroskedasticity the $\ln \eta_{i,j}$ is not statistically independent on the regressors).

The second problem is the inability of the traditional approach to deal with the zero values of the dependent variable (Silva & Tenreyro (2006), Linders & Groot (2006)), as the logarithm of zero is not defined. The zero values are automatically dropped in the OLS estimation, which leads to the sample selection bias.

Zero values can have different causes, real zero values (for countries that do not trade with each other), rounding down of small values or missing obser-

vations. Silva & Tenreyro (2006) mentioned three possible solutions (for real zero values and for rounding down). Pair with zero trade values can be easily dropped ($T_{i,j} = 0$), which is the most often; another possibility is to modify all the trade flows in a same way ($T_{i,j} + 1$), and the last proposed solution is the use of the Tobit estimator. However, as Silva & Tenreyro (2006) suggested, there is no reason to believe that any of them leads to a consistent estimate.

4.4 Multiplicative Form, Poisson Pseudo Maximum-likelihood Estimator

Due to the shortcomings of the log-linear version of the gravity model mentioned in the previous section, many authors (including Silva & Tenreyro (2006) or Shepherd (2013), Westerlund & Wilhelmsson (2009)) recommended the multiplicative form of the model to be advisable.

The non-stochastic multiplicative version of the gravity relationship from the previous section is:

$$T_{i,j} = \exp\left[\ln \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{i,j}\right] \tag{4.4}$$

which can be interpreted as conditional expectation of $T_{i,j}$ given Y_i, Y_j and $D_{i,j}$: $\mathbb{E}(T_{i,j}|Y_i, Y_j, D_{i,j})$.

However, as in the log-linear case, the non-stochastic version of the relationship is not realistic, equation (4.4) holds only on average, in reality each observation is associated with an error term, $\epsilon_{i,j}$: $\epsilon_{i,j} = T_{i,j} - \mathbb{E}(T_{i,j}|Y_i, Y_j, D_{i,j})$. This finally leads to the stochastic version of the multiplicative constant elasticity model recommended to be used for the estimation:

$$T_{i,j} = \exp\left[\ln \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{i,j}\right] + \epsilon_{i,j} \tag{4.5}$$

with $T_{i,j} \geq 0$ and $\mathbb{E}(\epsilon_{i,j}|Y_i, Y_j, D_{i,j}) = 0$. Except the ability to deal with the heteroskedasticity and the zero values of the dependent variable, the multiplicative form provides with additional helpful attribute. It can be easily interpreted, the approximate interpretation is the same as in case of linear model.

The tool that is supposed to be the most suitable for the estimation of equation (4.5) by numerous authors is the Poisson pseudo maximum-likelihood estimator. α obtained in PPML estimation is a result of maximization of the log-likelihood function (described by Wooldridge (2008)). General form of the

log-likelihood function is as follows:

$$\mathcal{L}(\alpha) = \sum_{i=1}^{n} \ell_i(\alpha) = \sum_{i=1}^{n} \{y_i x_i \alpha - exp(x_i \alpha)\} \tag{4.6}$$

where x_i and y_i represent random sample: $\{(x_i, y_i) : i = 1, 2, ...n\}$, in our case y_i is $T_{i,j}$ and x_i is Y_i, Y_j and $D_{i,j}$.

PPML main advantages are according to Silva & Tenreyro (2006) its reasonability and efficiency even under wide range of heteroscedacticity patterns, simplicity of implementation and low demands (as it is the pseudo estimator, the data do not have be Poisson at all, and moreover, the dependent variables do not have to be integers). The same was confirmed by Martínez-Zarzoso *et al.* (2007), Westerlund & Wilhelmsson (2009) or ao Santos Silva & Tenreyro (2009).

Chapter 5

Empirical Framework

Our model covers a period of 19 years, from the early stages of the Czech Republic (1995) till present (2013). For the sake of comparison, we investigate the export function of the Czech Republic but also of France. Based on the CZSO, IMF, United Nations (UN), Organization for Economic Co-operation and Development (OECD) and Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) databases, we were able to collect data on 183 countries, on the export from the Czech Republic (France) to 182 countries. We use both types of flexibility mentioned earlier, flexibility in the independent variables and in the degree of disaggregation. One of the crucial aims of the thesis is to detect and describe differences in the elasticities on the different aggregations. For these purposes we use three different models that differ in dependent variables (total export, export of SITC 7 and export of SITC 716.1, 716.2 and 716.3). As the economics is not physics, the masses (GDPs) and the physical distance are not able to fully describe the international flows. From this reason, we include additional independent variables, the new economic geography variables.

5.1 Data

The data capture period between 1995 and 2013. The initial year, 1995, is chosen with regards to the transition period in the beginning of the nineties. This year, 1995, is supposed to be the year, from which the Czech economy has been stabilized and the data relevant for the analysis. Our sample includes 183 countries. States that were not monitored or were difficult to be monitored are not included; Kosovo, Montenegro, Serbia and East Timor from the political

reasons, and for example Vatican City, Cocos Islands or Guam from the poor data availability reasons.

5.2 Variables

Our models consist of the gravity model core variables, home country export (Czech and French) as the dependent variable, and home and partner country's GDPs PPPs and physical distance in kilometers (basic form gravity model variables) as the independent variables. The model is further extended by the partner's population variable, that serves as the market size proxy, and new economic geography variables, as the physical distance alone is not able to capture the real distance.

We are trying to detect differences in elasticities on different aggregations (on the total export level, on the industry export level and on the product export level), that is why we employ three models that differ in dependent variable. To obtain the data on the different aggregations we use the (SITC). The first estimated model refers to the whole economy. That is why we are simply using the total export. The second model goes further into the disaggregation, machinery and transport equipment is classified at one digit level as the section 7, we are estimating export for this section. The third model focuses on the specific products, electric motors and generators, with 4-digit codes 716.1, 716.2 and 716.3. For more details about the SITC see Standard International Trade Classification (SITC) (Appendix A).

The physical distance (the basic form gravity model variable) is not able to capture the real distance. Bergeijk & Brakman (2010) highlighted that differently from the physical distance, the economic distance is not unambiguously defined and cannot be simply measured. The economic distance is multifaceted, and has to include many other factors apart from the physical distance. The tool that has been becoming very useful for the economic distance approximation is the new economic geography. Both economic (common currency, exchange rate or some kind of a free trade area existence) and non-economic (cultural and institutional factors) components of distance approximation play a crucial role.

Table 5.1 below shows all the variables used for the Czech export models estimation. Some variables used for the French export estimation have to be changed with regards to the different countries' characteristics, these changes and variables are commented subsequently (Table 5.2).

Table 5.1: **Variables Used for the Czech Export Estimation:** Table showing variables used for the estimation of the Czech export function (details on the data sources are available in Table B.1)

		Variable	**Abbr.**	**Units**
Dependent Variable		Export	*export*	ths. EUR
Basic Form Variables		Partner's GDP PPP	GDP_j	bil. EUR
		Czech GDP PPP	GDP_c	bil. EUR
		Distance	*dist*	km
Market Size Proxy		Population	*pop*	millions
New Economic Geography Variables	Economic Distance Variables	ERDI	$ERDI$	w.r.t. USD
		Recession (CR)	rec_c	dummy (0/1)
		Recession (partner)	rec_j	dummy (0/1)
		Euro	EUR	dummy (0/1)
		European Union	EU	dummy (0/1)
	Cultural Distance Variables	Czechoslovakia	CZS	dummy (0/1)
		CEE	CEE	dummy (0/1)
		FSU or CEE	$FSCE$	dummy (0/1)
		Austria-Hungary	AHE	dummy (0/1)
	Geographic Distance Variables	Landlockness	*land*	dummy (0/1)
		Common border	*bor*	dummy (0/1)
	Institutional Distance Variables	Property rights	*propr*	per cent (0-100)
		Freedom from corruption	$frecor$	per cent (0-100)
		Fiscal freedom	$fisfre$	per cent (0-100)
		Government spending	*gvtsp*	per cent (0-100)
		Business freedom	$busfre$	per cent (0-100)
		Labor freedom	$labfre$	per cent (0-100)
		Monetary freedom	$monfre$	per cent (0-100)
		Trade freedom	$trafre$	per cent (0-100)
		Investment freedom	$invfre$	per cent (0-100)
		Financial freedom	$finfre$	per cent (0-100)
		Education index	*edu*	per cent (0-100)

Source: Author's computations.

The first core variables, GDP_c and GDP_j, measure the economic size of the home country (the Czech Republic) and of the partner, respectively. According to Gencer (2012), the GDP of the exporting country indicates its exportable surplus; the partner's GDP indicates its purchasing power. We are using GDPs PPPs for the purposes of our model, which is the most suitable for the international comparison. Data on countries' GDPs were available in the United States Dollar (USD), to make the GDPs consistent with the export data, we convert them into euros using an annual average USD-euro (EUR) exchange rate. For

both, GDP_c and GDP_j, we expect the positive sign of the coefficient, the larger the trading partners GDP, the larger the bilateral trade.

The second core independent variable, distance in kilometers ($dist$), is included in the weighted form. Additionally to the simple distance measurement, it incorporates population distribution information. The weighting was developed by Head & Mayer (2002), they used the share of the cities' population in the overall countries populations' to weight the distance between the countries' most important cities. The distance is supposed to have a negative effect on the export; the larger the distance, the smaller the trade flows between the partners, as the larger distance enhances the transportation costs.

As we are using GDPs PPPs together with the USD-EUR exchange rate that does not incorporate the purchasing power parity, we have to account for this fact. We are doing so by using the $ERDI$ variable. Exchange Rate Deviation Index (ERDI) is a number that indicates how many times the real exchange rate of the currency is lower than the rate derived from the purchasing power parity. ERDI is a ratio of the GDP PPP and the GDP in the current prices. The original GDPs are in the USD, that is why we are computing the ERDI with respect to the USD, any other conversion might cause inaccuracies. Less developed countries usually have a higher ERDI, the reason is simply visible from the GDP PPP and the GDP in current the prices ratio. From this reason, we expect a negative sign of the estimated parameter, the less developed countries are not that able to export or import.

