

International Trade and Economic Growth (the Czech Republic)

Bachelor thesis

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Hereby, I would thank the supervisor of my thesis, Ing. Miroslav Radiměřský, for his expert guidance and valuable advices that were so kindly provided throughout the whole writing process.

I would also like to thank my family and friends for their patience and support.

Statutory Declaration

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Abstract

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The bachelor thesis investigates the effect of international trade on economic growth of the Czech Republic. It provides an overview of the volume and structure of trade as well as a description of growth of the economy. In the chapter of literature review it presents a compilation of expertise related to the topic and in the next chapter, it provides a study of the effect based on the Ordinary Least Squares method processed in the economic software Gretl.

Keywords

International trade, economic growth, the Czech Republic, econometrics, export, import, openness

Abstrakt

Tůmová, E., Mezinárodní obchod a ekonomický růst (Česká republika). Bakalářská práce. Brno: Mendelova univerzita, 2016.

Bakalářská práce zkoumá vliv mezinárodního obchodu na ekonomický růst České republiky. Práce nabízí studii objemu a struktury zahraničního obchodu Česka nebo charakteristiku růstu ekonomiky. V kapitole nazvané literární přehled je poskytnut souhrn odborných znalostí souvisejících s předloženým tématem a následující kapitola uvádí studii vlivu obchodu založenou na metodě nejmenších čtverců v ekonometrickém programu Gretl.

Klíčová slova

Mezinárodní obchod, ekonomický růst, Česká Republika, ekonometrie, vývoz, dovoz, otevřenost

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1 Introduction

Economics and its growth is a subject to extensive studies aiming to interpret what factors and variables it is influenced by and how significantly. There have been various papers written producing rather conflicting results on this topic and many of those have been also widely criticised having several reasons for the critics.

The most common problem appearing mostly in older studies is a lack of reliable data which impedes the credibility of the results. There are not only difficulties with the quality of the data, though, as the results may also be influenced by other variances, such as the detail of the dataset used.

Apart from the quality and detail, some differences can also be found in the way how particular variables are interpreted and what data is used for its interpretation. As an example, we can use the variable of country openness.

There have been disputes among economists on how to assess this variable in the econometric models, however, there are two approaches that are most widely used. Economists frequently employ a distinction into four groups of inward and outward country orientation (strongly inward, moderately inward, moderately outward and strongly outward), or the ratio of export to GDP, import to GDP or trade to GDP (export plus import to GDP).

There are also differences when it comes to the approaches investigators take to examine the influence. Some of the papers are focused on one country only, some compare two countries to assess the effects and some use panel data of a higher number of states. Economists also use countless kinds of variables to prove or disprove the influence and are still coming up with new factors that could be of a significant effect (either positive or negative) on the growth, such as, for example, the geographical factors.

We, however, need to keep in mind that economic growth may be influenced by a large amount of factors and not all of them can be assessed by economic numbers and statistics. There are factors influencing trade and growth that cannot be calculated nor predicted in any way like natural changes or disasters, etc. It is, therefore, clear that the growth variable cannot be explained

completely by an equation and there will always be an unexplained part within the model as it is impossible to build a model completely explaining a given problem in reality.

Being aware of this issue, I am going to review some of the most important papers written on this topic and choose an equation presented in one of the published papers concerning the discussed relationship and use it to examine the influence of international trade and other variables on the economic growth of the Czech Republic.

2 Aim and methodology of the thesis

2.1. *Aim of the thesis*

The goal of my paper is to investigate and interpret the influence of international trade on the economic growth of the Czech Republic as this problem is nowadays being extensively researched and cited, the outcomes of such studies differing significantly.

The paper will characterise the volume as well as the structure of the trade and describe the growth of the Czech economy.

The literature review will present factual compilation of expertise related to the topic and the analytical part will find out to what extent the international trade affects the economic growth.

2.2. *Methodology of the thesis*

The thesis is divided into two main parts. The first part called Literature review summarizes the main pieces of knowledge regarding the international trade and economic growth studies. It reviews the most important papers written by economists and investigators from the recent years as well as some of the earlier ones.

The second one, the practical part called The influence of trade on the Czech economy, discusses the data needed for the economic growth interpretation and implements a model to test the significance of the chosen equation and its variables.

I am going to choose one of the equations published in recent studies and apply it on the environment of the Czech Republic to either confirm or disprove the influence of the chosen variables.

Then I am going to test the significance of the variables used as well as the model itself to make sure it is correctly built and then interpret the results using the Gretl econometric software.

Exercising various tests, it is evaluated whether the chosen model is correctly specified and how strong the effects of trade on the growth are.

For further information regarding the methodology of the analysis, please see chapter 4.2., where the model is explained to a greater detail.

3 Literature review

3.1. *Trade openness interpretation*

International trade is affected by openness and trade liberalization, which can be achieved through reduction of trade barriers, such as import and export tariffs, technical barriers or quotas.

Openness itself, as it will be explained in the next chapter, can be interpreted in various ways. The narrower terms include only import and export taxes and subsidies, while the broader interpretations may cover e.g. exchange rate policies, competition and other regulatory policies, the form of the government, domestic subsidies and taxes, the legal system and its nature, culture, etc.

The results in studies of trade in various countries are rather conflicting. Some results show a higher performance of export and thus higher country income in liberal markets, however, some suggest there is only a little effect on some of the world economies.

As for the nature of the studies, mostly a comparison of a gross domestic product growth between open and closed economies is used. The other view often adopted is comparison of the economy performance before and after a liberalization.

The World Bank, for example, came up with a classification of 41 researched countries into 4 groups: strongly outward, moderately outward, moderately inward and strongly inward oriented. This study concluded that performance of the outward oriented countries was better than the one of the inward oriented economies. A paper called "Trade policy and industrialization" (WORLD BANK, 1987) states the following about economy orientation:

"...inward-oriented regimes are generally characterized by high levels of protection for manufacturing, direct controls on imports and investments, and overvalued exchange rates. By contrast, outward orientation links the domestic economy to the world economy."

3.2. *The most influential studies of trade openness*

One of the most dominant papers concerning the trade and growth influenced by the country orientation is the one of Dollar (1992). He uses a sample of 95 developing countries to examine the sources of their growth within the years 1976-1985. By comparison of Asian outward oriented countries and more inward oriented economies of Latin America and Africa while controlling for development of these countries, he concludes that the outward oriented states do grow more rapidly.

Another influential study was carried out by Frankel and Romer (1999), who added geographical variables into their investigation. This factor is implemented due to the fact that it may naturally affect a country's trade as there are states that are isolated and do not have so many trade opportunities as opposite to those which lie next to some well-populated ones. The study thus concludes that trade raises income, having higher influence for larger countries that within their borders have more trade opportunities. However, as Frankel and Romer close, this method and its results can be applied to the effect of trade policies in a rather limited manner producing, at the end, dissimilar conclusions.

As an example of a paper concerned with trade liberalization and the effects of opening up the economy it can be used one executed by Aksoy and Salinas (2004), who studied the trade after liberalization and its impacts on the economic growth for a sample of 39 developing countries. They found out that the liberalization was followed by an increase in GDP per capita in an amount of 1.2 to 2.6 percent. In the research, Aksoy and Salinas used a sample of countries that do not have conflicts, do not depend on a single natural resource and are not transitioning from socialism. The growth in output was, as well, followed by a growth in investment and higher share of manufacturing exports, being most significant in smaller countries.

3.3. *Recent studies and their contribution*

3.3.1. Conflicting results and scepticism

Sarkar (2005) in his study based on Korea and India, on the other hand, concludes there is no link between openness and GDP and if there was some, then it would be negative. At the beginning, he has observed that after these countries opened up, the trade shares rose significantly. The process of opening up accelerated in India and decelerated in Korea but the real growth rate in these countries fluctuated resulting in a growth in India but a subsequent fall in the country of Korea.

There are, in general, a lot of disagreements among economists and researchers, concerning the relationship of the international trade and economic growth and the nature of this link. The inward and outward orientation and the impact of policies affecting the openness of a country to trade are subject to many studies. There are, furthermore, differences in the detail of the analysed data as well as their quality. All in all, the studies of developing countries are impeded by a lack of quality data resulting in possibly affected conclusions.

Rodrik and Rodríguez (2001) in their considerably sceptic study review the most influential papers which concluded that international trade has a positive impact on the economic growth. They, for example, investigate the work of Dollar (1992) or Frankel and Romer (1999) discussed above. In their paper Rodrik and Rodríguez state most of the results are obtained either from clear misspecifications or as a result of wrong openness measures usage having an independent effect on growth. To recapitulate, the paper explains the shortcomings of the most cited studies and concludes that the relationship is not significant but not negative either.