Following the IMF definition of the recession, as two consecutive quarters of decline in a country's real GDP, we create home and partner's recession dummy variables (rec_c and rec_j). The recession dummy variable takes a value 1 for a year with recession and 0 otherwise. We expect negative influence of the recession on the export; this indirectly follows the explanation for the GDPs variables influence on the level of export. Moreover, it was intuitively described in the part commenting the Czech top trading partners when referring to the recent crisis and Germany as a very influential country for the Czech export.

Other variables are connected with a common currency and/or with the EU. The first one is the dummy variable for the euro (EUR), it takes a value 1 for states using the euro and 0 otherwise. The euro variable is expected to have a positive effect on the export. We suppose it to be much easier to trade with the eurozone countries for the Czech Republic than with the rest of the world, which is closely connected with the EU membership.

The last variables of the economic character approximating the distance

is the variable for the EU membership of the partner (EU). International organization membership or the existence of an agreement removing the trade barriers and enhancing trade are traditionally used variables in the gravity model. The most influential membership for the Czech Republic is undoubtedly the EU one. The dummy variable for the EU membership takes a value 1 if the state belongs to the EU and 0 otherwise. We suppose the EU membership to enhance the trade between the members.

To account for all the factors influencing the transaction costs and so the real distance, the economic components are not enough. Other traditionally used and important factors are cultural and geographic variables that take into account geographic location and historical background.

The most important from the cultural point of view are undoubtedly common language and common history. Common language variable for the Czech Republic could have been the dummy variable for the Czech/Slovak language. However, as this dummy would have totally the same values as the Czechoslovakia (CZS) dummy (described right after), we do not include language variable in the case of the Czech Republic. The common history is accounted for by using dummies for being (takes a value 1) or not being (takes a value 0) a part of the former Czechoslovak Republic (CZS), Central and Eastern Europe (CEE), Central and Eastern Europe or former Soviet Union ($FSCE$) and Austro-Hungarian Empire (AHE). All these dummies are expected to have a positive effect on the export.

Other variable we expect to enhance the trade flows is a common border (bor). Countries sharing a border might have a closer relationship, moreover, the distance and so the transaction costs are smaller for the neighbouring countries. The second geographic variable is the landlockness ($land$). Direct sea access can bring an advantage for the country; it gives it a possibility to use a cheap maritime transport. We include both geographic variables using dummy variables, which take a value 1 for sharing border or being landlocked and 0 otherwise.

The last variables represent different institutional factors. These variables are incorporated mainly with respect to the endogenous growth theory, where the institutions play a crucial role. The first ten variables are published by the Heritage Foundation, and they measure rule of law ($propr$, $frecor$), limited government ($fisfre$, $gvtsp$), regulatory efficiency ($busfre$, $labfre$, $monfre$) and open markets ($trafre$, $invfre$, $finfre$). The very last variable, the education index (edu), reflects average years of schooling and expected years of

schooling. All the institutional variables are measured in percentage, the higher the economic freedom or education level, the higher the percentage. We suppose the signs of all the institutional variables coefficients to be positive, as we suppose the countries with more efficient market freedom and/or higher level of education to trade internationally more freely and easily.

French Model Adjustments

To account for the differences arising from the different Czech and French development and characteristics, we have to adjust some variables. We keep the basic form variables, variables with the general validity (market size proxy, institutional distance variables and a part of the economic distance variables), and variables dealing with common characteristics for France and the Czech Republic (euro and the EU dummies) unchanged. However, the cultural distance variables have to be adapted. All the variables for the French export model are visible in Table 5.2.

France has, differently from the Czech Republic, experienced a rich colonial history, which affected the French language extension, current relations with the former colonies and current political organization of France. The language sharing is included using three language dummy variables, dummy for French as an official language ($lang\_of$), for French being a language spoken by at least 20% of the partner's population ($lang\_20$), and for French being spoken between 10% and 20% of the population ($lang\_10$). Further, we include two dummy variables for being a former French colony. Based on Mayer & Zignago (2011), we differentiate two types of colonies, the short-term or with a lower French influence (col_st), and the long-term or with a stronger French influence (col_lt). The last cultural distance dummy variable accounts for the administrative division of France, in particular for overseas departments and territories ($osdt$), it takes a value of 1 for being overseas department or territory and 0 otherwise. All the cultural dummies are supposed to have a positive effect on the export, as all of them indicates closer relations with France.

5.3 Model Specification

The aim of the thesis is the comparison of the elasticities on the different aggregations (on the total export level, on the industry export level and on the product export level), which gives us three different models (models with different

Table 5.2: **Variables Used for the French Export Estimation:** Table showing variables used for the estimation of the French export function (details on the data sources are available in Table B.1)

		Variable	**Abbr.**	**Units**
Dependent Variable		Export	export	ths. EUR
Basic Form Variables		Partner's GDP PPP	GDP_j	bil. EUR
		French GDP PPP	GDP_f	bil. EUR
		Distance	$dist$	km
Market Size Proxy		Population	pop	millions
New Economic Geography Variables	Economic Distance Variables	ERDI	ERDI	w.r.t. USD
		Recession (FR)	rec_f	dummy (0/1)
		Recession (partner)	rec_j	dummy (0/1)
		Euro	EUR	dummy (0/1)
		European Union	EU	dummy (0/1)
	Cultural Distance Variables	Common language (official)	$lang\_of$	dummy (0/1)
		Common language ($\geq 20\%$)	$lang\_20$	dummy (0/1)
		Common language ($\geq 10\%$)	$lang\_10$	dummy (0/1)
		Former colony (short-term)	col_st	dummy (0/1)
		Former colony (long-term)	col_lt	dummy (0/1)
		Overseas departments and territories	$osdt$	dummy (0/1)
	Geographic Distance Variables	Landlockness	$land$	dummy (0/1)
		Common border	bor	dummy (0/1)
	Institutional Distance Variables	Property rights	$propr$	per cent (0-100)
		Freedom from corruption	$frecor$	per cent (0-100)
		Fiscal freedom	$fisfre$	per cent (0-100)
		Government spending	$gvtsp$	per cent (0-100)
		Business freedom	$busfre$	per cent (0-100)
		Labor freedom	$labfre$	per cent (0-100)
		Monetary freedom	$monfre$	per cent (0-100)
		Trade freedom	$trafre$	per cent (0-100)
		Investment freedom	$invfre$	per cent (0-100)
		Financial freedom	$finfre$	per cent (0-100)
		Education index	edu	per cent (0-100)

Source: Author's computations.

dependent variables) to be estimated ($export$, $export\_sitc7$ and $export\_sitc716.x$. Moreover, besides our main country (the Czech Republic), we estimate the same for France to have another possibility of comparison, not between the aggregations but between the states.

As we have already stated in Chapter 4 (Model), we are using both, the simple linear estimation method and the PPML estimation. However, as we are

aware of the shortcoming of the linear method (when heteroskedasticity and the zero trade values occur), we are not using it through the whole research. The linear estimation is used only for the very basic model, for the total trade model, to illustrate the differences between its and the PPML results. Not only it is not useful to have the linear model results on all the aggregations (as we know they are not precise), the sample selection bias is getting even worse as there are more zeros when going further into the disaggregation.

We are having both time series and cross-sectional data, the most appropriate method to account for it is the use of the panel data. Based on the results of the Hausman specification test, we decide between the random and the fixed effects models.

Lumping the above mentioned together, we can write all the model we use in our estimation. We use the log-linearized form of the gravity model for the total export for the Czech Republic (equation 5.1) and for France (equation 5.2), and the multiplicative form of the model for all the aggregations for the Czech Republic (equation 5.3) and for France (equation 5.4).

In the very end, we add four more simple models. We estimate the export functions only for one period, for 1995 and for 2013, for both, France and the Czech Republic. This step is added mainly because of changes in the beginning of the nineties in the Czech Republic (described in Czech Position: International Trade and Industry). The one-period models are basically the same as equation 5.3 and equation 5.4, with the only exception, we do not have to account for different periods (t).

$$\begin{aligned}
&\ln export_{c,j,t} = \\
&\beta_0 + \beta_1 \ln GDP_{c,t} + \beta_2 \ln GDP_{j,t} + \beta_3 \ln dist_{c,j,t} + \beta_4 \ln pop_{j,t} \\
&\quad + \beta_5 \ln ERDI_{j,t} + \beta_6 rec_{c,t} + \beta_7 rec_{j,t} + \beta_8 EUR_{j,t} + \beta_9 EU_{j,t} \\
&\quad + \beta_{10} CZS_{j,t} + \beta_{11} CEE_{j,t} + \beta_{12} FE_{j,t} + \beta_{13} AH_{j,t} + \beta_{14} land_{j,t} \\
&\quad + \beta_{15} bor_{j,t} + \beta_{16} propr_{j,t} + \beta_{17} frecor_{j,t} + \beta_{18} fisfre_{j,t} \\
&\quad + \beta_{19} gvtsp_{j,t} + \beta_{20} busfre_{j,t} + \beta_{21} labfre_{j,t} + \beta_{22} monfre_{j,t} \\
&\quad + \beta_{23} trafre_{j,t} + \beta_{24} invfre_{j,t} + \beta_{25} finfre_{j,t} + \beta_{26} edu_{j,t} + \epsilon_{c,j,t}
\end{aligned} \tag{5.1}$$