To get back to the more current work, Yanikkaya (2003) in his paper used various measures of openness to investigate this relationship and found conflicting results. The measure of trade shares would suggest a positive correlation between the studied variables, however, different measures of trade barriers proposed a positive association with growth in the developing countries.

In his paper, he reviews the existing measures of openness and divides them into five categories. The most basic measure of openness that he uses is, as noted above, the equation of trade shares, being import plus export divided by the gross domestic product: $(I+E)/GDP$. As Yanikkaya revised, most of the studies based on this simple equation conclude that there is a positive and significant relationship between international trade and economic growth. In his calculations, he also adds population density to measure the country openness assuming a country with higher density would be more open and grow faster.

As a second category, he presents a measure of trade barriers. This segment produces mixed results among economists. Third group would then be bilateral payment arrangements used as a measure of country orientations. The fourth class being an exchange rate with a black market premium used as the most common measure in this category. After revision of studies using this measure, Yanikkaya concludes that most of them confirm a significant and negative relationship with the growth. Fifth, the last category, a trade orientation, then discusses the outward and inward orientation that was reviewed above.

3.3.2. Studies focused on one country

Apart from the researchers studying multiple countries at once, some of the economists focused only on one country exclusively. An example may be Deme (2002) studying the country of Nigeria, whose paper confirmed a long-run relationship between trade and economic growth.

Sun and Heshmati (2003) present another one-country research following up China's economic growth. They have investigated 6-year panel data of 31 Chinese provinces and confirmed a positive impact of international trade on the country's economic growth. The possible drawback of this study may, however, be the short period of time investigated in the paper.

Edoumiekumo and Opukri (2013) used real gross domestic product in their annual time-series data to study the contribution of international trade on economic growth as well on Nigeria. They found a positive relationship between import, export and economic growth recommending diversification of export products as the export variable has been established as insignificant.

The study of Kenya made by Musila and Yiheyis (2015) focused on two types of trade openness: aggregate (or de facto) and trade-policy induced openness. A negative correlation was found between the trade-policy induced openness and economic growth. This result may have been caused by the fact that intermediate input costs increased in the country after liberalization and, furthermore, there was witnessed a collapse of some textile and automobile factories after the opening up as a result of incapability to compete with cheap foreign imports.

As an example of a one-country research based on a comparison of data before and after liberalization a study called "Impact of trade liberalization on economic growth of Sri Lanka: An econometric investigation" by Herath (2010) can be used. This paper confirmed a positive significant relationship between economic growth and trade liberalization for years 1977-2007. The rate of growth increased in the post-liberalization era by 1.73 percent.

3.3.3. Recent studies and revisions

Kneller (2002) came up with an investigation of the difference in the economy growth of countries that used to have a highly restrictive trade policy and recently liberalized with those where these kinds of policies still remain. They used the so-called "difference-in-differences" method for processing the comparison and concluded that there was not much of a difference in the economy performance between the two sets of countries and the growth has thus not been caused by the liberalization but rather some other external factor.

They, however, noted a possible link between welfare spending and social security and the liberalization as their levels relative to GDP went up after the opening up and did not change significantly in those non-liberalizing countries. No direct effect has been found after the regression, though, and the effects are thus rather indirect.

To sum up, Kneller's investigation found no proof that the changes of fiscal policy would offset the effect of trade liberalization on economic growth. Nonetheless, they suggest there is an indirect effect of the policies.

Another revision of the most cited papers as well as the more recent ones was then done by Andersen and Babula (2008), who analysed the link of trade and

productivity growth. Even though they conclude that there seems to be a positive relationship, they admit two important shortcomings. Firstly, they are concerned with the measurement biases and how these are handled. Secondly, they question the amount of productivity growth the developing countries are able to gain through international trade.

Most of the economists and researchers focused on the statistical significance of the investigated relationship. Lewer and Van den Berg (2003), on the other hand, were more concerned with the economic one. The study related to the size of the relationship discovered a rise of one-fifth of a percentage point in the rate of economic growth (either in GDP per capita or real GDP) for every one percentage point increase in trade. They thus finally conclude that free trade is beneficial for economic growth and subsequently for a human welfare.

If we would like to summarize the reasons for the contradictory results obtained by economists regarding this issue, we can use the following study executed by Greenway et al (2002). They used various measures of liberalization as well as several samples to find out the reason why the studies composed on the problem of liberalization and growth differ so significantly. They found out there is an effect of trade liberalization and GDP growth, however, it is merely moderate and appears to be lagged pointing to a j-curved type of response. GREENWAY et al (2002) highlighted the most important reasons for the varying conclusions of the economic studies interested in this issue as follows:

“First there is the obvious point that sample sizes and composition vary as do methodological approaches. Second, different analysts have used different measures; some are ex ante indicators of liberalisation, some are ex post and others are clearly indicators of openness. Third it is clear that many models which have been estimated are mis-specified. Fourth, it is important to model the dynamics in order to distinguish between impact and medium run effects.”

4 The influence of trade on the Czech economy

4.1. *Data interpretation*

The key variable that is used to investigate the economic situation of a country or comparing the country's economic results and development with other states is the Gross Domestic Product. It is a fundamental indicator of a national economy measuring its productivity.

Focusing on the Czech Republic, it can be said that the variable had had an increasing trend till the year 2008 when the great recession took place, which stopped the growth of the amount of GDP. In the last years we can, again, observe a slow increase of the overall amount reaching more than 4000 billion Czech crowns. Since the year 1993, this amount has grown in approximately triple its original size.

This development of the data presented in billion Czech crowns and overtaken from the Czech Statistical Office database can be seen in the graph below.

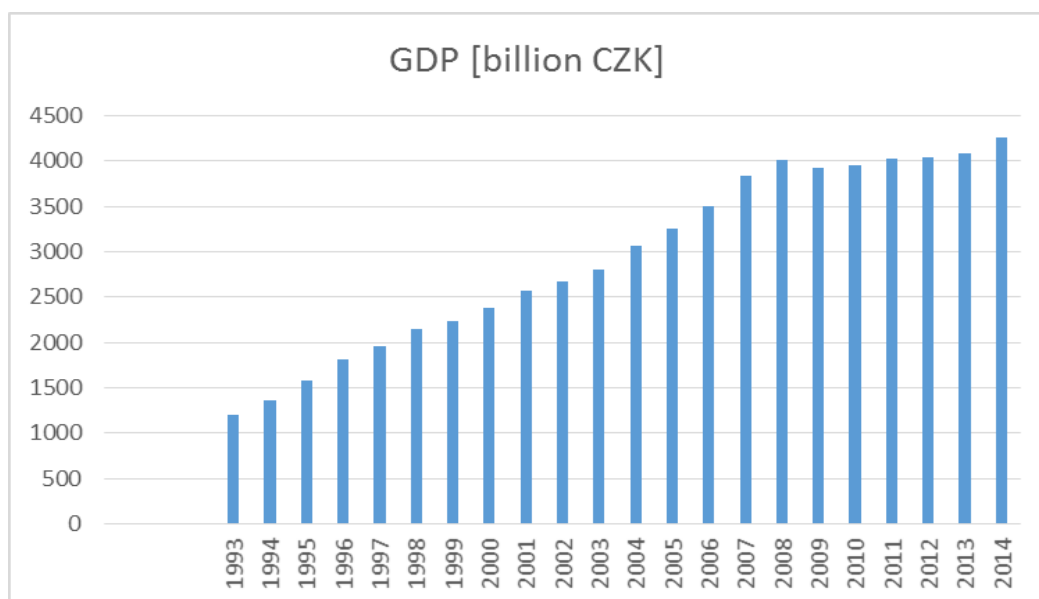


Figure 1: GDP in billion CZK in years 1993-2014 (Source of data: ČSÚ)

For the purpose of my study, it is vital to investigate the significance and overall amount of international trade and how it is distributed. The next graph thus shows the development of import and export of the Czech Republic throughout the first eleven years of the country being independent.

In the recent years, the most important export commodities have been cars and vehicle parts when the share of car export rose from approximately 4 percent to 10 percent in 2013.

The most crucial import commodity in the first years of the independent Czech Republic used to be crude petroleum which is now being overrun by the vehicle parts and accessories with the overall share of more than 5 percent.

In the following chart of export and import development there is once again an increasing trend with a rather significant drop visible in years 2008 and 2009 implying yet again to the great recession. In the recent years, the export amount is slowly beginning to overlap the one of import.

Data calculated by the Czech National Bank are displayed below, both variables reaching almost 250 billion CZK, which is about five times more than at the beginning.