$$\begin{aligned}
&\ln export_{f,j,t} = \\
&\beta_0 + \beta_1 \ln GDP_{f,t} + \beta_2 \ln GDP_{j,t} + \beta_3 \ln dist_{f,j,t} + \beta_4 \ln pop_{j,t} \\
&\quad + \beta_5 \ln ERDI_{j,t} + \beta_6 rec_{f,t} + \beta_7 rec_{j,t} + \beta_8 EUR_{j,t} \\
&\quad + \beta_9 EU_{j,t} + \beta_{10} lang_of_{j,t} + \beta_{11} lang_20_{j,t} + \beta_{12} lang_10_{j,t} \\
&\quad + \beta_{13} col_lt_{j,t} + \beta_{14} col_st_{j,t} + \beta_{15} osdt_{j,t} + \beta_{16} land_{j,t} \\
&\quad + \beta_{17} bor_{j,t} + \beta_{18} propr_{j,t} + \beta_{19} frecor_{j,t} + \beta_{20} fisfre_{j,t} \\
&\quad + \beta_{21} gvtsp_{j,t} + \beta_{22} busfre_{j,t} + \beta_{23} labfre_{j,t} + \beta_{24} monfre_{j,t} \\
&\quad + \beta_{25} trafre_{j,t} + \beta_{26} invfre_{j,t} + \beta_{27} finfre_{j,t} + \beta_{28} edu_{j,t} + \epsilon_{i,j,t}
\end{aligned} \tag{5.2}$$

$$\begin{aligned}
&export_{c,j,t}\,(export_sitc7_{c,j,t}, export_sitc716x_{c,j,t}) = \\
&exp\,[\beta_0 + \beta_1 \ln GDP_{c,t} + \beta_2 \ln GDP_{j,t} + \beta_3 \ln dist_{c,j,t} + \beta_4 \ln pop_{j,t} \\
&\quad + \beta_5 \ln ERDI_{j,t} + \beta_6 rec_{c,t} + \beta_7 rec_{j,t} + \beta_8 EUR_{j,t} + \beta_9 EU_{j,t} \\
&\quad + \beta_{10} CZS_{j,t} + \beta_{11} CEE_{j,t} + \beta_{12} FE_{j,t} + \beta_{13} AH_{j,t} + \beta_{14} land_{j,t} \\
&\quad + \beta_{15} bor_{j,t} + \beta_{16} propr_{j,t} + \beta_{17} frecor_{j,t} + \beta_{18} fisfre_{j,t} \\
&\quad + \beta_{19} \ln gvtsp_{j,t} + \beta_{20} busfre_{j,t} + \beta_{21} labfre_{j,t} + \beta_{22} monfre_{j,t} \\
&\quad + \beta_{23} trafre_{j,t} + \beta_{23} invfre_{j,t} + \beta_{24} finfre_{j,t} + \beta_{25} edu_{j,t}] + \epsilon_{i,j,t}
\end{aligned} \tag{5.3}$$

$$\begin{aligned}
&export_{f,j,t}\,(export_sitc7_{f,j,t}, export_sitc716x_{f,j,t}) = \\
&exp\,[\beta_0 + \beta_1 \ln GDP_{c,t} + \beta_2 \ln GDP_{f,t} + \beta_3 \ln dist_{f,j,t} + \beta_4 \ln pop_{j,t} \\
&\quad + \beta_5 \ln ERDI_{j,t} + \beta_6 rec_{f,t} + \beta_7 rec_{j,t} + \beta_8 EUR_{j,t} + \beta_9 EU_{j,t} \\
&\quad + \beta_{10} lang_of_{j,t} + \beta_{11} lang_20_{j,t} + \beta_{12} lang_10_{j,t} + \beta_{13} col_lt_{j,t} \\
&\quad + \beta_{14} col_st_{j,t} + \beta_{15} osdt_{j,t} + \beta_{16} land_{j,t} + \beta_{17} bor_{j,t} + \beta_{18} propr_{j,t} \\
&\quad + \beta_{19} frecor_{j,t} + \beta_{20} fisfre_{j,t} + \beta_{21} gvtsp_{j,t} + \beta_{22} busfre_{j,t} + \beta_{23} labfre_{j,t} \\
&\quad + \beta_{24} monfre_{j,t} + \beta_{25} trafre_{j,t} + \beta_{26} invfre_{j,t} + \beta_{27} finfre_{j,t} + \beta_{28} edu_{j,t}] \\
&\quad + \epsilon_{i,j,t}
\end{aligned} \tag{5.4}$$

where $j = 1, \ldots 182$ stands for partner country, $t = 1995, \ldots 2013$ for time and c and f indicates Czech Republic and France.

All the variables that are not dummies or in percents are incorporated in logarithms, which ensures lucidity in the elasticities interpretation. Dummy variables have to be adjusted as recommended by Wooldridge (2008). Coefficients for dummy variables visible in the tables of results in the following chapter are valid for the $ln(export)$ (see equation 5.1 - equation 5.4) not for the *export* as desirable. In order to get the correct coefficients, we employ the following relation: $\%\Delta y = 100\left[exp(\hat{\beta}\Delta x) - 1\right]$. Coefficients that are originally in percentage (institutional variables) are adjusted using simple log-level regression adjustments.

Chapter 6

Results

This section provides results and their interpretation for the models described in the previous subsection. However, before the own estimation we have to run the Hausman specification test for the panel data models (to decide between the fixed and random effects model), and statistical assumption violation tests, and further do the appropriate adjustments if necessary.

Only after all the mentioned steps are done, we move to the estimation of the export functions. Firstly, we show and comment on the differences in results when using the fixed effects (FE) linear model and the FE PPML estimation. After, we look at the differences between the aggregations and countries (the Czech Republic and France). In the very end, we compare the export functions of 1995 (the first year of our estimation) and 2013 (the last year).

6.1 Before Estimation

Before going to the own estimation and interpretation, we have to choose between the fixed and the random effects model (speaking of the panel data models), and test for the model assumptions and correct any possible inaccuracies if necessary. In the following paragraphs we comment on the Hausman specification test, test for multicollinearity, heteroskedasticity, autocorrelation and normality. All these tests and consequent correction prevent from problems with the over or underestimation of the coefficients significance because of the bias in the standard errors, inefficiency, inconsistency or bias in the coefficients.

Employing the Hausman test with the null hypothesis the unobserved effects to be uncorrelated with the explanatory variables (random effects model), the choice of the fixed effects model shows up to be more suitable in our models.

Moving to the statistical assumptions violation tests, firstly, we test for multicollinearity. Multicollinearity indicates the phenomena when two or more independent variables are highly correlated, which might lead to a biased estimate (Wooldridge (2008)). According to the variance inflation factor (VIF) test for multicollinearity, we have problems with some cultural distance variables and with some institutional distance variables (in both cases, the Czech Republic and France), as we could have expected.

In the both cases we drop the property rights (*propr*). Heritage Foundation classifies the property rights and freedom from corruption as the rules of law (they describe a similar phenomena), and we consider the freedom from corruption to be more influential. In the model for the Czech Republic, we further decide to drop the $FSCE$ variable, as it describes a similar phenomena as the CEE variable. In the French export model, we drop the overseas departments and territories (*osdt*), the dummy for French being spoken by more than 20% of the population ($lang\_20$), and the dummy for French being spoken between 10% and 20% of the population ($lang\_10$). We also merge the variables for the former colonies to only one variable (*col*), as it makes more sense in the further results interpretation.

To make our research comparable across all the estimates, we try to keep the same sets of variables for all the models. However, as you will see in the last estimates (one-period models), we are not able to follow this in all the cases. The reason is apparent and results from our data characteristics, and it is explained with the respective estimations.

The second assumption to be tested is the heteroskedasticity, whether the

variance of the error terms conditionally on the independent variables is constant. If the assumption is not fulfilled, the tests of the statistical significance might be invalid (Wooldridge (2008)). Heteroskedasticity is tested using the modified Wald test. Depending on the results of the test for the individual models, we adjust the models if necessary. The adjustment differs with the type of the model. In the log-linearized version, we use the Huber-White's (sandwich) estimator recommended by Davidová & Benáček (2014) or Torres-Reyna (2007). The PPML version is estimated by a special Poisson estimators providing the robust standard errors described by Simcoe (2007) for the panel data case, and by Silva & Tenreyro (2010) for the cross-sectional case.

The last important assumption to be tested is the autocorrelation referring to the similarity between observations in time (from which is clear that the autocorrelation is a problem of the panel data only). Autocorrelation causes smaller standard errors and higher R-squared than in reality. It is tested using the Wooldridge test for the autocorrelation in the panel data. If the autocerrelation is detected, it is accounted for by clustering the standard errors.

The last assumption, which however does not have to be tested, is the normality of residuals. As we are having data set with a large N and a small T, the normally distributed error terms are not necessary (Davidová & Benáček (2014)).

The very last adjustment we have to do before the estimation, is the drop of one more variable in both, models for the Czech Republic and for France. To make the clustering possible, we have to drop the partner's recession dummy (rec_j). The data available for its computation are not sufficient, and it suffers from many missing values.

6.1.1 Panel Data Estimation Issues

Due to the presence of the autocorrelation, we have to somehow cluster the standard errors. Because of our data characteristics it is relatively clear, that the observations are very probably correlated within the same country. By clustering the standard errors in countries, we allow for correlation among observations within the same country over time. By doing so, we succeed to solve the autocorrelation problem.

By clustering the standard errors in countries, the export function reveals: "how much to expand exports to given country in time" (Davidová & Benáček

(2014), pg. 10). In the other words, longer time decisions of dynamic development of the exporter.

Another important note is that as we are using the fixed effects estimation for our panel data models, all the time invariant variables automatically disappear (Kucharčuková *et al.* (2010)). This might have been a problem when especially focusing on the core model variables (including distance), or on only one model and trying to discover all the factors influencing the trade function. However, none of those is the purpose of our research. We are aware of the fact that there are variables dropped from our FE model, and that there are ways to estimate them (using dummies, different ways for their inclusion that vary over time,...). However, we are not focusing on the solution of the FE problems in the gravity models, we are focusing on a simple comparison of the export functions, and the gravity model provides us rather a kind of framework than a precise guide.

6.2 FE Linear Model and FE PPML Estimation

The very first models comparison is rather illustrative and complementary from the theoretical point of view than necessary directly for our analysis. It is reason why we are not going so much into the details in the coefficients interpretation, more on that is done in the subsequent sections.

Table 6.1 shows the coefficients and their p-values for our basic model (the total export function) estimated with the FE linear model and with the FE PPML estimator. We do not do this comparison for the other two aggregations (SITC 7 and SITC 716.X). The gravity model in its log-linearized form is not able to deal with zero trade values that are more and more often when going further into the disaggregation, and so the linear model estimation would provide more and more biased estimate. We do the same for the French case. However, the results are not shown, but they are commented hereinafter.

The linear regression model is not badly specified, R-squared was equal to almost 70%. On the other hand in comparison with the Poisson regression, it does not seem to be sufficient. In the Poisson model, the explanatory variables described more than 99% of the variation in the Czech export. From the p-value for the chi-square, we can see that both models as whole were statistically significant.

Looking at the coefficients and their significance, the linear and the Poisson model differs a lot. Basically, the only coefficient that is significant and has the same sign is the ERDI ($ERDI$). However according to the Poisson model, it is more influential. In the linear case, the ERDI elasticity is close to 1. In the Poisson case, it is more than 1.3.

The last column of Table 6.1 indicates similarity in significance and sign of coefficient. Looking at it, it might seem the models are relatively similar. However, we have to realize that the vast majority of the variables with the similar coefficients are not statistically significant, and that there is no compliance in the core or at least the traditionally more influential variables. Institutional variables, that comply in our models, are often even neglected in the researches.

Except the $ERDI$; GDP_j, EU dummy variable and education index (edu) are statistically significant in the linear case, whereas, GDP_c, population (pop), rec_c and government spending ($gvtsp$) in the Poisson case.

Speaking of the French case, the difference is obvious as well. Only the $ERDI$ and GDP_f are statistically significant in the linear model case, while both, partner's and French GDPs (GDP_f and GDP_j), $ERDI$, dummy for

Table 6.1: **FE Linear Model and FE PPML Model Estimation Comparison: Czech Export:** Table showing comparison of the FE linear model and the FE PPML model for the total export functions for the Czech Republic, the last column indicates statistical significance and sign of coefficient similarity

	FE Linear Model		**FE PPML Model**		**Coefficient Sign Statistical Significance Similarity**
	$Prob>F = 0.0000$		$Prob>\chi^2 = 0.0000$		
	$R^2 = 0.6947$		$R^2 = 0.9923$		
	ln(export)		**export**		
	Coefficient	$P>\|t\|$	Coefficient	$P>\|z\|$	✓/×
$ln(GDP_c)$	0.4538	0.190	**2.6526**	**0.000**	×
$ln(GDP_j)$	**0.8495**	**0.002**	-0.2772	0.310	×
$ln(pop)$	0.7078	0.215	**1.3960**	**0.034**	×
$ln(ERDI)$	**-0.9998**	**0.000**	**-1.3165**	**0.000**	✓
rec_c	-0.0616	0.218	**-0.0572**	**0.004**	×
EU	**0.0874**	**0.000**	-0.0003	0.667	×
EUR	0.4601	0.551	0.0234	0.999	✓
$frecor$	-0.0028	0.503	0.0001	0.971	✓
$fisfre$	-0.0053	0.258	-0.0019	0.492	✓
$gvtsp$	0.0007	0.841	**-0.0042**	**0.039**	×
$busfre$	0.0034	0.407	0.0034	0.234	✓
$labfre$	0.0031	0.633	0.0033	0.182	✓
$monfre$	-0.0036	0.254	-0.0032	0.227	✓
$trafre$	0.0016	0.664	0.0039	0.203	✓
$invfre$	0.0037	0.158	0.0011	0.533	✓
$finfre$	0.0044	0.111	0.0014	0.450	✓
edu	**0.0381**	**0.005**	0.0128	0.229	×

Source: Author's computations.

recession (rec_f) and for the EU membership (EU) are significant in the Poisson model case. Moreover, both, the $ERDI$ and the GDP_f have higher elasticities in the Poisson case.

Because of considerable differences and the theoretical findings mentioned in Chapter 5 (Empirical Framework), we prefer the PPML estimate. Comparison done in this part basically only confirms and supports all the theory mentioned earlier.

6.3 Different Aggregations Comparison

Following sections estimate and describe the Czech and the French export on different aggregations. Based on the results for the particular aggregations, we describe the aggregation, compare it with the two remaining and try to discover the reasons for the differences between them. An important reminder for a better understanding and orientation is that we are using the SITC for the disaggregation. In the following paragraphs, we are referring to the total export; the SITC 7 export, which indicates machinery and transport equipment; and to the SITC 716.X (716.1, 716.2 and 716.3), which indicates electric motors and generators. For more details see Appendix A (Standard International Trade Classification (SITC))

6.3.1 Czech Export on Different Aggregations

To make the research synoptic, we divide the aggregations comparative analysis into two sections. Following section is dedicated to the Czech Republic analysis.

Total Export

Variables we have selected described the model well, R-squared was high, more than 99%. From the p-value for the chi-square, we can see that the model as a whole was statistically significant. All the variables' coefficients that were statistically significant, except the government spending, had expected signs.

The first variable that had a statistically significant influence on the Czech export was the home country's (Czech) GDP (GDP_c). Its elasticity considerably exceeded unity, and it was statistically highly significant as $P < 0.001$. Holding other factors fixed, 1% increase in the Czech GDP led to 2.7% increase in the Czech export. Possible interpretation for this effect is a higher total export in good years (years with a higher GDP) for the home economy. This statement was confirmed by the effect of the recession (rec_c). If the recession occurred in a given year, the export was 5.6% lower. Because of the high importance of the export for the Czech economy (Czech Position: International Trade and Industry), this effect works also in reverse, a high export can boosts an economic performance.

Table 6.2: **Comparison Based on Aggregations: Czech Export:** Table showing coefficients estimated and respective p-values for the total, SITC 7 and SITC 716.X export functions for the Czech Republic, the last three columns indicate statistical significance and sign of coefficient similarity, all the models are estimated by the FE PPML estimation.

	Total Export		**SITC 7 Export**		**SITC 716.X Export**		**Statistical Significance and Sign of Coefficient Similarity**		
	$Prob>\chi^2 = 0,0000$ $R^2 = 0.9923$		$Prob>\chi^2 = 0,0000$ $R^2 = 0.9743$		$Prob>\chi^2 = 0,0000$ $R^2 = 0.9834$		Total Export and SITC 7 Export	Total Export and SITC 716.X Export	SITC 7 Export and SITC 716.X Export
	Coefficient	$P>\|z\|$	Coefficient	$P>\|z\|$	Coefficient	$P>\|z\|$	✓/×	✓/×	✓/×
$ln(GDP_c)$	**2.6526**	**0.000**	**0.9338**	**0.038**	**3.4575**	**0.000**	✓	✓	✓
$ln(GDP_j)$	-0.2772	0.310	**0.5501**	**0.021**	-0.8141	0.299	×	✓	×
$ln(pop)$	**1.3960**	**0.034**	1.2343	0.168	1.1235	0.576	×	×	✓
$ln(ERDI)$	**-1.3165**	**0.000**	-0.2411	0.446	**-1.9451**	**0.000**	×	✓	×
rec_c	**-0.0572**	**0.004**	**-0.2949**	**0.000**	**-0.0970**	**0.026**	✓	✓	✓
EU	-0.0003	0.667	**0.4661**	**0.098**	-0.2860	0.290	×	✓	×
EUR	0.0234	0.971	0.0718	0.637	0.2169	0.177	✓	✓	✓
$frecor$	0.0001	0.999	**0.0127**	**0.019**	0.0031	0.473	×	✓	×
$fisfre$	-0.0019	0.492	-0.0018	0.749	**-0.0234**	**0.005**	✓	×	×
$gvtsp$	**-0.0042**	**0.039**	**-0.0075**	**0.027**	**-0.0120**	**0.011**	✓	✓	✓
$busfre$	0.0034	0.234	-0.0001	0,981	0.0025	0.547	✓	✓	✓
$labfre$	0.0033	0.182	-0.0001	0.996	0.0067	0.247	✓	✓	✓
$monfre$	-0.0032	0.227	-0.0064	0.403	-0.0038	0.600	✓	✓	✓
$trafre$	0.0039	0.203	**0.0188**	**0.050**	0.0118	0.136	✓	✓	✓
$invfre$	0.0011	0.533	-0.0011	0.771	0.0066	0.282	✓	✓	✓
$finfre$	0.0014	0.450	-0.0044	0.236	0.0006	0.859	✓	✓	✓
edu	0.0128	0.229	**0.0573**	**0.000**	0.0154	0.457	×	✓	×

Source: Author's computations.

Another statistically significant variable in the total export model was the partner's population (*pop*). As well as for the previous one, its elasticity exceeded unity, 1% increase in the partner's population increased the Czech export to the partner by more than 1.4%. The population is regarded as the market size proxy, so the Czech Republic exported more to the states with a larger market. There might be several causes, larger markets are able to absorb more products, they might be more prone to need for additional goods, or there might be a space for the Czech products (as the Czech Republic is a small economy and can suffer from obstacles when competing with larger ones).

The $ERDI$ is another variable statistically significantly influencing the Czech export between 1995 and 2013. Its effect was as expected negative, and highly significant. The Czech Republic exported less to the less developed countries (as we expect less developed countries to have a higher ERDI, see Empirical Framework). As already stated, less developed countries are not so able to export or import.

The only statistically significant variable of the institutional variables was the government spending (*gvtsp*). It indicates government spending as a percentage of the GDP. Even if it is difficult to determine an ideal level (depending on particular structure of the economy, public goods provided, culture, etc.), an excessive spending leads to the problems with the economic dynamism in the long-term. The sign of its coefficient was opposite than we would have expected, negative. This might have had several reasons according to us. Czech exporters did not take the government spending into account and the sign was rather random, or they took into account also the cultural factors, public goods, etc. that are not considered in the government spending index computation.

SITC 7 Export

R-squared for the export of machinery and transport equipment was slightly lower than in the total export case but still high, 97.4%. The model as a whole was again well specified. All the variables' coefficients, except the government spending again, had the expected sign.

In the export of machinery and transport equipment model, both GDPs, home and partner's, were statistically significant. This time the Czech GDP (GDP_c) as well as the partner's GDP (GDP_j) had a lower than a unity elasticity. Holding other factors fixed, 1% increase in the Czech GDP led to 0.9%

increase in the Czech export, 1% increase in the partner's GDP led to 0.6% increase in the export to the partner.