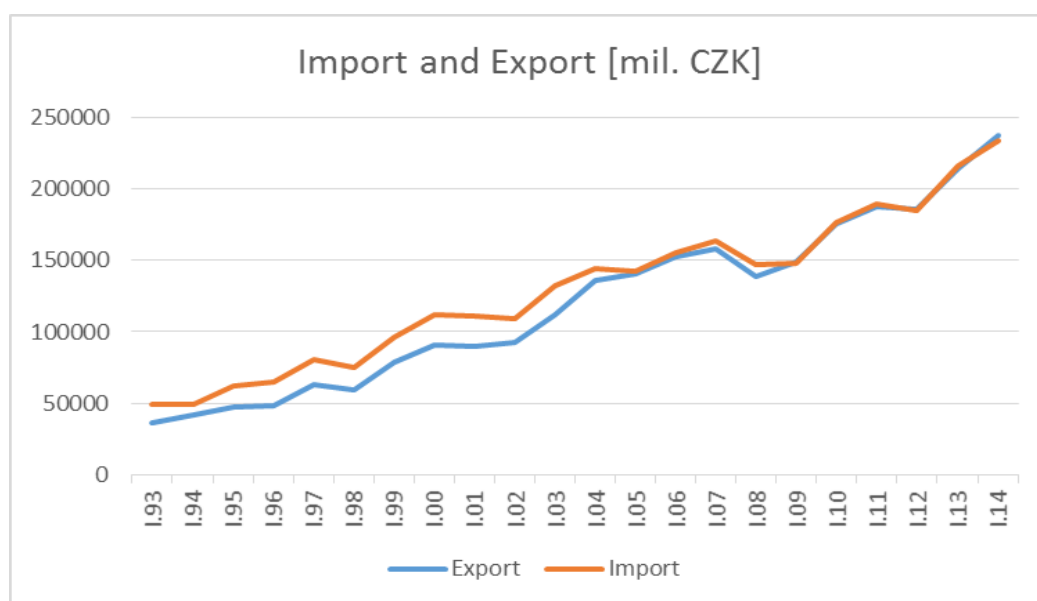


Figure 2: Import and Export in million CZK in years 1993-2014 (Source of data: ČNB)

The trade structure is then best assessed using the Standard International Trade Classification (SITC). This system classifies import and export into ten categories labelled by numbers from zero to nine, which provides an essential basis for the comparison of various countries concerning the international trade.

The ten categories as published by the United Nations Statistics Division (UN, 2016) are listed below:

- 0 – Food and live animals
- 1 – Beverages and tobacco
- 2 – Crude materials, inedible, except fuels
- 3 – Mineral fuels, lubricants and related materials
- 4 – Animal and vegetable oils, fats and waxes
- 5 – Chemicals and related products
- 6 – Manufactured goods classified chiefly by material
- 7 – Machinery and transport equipment

- 8 – Miscellaneous manufactured articles
- 9 – Commodities and transactions not classified elsewhere in the SITC

Based on the this system and data published by the Czech Statistical Office, the structure for the latest and the most recent years available online, 1999 and 2012, can be compared by means of the below tables.

Table 1: Structure of export based on SITC (Source of data: ČSÚ)

Structure of export [%]	1999	2012
Food and live animals	2,9	3,5
Beverages and tobacco	0,9	0,6
Crude materials	3,8	2,8
Fuels and related products	2,9	3,9
Animal and vegetable oils, fats and waxes	0,1	0,3
Chemicals and related products	7,4	6,2
Manufactured goods classified chiefly by material	26	17,3
Machinery and transport equipment	42,4	54,2
Miscellaneous manufactured articles	13,5	11,1
Not specified	0,1	0,1

Table 2: Structure of import based on SITC (Source of data: ČSÚ)

Structure of import [%]	1999	2012
Food and live animals	4,7	5
Beverages and tobacco	0,8	0,7
Crude materials	3,2	2,9
Fuels and related products	6,7	11,1
Animal and vegetable oils, fats and waxes	0,3	0,2
Chemicals and related products	12,3	11,1
Manufactured goods classified chiefly by material	21,1	17,8
Machinery and transport equipment	39,4	41,4
Miscellaneous manufactured articles	11,5	9,7
Not specified	0,2	0,3

As discussed above, the tables confirm that the most important export and import commodities fall into the category of machinery and transport equipment, which includes the vehicle parts and accessories mentioned.

The second place is then occupied by a category called 'manufactured goods classified chiefly by material', which, according to UN (2016) includes, for example, leather or wood manufactures, paper, iron and steel, manufactures of metals, etc.

If we take a closer look at the tables and compare the two years, 1999 and 2012, we can see there has not been a large change made in the structure within the thirteen years. In the export structure, the biggest differences can be observed in a category number 6 explained above, when its share decreased throughout the years by approximately nine percentage points. On the other hand, a significant rise, by about twelve percent, can be observed in the category number 7, which contains commodities related to machinery and vehicles. The share of the rest of the categories then did not change by more than two percentage points.

As for the import structure of the Czech Republic, in this table there can be noticed a similar trend to the one of export. The most significant changes were made in the categories 6 and 7, however, a significant rise is also witnessed in a category number 4 concerned with fuels and the related products. This increase amounts to approximately five percent.

Another variable connected to a trade and the economic situation, which also plays an important role in this study, is the openness of the Czech economy to international trade. This variable is basically a combination of those described above and can be explained by the ratio of export to GDP, import to GDP or export plus import to GDP $[E+I/GDP]$. All these possible calculations and their results are shown below.

The Czech Republic is considered an open economy and according to MIT Macro Connections¹ it is the 6th most economically complex country in the world based on a matrix that connects countries to products that they export.

¹ Macro Connections website that presents data for the Czech Republic based on MIT publications is the following: <http://atlas.media.mit.edu/en/profile/country/cze/>

The data are again acquired from the Czech National Bank and the Czech Statistical Office. The results show an increase mainly in the last six years, starting in 2009. Both the export and import openness measures suggest approximately seventy to eighty percentage openness, which is about twice the original amount in the year 1993.

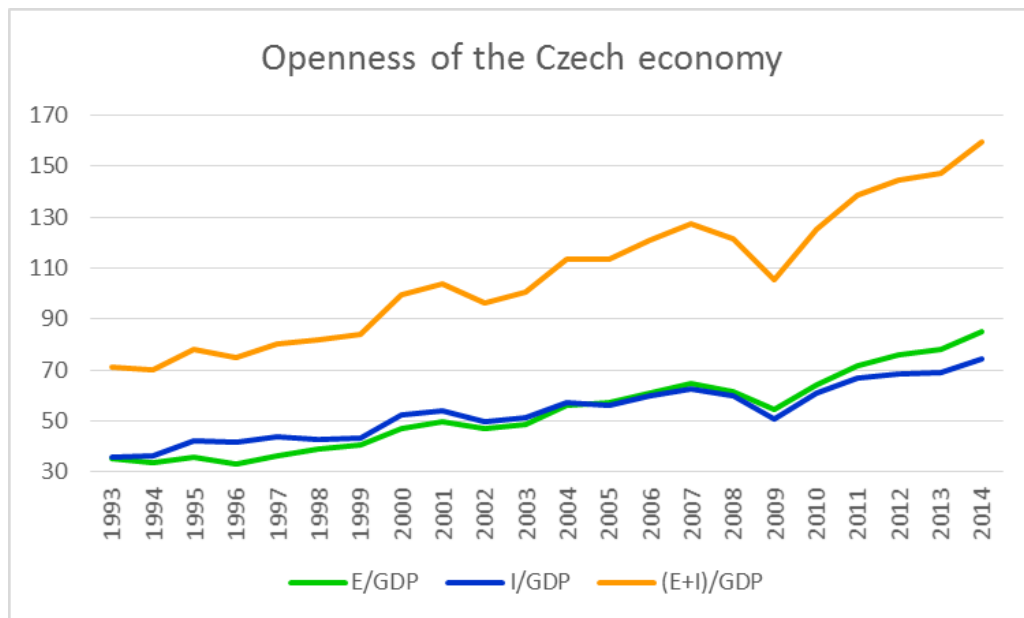


Figure 3: Openness of Czech economy (Source of data: ČSÚ and ČNB)

When investigating the international trade and openness of an economy, it is vital to define with whom the trade is conducted. This is even more important for the environment of the Czech economy, which is, due to its size, strongly affected by bigger economies it is surrounded by. It is no surprise that the biggest trade partner of the Czech Republic is Germany that leads the statistics for both export and import.

The export rate to Germany had been increasing since the formation of the independent Czech Republic till the year 1999 when the share was about 41 % of the overall Czech export. Since then the amount has been rather decreasing reaching approximately 29 % in the year 2013.

The second largest export partner is then Slovakia whose share showed a steady decrease till the turn of the millennium falling throughout the time from 21 to 6.5 percent. Since then the share has been equal to approximately 6-8 %. The below graph shows the development of the two most important export partners of the Czech Republic, Germany and Slovakia, based on the data acquired from MIT Macro Connections.