The effect of the GDPs can be again interpreted as a higher export in good times (this time both in home and in partner's economy). And again, for the Czech GDP it was supported by a negative effect and a statistical significance of the recession dummy (rec_c). If the recession occurred, the machinery export was 25.5% lower, which was definitely not negligible effect. The value of the partner's GDP's coefficient indicated that the Czech export to the partner was far from being proportional to the size of the partner's economy , which is not unanticipated in the specific industry export.

Being or not being the EU member (EU), was another variable having had a huge influence on the Czech machinery and transport equipment export. Being the EU member meant 59.4% higher import of the Czech machinery and transport equipment products.

In the SITC 7 export case, there were more statistically significant institutional variables. For the government spending index ($gvtsp$) the effect was again negative (1% increase in the government sending led to 0.8% decrease in the machinery and transport equipment export). Possible explanation is the same as in the previous case. The other two statistically significant institutional variables had an expected effect, but much higher importance than we would have expected. Trade freedom indicates how easily the export and import is possible to/from the country, it measures the absence of the barriers to trade (both tariff and non-tariff). It is nothing strange about the fact that the Czech exporters considered these factors, 1% increase in the trade freedom ($trafre$) led to 1.9% increase in the machinery and transport equipment export from the Czech Republic. The coefficient for the education index (edu) indicated that 1% increase in the index led to 5.7% increase in the export.

SITC 716.X Export

As in the both previous cases, R-squared was high for the SITC 716.3X export model, 98.3%, and the model as a whole was well specified. In the SITC 716.X export model, all the variables, but the institutional (fiscal freedom and government spending), had expected effects.

Gross domestic product's of the Czech Republic (GDP_c) elasticity again exceeded unity (as in the total export model case); and now, it attained even

higher value. 1% increase in the Czech GDP led to 3.5% increase in the Czech SITC 716.X export. Possible explanation comply with the previous ones.

The dummy for the Czech recession (rec_c) was again statistically significant. If there was a recession in a given year, the SITC 716.X export decreased by 9.2%.

Another statistically significant variable was the ERDI ($ERDI$), 1% increase in the ERDI led to 2% decrease in the SITC 716.X export. The reason might have been again the fact that the states with a higher ERDI are less developed, and are not able to export or import. Moreover, the export of such a specific group of products is much more probable to the advanced economies.

Both statistically significant institutional variables, government spending ($gvtsp$) and fiscal freedom ($fisfre$), had an opposite sign of coefficient than we would have expected. Possible explanation for the government spending is the same as in the total and machinery and transport equipment export cases. Fiscal freedom is an index referring to the tax burden imposed by the state; it is from the same group of variables as the government spending (according to the Heritage Foundation that provides with these institutional indexes), so the explanation might have been similar.

Comparative Analysis

Concerning the coefficients of determination, variables in all the models were able to describe a large amount of the variation. The highest R-squared was for the total export, which is not unanticipated, as all the variables were chosen with regards to the trade in general (not to the specific industry or group of products). Little bit unanticipated for us is a higher R-squared for SITC 716.X export than for the SITC 7 export. Machinery and transport equipment plays an important role in the Czech export, and we would have expected it to be determined by very similar factors as the total export (and so to have a higher R-squared than the SITC 716.X model) . However, the difference between the coefficients of determination is not substantial, it is less than 1%.

There were variables that had a statistically significant influence on the export on all the three aggregations, the Czech GDP (GDP_c), dummy variable for the recession in the Czech Republic (rec_c), and the government spending index ($gvtsp$). All these variables complied also in the signs of coefficients.

As we have already stated before, home GDP and recession in the Czech Republic are closely related. If the economy is doing well (high GDP or no

recession), the export is higher. However, from the common sense, and/or from statistical assumptions (that our model fulfills), it is clear that the GDP_c and rec_c cannot be perfectly collinear, and that there must have been some other information hidden behind the Czech GDP.

From the recession point of view, if the Czech Republic was in a recession, the total export decreased by 5.6%, the machinery and transport equipment export by 25.5% and the SITC 716.X export by 9.2%. So the aggregation that was the most sensitive to the presence of recession in the sense of export was the machinery and transport equipment, it was followed by the SITC 716.X, and the least sensitive was the total export. An important note is that the difference between total and the SITC 716.X sensitivity was apparent but not that striking (differently from the machinery and transport equipment difference).

Omitting the explanation connected with the recession and good times and ability to export more, there is another simple explanation. According to Gencer (2012), the GDP of the exporting country indicates its exportable surplus. In the other words, between 1995 and 2013, there was the highest surplus and so the highest ability to export SITC 716.X, it was followed by the total export, and the lowest surplus (but still close to unity elasticity) of the machinery and transport equipment. From a slightly different point of view, we can say that the electric motors and generators production was the most export driven, while the machinery and transport equipment production the least.

The last variable that was statistically significant on all the aggregations was the government spending (*gvtsp*). As we have already stated earlier, we would have expected the coefficient of the government spending to have an opposite sign. That is why, we are not going in to the details in comparison, and we are not trying to find possible causes, it would be on the level of speculations.

We can also find a possible explanation why some factors were influential on some aggregation and not on the others.

Population (*pop*), our market size proxy, was influential only on the total export level. This might have been caused by the fact that an export of a more specific product is rather connected to the specific market needs than to the market size.

The fact that the EU membership had a very high and statistically significant influence on the machinery and transport equipment export and not even significant influence on the remaining aggregations, might have been caused by the existence of a special agreement on the export of some products included

in SITC 7 (and not in SITC 716.X) with some other EU member (the agreement between the Czech Republic and Germany in the automobile industry).

The differences in the institutional variables are hard to judge, and might have been caused by randomization or by specific exporters' preferences and decisions. That is why we are not going into the details in their comparison.

6.3.2 French Export on Different Aggregations

As we have already stated before, we divide the aggregation analysis into two parts. Following part deals with the French export analysis. We do not go so much into the details with the French export functions analysis as in the Czech case. The reasoning would be similar in some cases, and moreover, we suppose the Czech export analysis to be main outcome of our research and the French one serves rather as a mean of comparison.

Total Export

Variables selected were able to describe more than 99% of the variation in the model. Model as a whole was well specified, and all the statistically significant variables coefficients, except the euro dummy and the investment freedom, had expected signs.

In the total French export model, both GDP variables (GDP_f and GDP_j) were statistically significant. Reasoning for the coefficient having been positive follows the idea of (Gencer (2012)) about the exportable surplus, or partially the connection with the recession influence that were already mentioned. Speaking of the recession, the recession dummy coefficient (rec_f) indicates 4.3% lower total export when the recession occurred.

Partner's GDP was statistically significant, but the value of the coefficient did not indicate any important influence, 1% increase in the GDP led to less than 0.1% increase in the French export.

The negative sign of the $ERDI$ coefficient simply indicated the same fact as in the Czech export case. France exported less to the less developed countries. If the ERDI rose by 1%, the French export to the country decreased by 0.6%.

Table 6.3: **Comparison Based on Aggregations: French Export:** Table showing coefficients estimated and respective p-values for the total, SITC 7 and SITC 716.X export functions for France, the last three columns indicate statistical significance and sign of coefficient similarity, all the models are estimated by the FE PPML estimation.

	Total Export		**SITC 7 Export**		**SITC 716.X Export**		**Statistical Significance and Sign of Coefficient Similarity**		
	$Prob>\chi^2 = 0.0000$ $R^2 = 0.9926$		$Prob>\chi^2 = 0.0000$ $R^2 = 0.9780$		$Prob>\chi^2 = 0.0000$ $R^2 = 0.9275$		Total Export and SITC 7 Export	Total Export and SITC 716.X Export	SITC 7 Export and SITC 716.X Export
	Coefficient	$P>\|z\|$	Coefficient	$P>\|z\|$	Coefficient	$P>\|z\|$	✓/×	✓/×	✓/×
$ln(GDP_f)$	**0.8131**	**0.000**	**0.8173**	**0.000**	0.3610	0.122	✓	×	×
$ln(GDP_j)$	**0.0495**	**0.022**	**0.0558**	**0.040**	**-0.1247**	**0.017**	✓	×	×
$ln(pop)$	-0.3643	0.225	**-1.2111**	**0.008**	**-2.2641**	**0.000**	×	×	✓
$ln(ERDI)$	**-0.5871**	**0.000**	**-0.4281**	**0.004**	**-0.5191**	**0.011**	✓	✓	✓
rec_f	**-0.0439**	**0.000**	**-0.0899**	**0.000**	0.0240	0.695	✓	×	×
EU	0.1524	0.932	0.0682	0.538	**0.5162**	**0.039**	✓	×	×
EUR	**-0.0031**	**0.076**	0.0202	0.704	0.21045	0.111	×	×	✓
$frecor$	**0.0020**	**0.052**	0.0008	0.571	-0.0015	0.730	×	×	✓
$fisfre$	0.0020	0.380	0.0016	0.668	0.0026	0.171	✓	✓	✓
$gvtsp$	0.0015	0.187	**0.0047**	**0.030**	0.0009	0.390	×	✓	×
$busfre$	-0.0012	0.456	-0.0041	0.109	-0.0060	0.171	✓	×	✓
$labfre$	**0.0040**	**0.063**	**0.0090**	**0.046**	0.0034	0.390	✓	×	×
$monfre$	**0.0037**	**0.003**	**0.0070**	**0.000**	0.0034	0.600	✓	×	×
$trafre$	0.0044	0.158	0.0020	0.627	0.0053	0.375	✓	✓	✓
$invfre$	**-0.0037**	**0.003**	**-0.0066**	**0.004**	-0.0009	0.823	✓	×	×
$finfre$	0.0006	0.531	0.0014	0.445	0,0053	0.180	✓	✓	✓
edu	0.0091	0.146	0.0106	0.243	**0.0228**	**0.090**	✓	×	×

Source: Author's computations.

The euro currency dummy (EUR) is the first variable with an unanticipated coefficient sign for the first sight. France exported by 0.3% less to the countries having had the euro. However, there are several explanations for that. All the states being the EU members are not having the euro and France might have exported more to those states. France has a rich colonial history, which means sharing the language, culture and generally having closer relationship, and the former colonies are neither having the euro. Or the reasons mentioned by Davidová & Benáček (2014), the tries to diversify or the euro crisis between 2007 and 2011.

All the remaining statistically significant variables were the institutional variables, more precisely freedom from corruption ($frecor$), labor freedom ($labfre$) and monetary freedom ($monfre$), all of them had an elasticity lower than 0.5%. Checking the interpretation of the indexes, the French exporters were interested in the level of corruption, legal and regulatory framework of a partner's labor market and price stability. There was one more statistically significant institutional variable, the investment freedom ($invfre$) that, however, had an opposite effect than we would have expected.

SITC 7 Export

Machinery and transport equipment export model as well as the previous one had a high R-squared, and according to the p-value for the chi-square, it was well specified. All the statistically significant variables, except population and investment freedom, had expected effects on the machinery and transport equipment export.

As in the total export case, both GDPs were statistically significant. Even the values were similar as in the previous case. Holding other factors fixed, 1% increase in the French GDP led to 0.8% increase in the machinery and transport equipment export. For the partner's GDPs, 1% increase led to 0.1% increase in the export.

There was again also a statistically significant effect of the recession (rec_f), that was, however, more influential than in the total export case. If the recession occurred, the machinery and transport equipment export was 8.6% lower.

Population (*pop*) elasticity was the opposite than we would have expected it to be, 1% increase in the country's population were causing 1.2% decrease in the machinery and transport equipment export to the country. As we have already stated in the Czech case, no effect of population might have been

caused by more specific products and needs, the negative effect might have been additionally caused by the the market size resistance effect explained e.g. by Hamilton & Winters (1992). The market size resistance refers to the fact that the greater the country is, the tougher is the domestic competition to imports, and the more difficult is the export penetration.

Another statistically significant variable was the $ERDI$. The ERDI had again the expected effect, it does not need any comment, as it was already commented before.

The remaining statistically significant variables were the institutional variables, the government spending ($gvtsp$), labor freedom ($labfre$) and investment freedom ($invfre$). As in the previous case, the significance of these variables depends rather on the concrete decision and opinion of the exporters. And same as in the previous case, investment freedom had an opposite effect than we would have expected.

SITC 716.X Export

As expected, R-squared was lower than in the two previous models, it was equal to 92.8%, which is, however, still very high. Referring to the p-value for the chi-square, the model was again well defined. However, the signs of the coefficients of the statistically significant variables are intuitively unexpected for us.

The economic size of France, its GDP (GDP_f), did not play any role in this case, as it was not statistically significant. Economic size of the partner (GDP_j) had a statistically significant effect, but the opposite than we would have expected, 1% increase in partner's GDP caused 0.1% decrease in SITC 716.X export to the partner.

Another variable that had a statistically significant influence on the SITC 716.X export was population (pop). However, also the population had an opposite effect than we would have supposed it to have (same as in the machinery and transport equipment export function). If the country's population rose by 1%, it led to 2.3% decrease in the SITC 716.X export to the country.

The ERDI variable again does not need any comment or reasoning, as it fulfilled our expectations, and we have already commented this before.

For the first time for the French export functions, the EU dummy (EU) was statistically significant, and had a large influence on the SITC 716.X export. Being the EU member meant 60% higher SITC 716.X export from France.

The second variable that was statistically significant for the first time, and had a large influence on the export was the education index (*edu*). 1% increase in the education index of the country led to 2.3% increase in the French export of SITC 716.X to the country. The education index influence is understandable, kind of products included in SITC 716.X are more probably to be needed and imported to the advanced economies.

Comparative Analysis

Speaking of the choice of the variables and their ability to describe the variation in the model, we can exactly see, what we have expected. The highest R-squared for the total export model and the lowest for the SITC 716.X model. We suppose the R-squared to go down with the disaggregation, as we are able to predict the factors influencing the total export better than the factors influencing the SITC 716.X export.

Speaking of the particular variables similarity, the total and the machinery and transport equipment models were more similar and also better meet our expectations than the SITC 716.X export model.

There was only one variable that was statistically significant and its coefficient had the same sign for all the models, the ERDI ($ERDI$). It means that the French export on all the aggregation we were investigating was influenced by the level of development of the partner's economy, which is directly connected with the ERDI. France exported less to the less developed countries. Moreover, also the values of the ERDI coefficients were relatively similar (the ERDI elasticity went from 0.6 to 0.4).

GDPs (GDP_f and GDP_j) had a similar influence on the total and on the SITC 7 export. Both GDPs had a positive influence on the export, French GDP elasticity was around 0.8 for the both aggregations, and partner's GDP elasticity was less than 0.1. Meanwhile, the the French GDP was not significant in the SITC 716.X export model, and partner's GDP had even a negative influence.

Population (*pop*) was not statistically significant at the total export level. On the SITC 7, and SITC 716.X level it had an opposite effect we would have expected, and the effect was more pronounced with the level of disaggregation (for SITC 716.X). We see the market size resistance effect to be the reason for that.

Recession dummy variable (rec_f) was statistically significant only for the first two aggregations (not for the SITC 716.X). Economic downturn was not

an important factor influencing the SITC 716.X export, as for example the production of such a specific products might not have been connected with the economic cycle of the economy.

There were several statistically significant institutional variables at the total and at the SITC 716.X export level, and as we have said these might have depended on very specific preferences of the French exporters.

However, there was only one statistically significant institutional variable on the SITC 716.X level, the education index (edu), plus the index was not significant on the other two aggregations. In general, it is easier to export the quality products (that the SITC 716.X products are) to the more advanced countries.

There were two more variables that had a statistically significant influence on only one aggregation, the euro dummy (EUR) statistically significant for the total export model, and the EU membership dummy (EU) statistically significant for SITC 716.X export model. The reasons for their significance were described in the respective previous sections.

6.3.3 French and Czech Export Functions Comparison

Starting from the core variables, GDPs, the difference is more than obvious for both, for the home as well as for the partner's GDP. Home country's GDP was more influential in the Czech export models, whereas, the partner's GDP in the French export models.

For the Czech Republic, the home country GDP exceeded unity in two cases (the total and the SITC 716.X export), the elasticity of the French GDP did not exceed unity in any of the models. The most noticeable difference for the home country GDP could have been observed in the 716.X models. The elasticity of the Czech GDP attained 3.5, whereas, the elasticity of the French GDP was not even significant. This could have been connected with a larger dependence of the Czech export on the state of the home economy, which is also visible in the larger influence of recession on the export than in the French case, or by a larger exportable surplus in the Czech Republic, or simply by the fact that the Czech Republic was more export-driven than France.

On the other hand, partner's GDP was more influential in the French case. It was statistically significant in all the three models in the French case. In the Czech case, it was significant only in the machinery and transport equipment model. This fact can have been connected with the size of the French economy

and its bargaining power relatively to the Czech one. The Czech Republic relies on its main and traditional trading partners (despite its tries to diversify). In the French case, there is a space for negotiation, where again more powerful countries (with a higher GDPs) are having an advantage.

As we have already mentioned, going further into the disaggregation, we suppose the needs of the market to be more important than its size. This was visible in the both countries' models. In the Czech case, the coefficients of the population variables were not statistically significant for the SITC 7 and for the SITC 716.X export models. In the French case, the market size was not statistically significant at the total export level, at the further disagragations it had even a statistically significant and negative effect. This was explained by the additional effect of the market size resistance.

The EU dummy was statistically significant only in one model for France (SITC 716.X), and in one model for the Czech Republic (SITC 7). We suppose the existence of a special trade agreement for the specific product or the cross-border cooperation for the product to be a possible reason. The dummy variable for the eurozone membership of the partner was statistically significant only in one model, in the model for the total French export. As we have already stated, the sign of the coefficient was opposite than we would have expected. The reason for that might have been the tries to diversify, trade with the partners with the common history that are not the eurozone members, trade with the EU members not having the euro, or the recent euro crisis.

The institutional variables seem to play a more important role in the French case. The effect of the particular variable depends on the specific preferences and choice of the exporter, so it would be very difficult to go variable by variable. However, there were several variables with an unanticipated effect or that at least deserve more attention.

The first one is the education index, we would have supposed the index to be more influential with the disaggregation, which was partially true. In the French SITC 716.X export model, the education index exceeded unity elasticity, 1% increase in the index led to 5.3% increase in export, however, the index did not have a statistically significant effect on the SITC 7 export level. On the contrary, in the Czech case, the education index did not have any effect on the SITC 716.X level, but had quite a large effect on the SITC 7 level, 1% increase in the index led to 5.7% increase in the export.

The other two coefficients that deserve comment are the fiscal freedom and

the government spending in the SITC 716.X Czech export case. Both coefficients exceeded unity, and moreover, both of them had a negative sign.

In general, the results of the Czech export models are intuitively more unanticipated. In the French case, we got some unanticipated results in the SITC 716.X model. However, we cannot suppose to be able to perfectly predict the results in such a specific and restricted field (SITC 716.X). In the Czech case, we got quite similar results for the total export model and for the SITC 716.X export model, but the results for SITC 7 differs. Not only we would have supposed the results to differ more when going further into the disaggregation, the SITC 7 export had represented very high share in the Czech export (more than 50% in 2013), and so we would have supposed it to be determined in a more similar way to the total export.

6.4 1995 and 2013 Comparison

Following section provides comparison of the export functions of 1995 and 2013. Following models are only one period models, so there is no reason for dropping the time invariant variables. However, this is not the main reason for the following estimations. We are rather interested whether the effects influencing the export functions differed over time and how. This is especially interesting in the Czech Republic models case, as the environment for the international trade in 1995 differs from the environment in 2013.

Unfortunately, because of our model characteristics, we are facing the dropping of another variables. We are focusing on the export function from a one country point of view, which means that the variables concerning the home country are constant over one year (GDP_i and rec_i in our case, where i stands for c and f). To be able to estimate the model, these variables have to be dropped (which prevents from the collinearity problem). Another variable that is dropped from a similar reason is the euro dummy. The euro currency was introduced in 1999, so the euro dummy values were the same for all the partners in 1995.