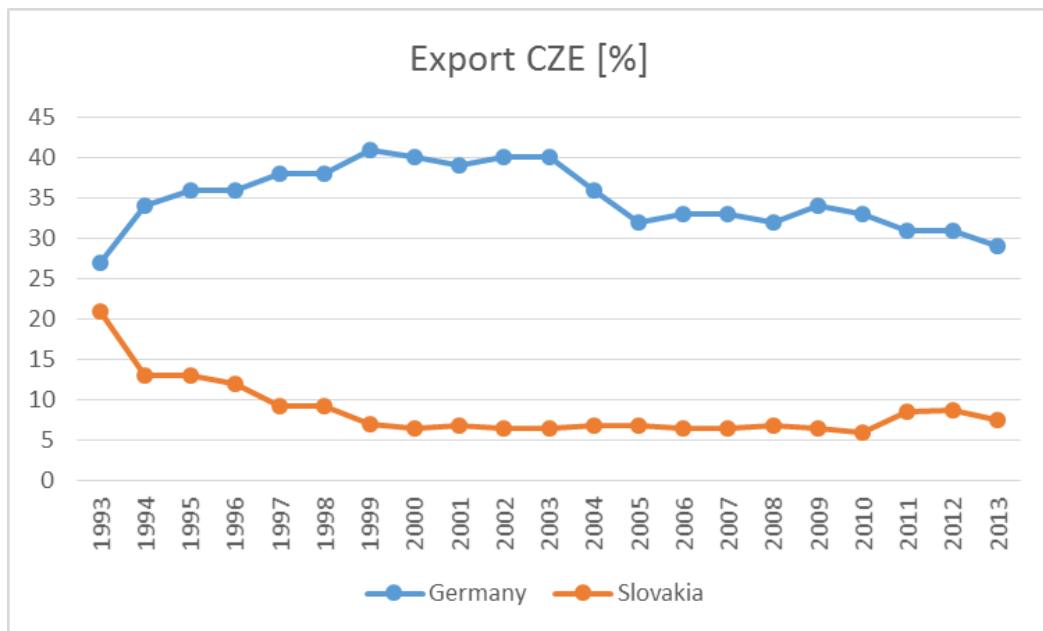


Figure 4: Export CZE to Germany and Slovakia 1993-2013 (Source of data: MIT data based website)

As mentioned above, the number one trade partner of the Czech Republic for both export and import is Germany. The second place in import statistics is, however, not that clear.

After the formation of the Czech Republic, the second largest import partner was, to no surprise, Slovakia. The share of import was around 26 % from Germany and 17 % from Slovakia.

Germany's share had been somewhat rising till the year 1998, however, then it slowly started to decrease with a very significant drop in 2004. From 2005 the portion had been again slowly decreasing every year when in 2013 the share reached 26 percent, which is the same percentage as at the beginning, in 1993.

Returning back to Slovakia, we can see in the graph below that its segment of import had been decreasing from the beginning till 1999 dropping from 17 to 6.1 percent. From this point it has been maintaining a share of approximately 5-6 percent losing its position of the second most significant import partner.