While estimation we discovered an additional problem with a hidden multicollinearity or endogenity with the dummy for sharing the language ($lang\_of$) in the French export models. That is why we drop also this variable.

Following estimations are done only for the total export. Even if it would be interesting to have them for all the aggregations, it would make our research rather confusing and unclear than more informative.

6.4.1 Czech Export in 1995 and 2013

Starting with the export functions of the Czech Republic, the independent variables chosen for our analysis again described the model well, R-squared was more than 98% in the both cases. All the variables, except the investment freedom in 2013, had expected signs of coefficients.

Speaking of the core variables, partner's GDP and distance (GDP_j and $dist$), their influence decreased between 1995 and 2013. In 1995, 1% increase in the partner's GDP led to 0.1% increase in the export to the partner; in 2013, it was 0.9% increase. It means that in 2013, the ratio was much closer to the export being proportional to the partner countries sizes ceteris paribus.

The influence of the distance rose from 0.7% to 1.1% decrease in the export

with 1% increase in the distance. This might seem unexpected, because of the increasing influence of globalization. However, many authors confirmed persistent importance of the distance for the international trade (Bergeijk & Brakman (2010)).

On the contrary, the influence of the population (*pop*) decreased between 1995 and 2013, from 0.2% to 0.1% increase in the export with 1% increase in the population. This might have been connected with the factors already mentioned in connection with aggregations. The market size might had been becoming less important in comparison with the market needs also with time.

The CZS dummy (CZS) was statistically significant with a really huge influence in both years. Holding other factors fixed, the export to Slovakia from the Czech Republic was 230.2% higher than to the different comparable country in 1995; in 2013, it was even higher, 409.7%. The rose might have been caused by the EU entrance (both, the Czech Republic and Slovakia entered in 2004). An important note is that a reason for the trade enhancement might not be purely the existence of the Czechoslovakia (one state) in the past, but also the common language, FSU influence, geographic location and the EU membership.

The two remaining cultural distance variables, (AH and CEE) gave us an unanticipated results, the statistical nonsignificance of the CEE dummy and the significance of the AH dummy (in 1995) at the same time. Being a state that was a part of the Austro-Hungarian Empire in the past, meant 60.5% higher export from the Czech Republic in 1995.

Moving to the geographic distance variables, sharing borders with the Czech Republic meant 455.0% higher export from the Czech Republic in 1995; and 35.5% higher export in 2013. Common borders were very influential in both years, however, as it is clearly visible, the effect in 1995 was much larger. The reason might have been the tries to diversify, together with the fact that Czech main trading partner has been Germany. The second geographic variable, the landlockness (*land*) appeared to be statistically significant only in 2013. Differently from our expectations, its effect was positive.

Concerning the institutional variables, only two of them had a statistically significant influence in 1995; in 2013, two more turned out to be influential. However, it is hard to do the conclusion, whether the Czech exporters started being more interested in the institutional indicators of the partner or vice versa. The two variables that were statistically significant in 1995 and remained significant in 2013 had a larger influence in 1995, and one of the newly statistically

significant in 2013 had an opposite effect we would have expected (the investment freedom).

Table 6.4: **1995 and 2013 Export Comparison: Czech Export:** Table showing coefficients estimated and respective p-values for the total 1995 and 2013 export functions for the Czech Republic, the last column indicates statistical significance and sign of coefficient similarity, both models are estimated by the PPML estimation.

	Export in 1995		**Export in 2013**		**Coefficient Sign and Statistical Significance Similarity**
	$R^2 = 0.9864$		$R^2 = 0.9948$		
	Coefficient	$P>\|z\|$	Coefficient	$P>\|z\|$	✓/×
$ln(GDP_j)$	**0.1298**	**0.008**	**0.8455**	**0.000**	✓
$ln(dist)$	**-0.7237**	**0.006**	**-1.1272**	**0.000**	✓
$ln(pop)$	**0.1638**	**0.000**	**0.0548**	**0.040**	✓
$ln(ERDI)$	-0.0314	0.936	0.0459	0.888	✓
EU	0.6327	0.136	0.3281	0.156	✓
CZS	**1.1945**	**0.000**	**1.6287**	**0.000**	✓
CEE	-0.8167	0.149	-0.0570	0.834	✓
AH	**0.4728**	**0.072**	-0.4382	0.104	×
$land$	0.0729	0.862	**0.4195**	**0.012**	×
bor	**1.7138**	**0.000**	**0.3038**	**0.087**	✓
$frecor$	0.0012	0.876	-0.0102	0.144	✓
$fisfre$	-0.0100	0.281	-0.0020	0.843	✓
$gvtsp$	0.0122	0.162	0.0037	0.372	✓
$busfre$	**0.0434**	**0.001**	**0.0129**	**0.028**	✓
$labfre$	-0.0050	0,532	-0.0046	0.208	✓
$monfre$	-0.0024	0.800	0.0088	0.289	✓
$trafre$	-0.0146	0.174	**0.0389**	**0.001**	×
$invfre$	0.0120	0.220	**-0.0106**	**0.095**	×
$finfre$	0.0765	0.228	0.0048	0.398	✓
edu	**0.0551**	**0.000**	**0.0223**	**0.021**	✓

Source: Author's computations.

6.4.2 French Export in 1995 and 2013

Same as in the case of the Czech Republic, R-squared were high, for both models more than 96%. As in the panel data models, there were generally more statistically significant institutional variables in the French case.

As in the Czech case, both core variables (GDP_j and $dist$) were statistically significant (in French case even highly), and had expected signs of coefficients.

Moreover, as in the Czech models, their influence increased between 1995 and 2013. If the partner's GDP rose by 1%, it led to 0.2% increase in the export to the partner in 1995, and even to 0.8% increase in 2013. If the distance between France and its partner increased by 1%, it led to 0.5% decrease in export to the partner in 1995; and to 0.7% decrease in 2013. As the effects and their changes were comparable to the previously described Czech ones, the reasoning would be analogical.

The effect of the population (*pop*) on the export was more or less similar to the Czech export model in 1995. In the Czech Republic, the effect of population on the export diminished between 1995 and 2013. In France it became even statistically insignificant. However, the explanation might have been again analogical.

Sharing borders (*bor*) dummy comply in statistical significance and in the sign of coefficient with the Czech models and with our expectations. Sharing borders with France meant 236.8% higher French export in 1995; in 2013, it was lower, but still very influential, 94.1%. Differently from the Czech case, the landlockness (*land*) dummy variable was statistically significant in both years, and differently from the Czech Republic, it had an expected effect.

The last dummy variable that had a statistically significant influence was the partner's EU membership (*EU*), which was statistically significant in 1995. Being the EU member meant 86.30% higher export from France. We see several reasons for its statistical significance in 1995 and nonsignificance in 2013, and significance in France (in 1995) and nonsignificance in the Czech Republic. France was one of the very first EU members, and so in 1995 it had certainly closer relations with the members than the Czech Republic (that entered the EU in 2004). From the French point of view, 1995 and 2013 comparison, in 1995, the EU was much narrower and the relationships much closer, which gives more than clear explanation for the partially seeming departure from the trade with the EU. Moreover, as we have already mentioned before, there was the euro crisis and the tries to diversify, which might have played a role, too.

Again, we do not go coefficient by coefficient in the institutional variables, we again highlight only variables with an unexpected effect. Differently from our anticipations, all the institutional variables had a strong influence on the export, and all of them had an elasticity exceeding unity, the monetary freedom ($monfre$) in 2013 even exceeded 2, 1% increase in the monetary freedom led to 2.4% increase the export. There were also variables with a negative influence (also exceeding a unity elasticity), the investment freedom ($invfre$) and the

education index (*edu*) in 2013. Again, it is really hard to do any conclusion about the importance of the institutional indicators and the difference between them in 1995 and 2013. There were more statistically significant institutional variables in 2013, on the other hand, two of them had an opposite effect we would have expected.

Table 6.5: **1995 and 2013 Export Comparison: French Export:** Table showing coefficients estimated and respective p-values for the total 1995 and 2013 export functions for France, the last column indicates statistical significance and sign of coefficient similarity, all the models are estimated by the PPML estimation.

	Export in 1995		**Export in 2013**		**Coefficient Sign and Statistical Significance Similarity**
	$R^2 = 0.9602$		$R^2 = 0.9754$		
	Coefficient	$P>\|t\|$	Coefficient	$P>\|z\|$	✓/×
$ln(GDP_j)$	**0.1958**	**0.000**	**0.7914**	**0.000**	✓
$ln(dist)$	**-0.4888**	**0.000**	**-0.7107**	**0.000**	✓
$ln(pop)$	**0.1208**	**0.000**	-0.0454	0.405	×
$ln(ERDI)$	-0.0421	0.909	-0.0934	0.741	✓
EU	**0.6222**	**0.056**	0.1726	0.452	×
col	0.4317	0.103	0.0940	0.219	✓
$land$	**-0.8666**	**0.074**	**-0.3701**	**0.062**	✓
bor	**1.2142**	**0.000**	**0.6632**	**0.000**	✓
$frecor$	**0.0123**	**0.047**	0.0029	0.422	×
$fisfre$	-0.0050	0.452	0.0025	0.694	✓
$gvtsp$	**0.0112**	**0.036**	-0.0023	0.708	×
$busfre$	0.0084	0.235	**0.0140**	**0.014**	×
$labfre$	0.0070	0.122	0.0005	0.888	✓
$monfre$	**0.0146**	**0.100**	**0.0244**	**0.004**	✓
$trafre$	0.0053	0.544	-0.0021	0.825	✓
$invfre$	-0.0005	0.930	**-0.0150**	**0.013**	×
$finfre$	**0.0108**	**0.048**	**0.0161**	**0.019**	✓
edu	0.0117	0.245	**-0.0151**	**0.069**	×

Source: Author's computations.

6.4.3 French and Czech Export Functions Comparison

To shortly sum up, we could have seen similar trends in the Czech and the French export functions between 1995 and 2013. The most unanticipated were the institutional variables results and some dummy variables.

The core variables fulfilled our expectations about statistical significance

and sign. Moreover, both of them followed the same trend in the Czech and the French export functions. In the both countries, their relative importance increased between 1995 and 2013.

On the contrary, the importance of the market size decreased in both states (in France it became even unimportant).

The EU membership appeared to be important only for the French export function in 1995. This might seem unanticipated as the EU membership is supposed to be the most influential membership for the Czech Republic. However, we found a possible explanation.

In connection with the cultural distance variables, in the French case, we were able to include only the dummy variable for being a former French colony, which was not statistically significant. In the Czech case, the cultural distance variables showed up to be quite influential. However, we did not anticipate the statistical nonsignificance of the CEE, and the statistical significance of the Austro-Hungarian Empire dummy at the same time (we would have expected the CEE to be more influential for the Czech export).

For the institutional distance variables, it is again very hard to do any comparison and conclusion. What we can say in general, is that we did not expect the institutional variables having been so influential.

Chapter 7

Conclusion

The aim of the thesis was the estimation and analysis of the Czech export with a further focus on the electrical engineering and on the electric motors and generators. Our research used widely applied tool for the international trade analysis, the gravity model of the international trade.

The basic form of the model assumes the trade flow between two countries to be proportional to their GDPs, and inversely proportional to the distance between them. Based on the endogenous theory of growth, we augmented the basic model by additional variables, which ensure the possibility to control for other factors commonly influencing the international trade. Strength of our research lies in its large span and novelty.

Differently from the vast majority of similar researches, we applied the gravity model on a one country's data, and we analyzed the export function valid only for this home country. Commonly used approach applies the gravity model on the bilateral trade flows of all the participating countries and estimates the average effects.

Further, we expanded our research by the analysis of the trade on disaggregated levels, and by the analysis of the export functions of one additional country, France. Both improvers were simply feasible, but both of them gave us a space for a powerful extension of the analysis. We were able to compare the export functions between, both, countries and aggregations.

The novelty is not the only contribution of our thesis. We tried to be the most precise possible and to provide a complete notion about the topic. That is why we started with a quite extensive description of the Czech industry and trade. Not only that having a deeper idea about the topic of the research is interesting, it also helps to better understand the results and implications.

Moving to the own analysis, the idea of the most complete notion possible is visible as well. Not only we estimated the panel data models that enabled the comparison of the elasticities between the countries and aggregations. In the very end, we provided additional models estimation. To gain the idea about the changes in the export functions between the first and the last year of our estimaion, between 1995 and 2013, we added one-period models.

The estimation method used through the whole thesis was the PPML estimator. Before the PPML was discovered to be a suitable estimator for the gravity model, the linear estimator had been commonly used. First, we showed the linear estimator inadvisability theoretically. It is not able to deal with the zero trade values and with the heteroscedasticity. After, we added an estimation of the same model by the linear estimation and by the Poisson estimation, which showed large differences in estimation results, and confirmed that the choice of the estimator matters. Based on this, we chose only one estimator for our research, the PPML estimator.

Moving to the own estimation, we analyzed the export functions of the Czech Republic and of France on three different aggregations (total, machinery and transport equipment and electric motors and generators export). We compared the results between the aggregations and countries, described them, and found causes for the differences. Having taken an advantage of the panel data, we were able to determine the factors influencing the Czech/French export decision from a longer time point of view.

In general, we found more unexpected the results for the Czech export functions. For France, we got unexpected results for the electric motors and generators export function, few statistically significant independent variables and a negative effect of the partner's GDP and population on the export. However, we have to realize that the independent variables were chosen with respect to the international trade in general not to such a specific group of products. For the Czech Republic, we did not get any unexpected results in statistical significance or a sign of some coefficient. However, we revealed an intuitively unexpected result showing that the export functions for the total and electric motors and generators were relatively similar, whereas, the export function for the machinery and export equipment differed.

What concerns the more concrete results, the Czech Republic was more influenced by its own GDP (possibly indicating the state of the home economy or exportable surplus), and so to be more export-driven than France. The most striking difference was visible for the electric motors and generators export. In

the Czech Republic, the export was very sensitive to the changes in home GDP (elasticity was equal to 3.5); in France, the export was not even sensitive to the home GDP changes. On the contrary, the French export was more sensitive to the changes in the partner's GDP.

Factor that followed similar trend in both countries was the population of the partner. Market size was becoming unimportant with disaggregation (for France the influence was becoming even negative).

The last highlight is the nonsignificance of the euro and the EU dummy. To be more specific, the euro dummy variable was statistically significant only for the total French export model and had a negative influence. We interpreted the phenomena by the recent euro crisis, closer relation of France to the eurozone, and on the other hand, by the recent tries to diversify and the fact that not all the EU members are having the euro. For the EU, that was statistically significant only on lower aggregations, we suppose the existence of some special agreement on a specific products to have been the possible reason.

In the very end, we looked at the export functions from a slightly different perspective. We added one period models to discover whether the factors having influenced the export differed with years. Those models were added mainly because of the Czech Republic that went through large changes from the beginning of nineties till now.

Generally, we did not see as many differences in the Czech and French export functions, as we would have expected. Moreover, some cultural, geographic and institutional variables were more influential than we would have anticipated. Partner's GDP and distance were statistically significant, and had an expected effect on the export. Moreover, their importance had an increasing trend in the both countries. On the contrary, the importance of the market size (approximated by the population) decreased in both countries (in France it even became unimportant). Finding that undoubtedly worth highlighting is the unanticipated statistical significance of the Austro-Hungarian Empire dummy in 1995, and at the same time, the nonsignificance of the CEE in any of the years in the Czech Republic. The EU dummy was statistically significant only for the French export in 1995, the reasoning could have been similar as in the panel data models for the EU or the euro.

We are aware of the fact that the PPML is not the only possible estimator as many authors showed. Even the authors that introduced the PPML did not suppose it to be the only suitable estimator under all the circumstances.

However, they showed it to be the best practice in general. Moreover, the aim of our research was not the different estimators comparison. The main intended contribution was the understanding of the Czech export and factors influencing it, which was successfully fulfilled. Our research, based on a single home country focus, and on comparison of the export functions between the various aggregations and with one additional country, is in contrast with the general approach very unique. As described above, the new way of gravity model utilization, as we performed in the thesis, has revealed findings that were not discovered before.

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Appendix A

Standard International Trade Classification (SITC)

Subgroup: 716.1 - Electric motors of an output not exceeding 37.5 W
• Section: 7 - Machinery and transport equipment • Division: 71 - Power-generating machinery and equipment • Group: 716 - Rotating electric plant, and parts thereof, n.e.s. • **Subgroup: 716.1 - Electric motors of an output not exceeding 37.5 W**
Subgroup: 716.2 - Motors (other than motors of an output not exceeding 37.5 W) and generators, direct current
• Section: 7 - Machinery and transport equipment • Division: 71 - Power-generating machinery and equipment • Group: 716 - Rotating electric plant, and parts thereof, n.e.s. • **Subgroup: 716.2 - Motors (other than motors of an output not exceeding 37.5 W) and generators, direct current**

Basic heading: 716.31 - AC motors (including universal (AC/DC) motors, but excluding motors of an output not exceeding 37.5 W)

- Section: 7 - Machinery and transport equipment
- Division: 71 - Power-generating machinery and equipment
- Group: 716 - Rotating electric plant, and parts thereof, n.e.s.
- Subgroup: 716.3 - Motors (other than motors of an output not exceeding 37.5 W) and generators, alternating current
- **Basic heading: 716.31 - AC motors (including universal (AC/DC) motors, but excluding motors of an output not exceeding 37.5 W)**

Basic heading: 716.32 - Generators, alternating current

- Section: 7 - Machinery and transport equipment
- Division: 71 - Power-generating machinery and equipment
- Group: 716 - Rotating electric plant, and parts thereof, n.e.s.
- Subgroup: 716.3 - Motors (other than motors of an output not exceeding 37.5 W) and generators, alternating current
- **Basic heading: 716.32 - Generators, alternating current**

Source: Author's computations.

Appendix B

Data Sources

Table B.1: **Data Sources:** Table showing the sources of the data we use for our estimations

Variable	**Source**
Export	CZSO, own estimation
Partner's GDP PPP	IMF, OECD
Czech (French) GDP PPP	IMF, OECD
Distance	CEPII
Population	IMF
ERDI	IMF, own estimation
Recession (CR, FR)	OECD, own estimation
Recession (partners)	OECD, own estimation
Euro	europa.eu
European Union	europa.cu
Common language	own estimation
Czechoslovakia	own estimation
CEE	OECD
FSU or CEE	OECD
Austria-Hungary	own estimation
Common language (official)	CEPII
Common language ($\geq 20\%$)	CEPII
Common language ($\geq 10\%$)	CEPII
Former colony (short-term)	CEPII
Former colony (long-term)	CEPII
Overseas departments and territories	france.fr
Landlockness	CEPII
Common border	own estimation

Property rights	Heritage Foundation
Freedom from corruption	Heritage Foundation
Fiscal freedom	Heritage Foundation
Government spending	Heritage Foundation
Business freedom	Heritage Foundation
Freedom from corruption	Heritage Foundation
Labor freedom	Heritage Foundation
Monetary freedom	Heritage Foundation
Trade freedom	Heritage Foundation
Investment freedom	Heritage Foundation
Financial freedom	Heritage Foundation
Education index	United Nations (Development Programme)

Source: Author's computations

CEPII

http://www.cepii.fr/cepii/en/bdd_modele/download.asp?id=6

CZSO

http://apl.czso.cz/pll/stazo/STAZO.STAZO?jazyk=EN&prvni=N

Europa.eu

http://europa.eu/

France.fr

http://www.france.fr/index.html

Heritage foundation

http://www.heritage.org/index/explore?view=by-region-country-year

IMF

http://www.imf.org/external/pubs/ft/weo/2013/02/weodata/index.aspx

OECD

http://stats.oecd.org/

UN (Development Programme)

http://hdr.undp.org/en/data