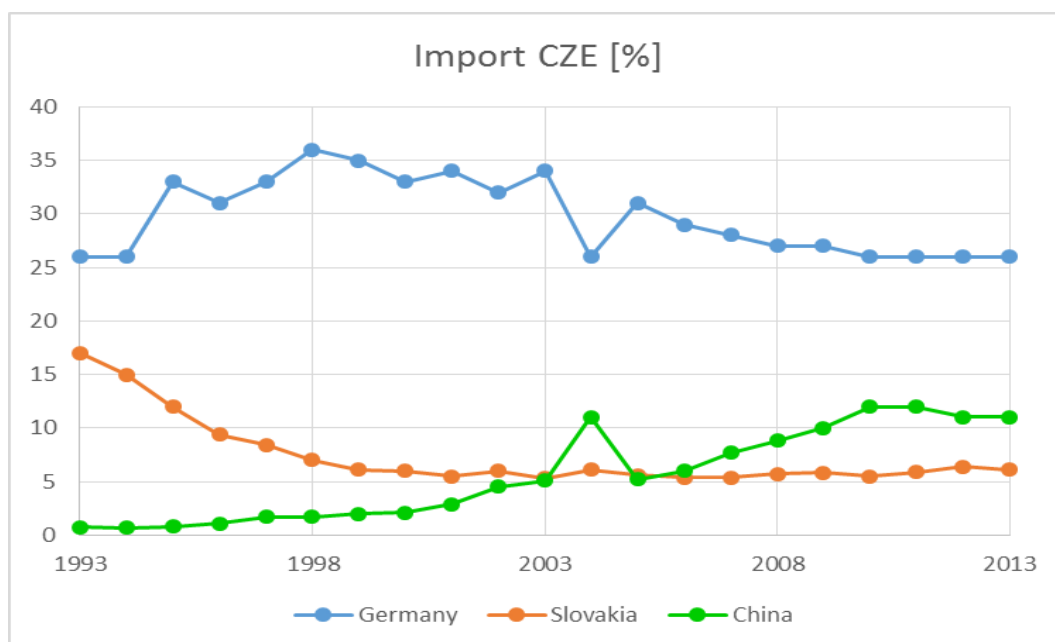


Figure 5: Import CZE from Germany, Slovakia and China 1993-2013 (Source of data: MIT data based website)

It is obvious in Figure 5 that around the year 2013 Slovakia was replaced by China at this position when it exceeded the borderline of 5% share of overall import conducted.

Then in the year 2004 we can observe fairly significant rise in the Chinese numbers. The German share dropped by 6 % while the Chinese one rose by approximately the same percentage (from 5.1 to 11 percent). Even though the portion again dropped to a number slightly higher than 5 %, the share has been increasing till now reaching around 11-12 percent.

Another important variable that is connected to import and export is the Real Effective Exchange Rate (REER), which is, simply put, a nominal effective exchange rate that is divided by a price deflator. The real effective exchange rate

is one of the indicators that can be used as a measure of the international competitive ability of a country.

Below we can see the development of REER within the years 1993 and 2014 with a base of the value 100 in the year 2010 based on the date from the ČNB.

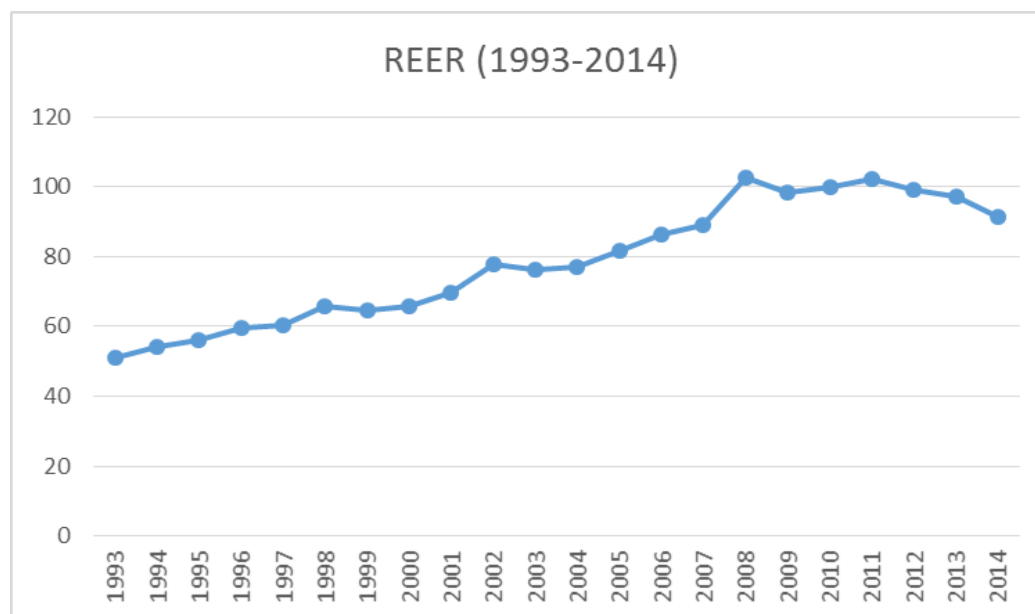


Figure 6: Real Effective Exchange Rate 1993-2014 (Source of data: ČNB)

The interpretation of the variable is fairly simple. For values above 100 it indicates a tendency towards decreasing competitive ability of the country, whereas decreasing value below 100 points to increasing the competitiveness compared to the base year.

4.2 *Methodology of the analysis*

The study is based on data collected for years 1993-2013, therefore from the establishment of the independent Czech Republic. The numbers used are secondary data published mostly by the World Bank, the Czech National Bank (ČNB) and the Czech Statistical Office (ČSÚ). Some additional data are taken also from a CSI database and the Macro Connections website² whose data are based on publications of the MIT (Michigan Institute of Technology).

The analysis is time-series based on the Ordinary Least Squares method. The model as well as the variables will be tested for their statistical significance and correctness. Other tests, such as the test of heteroscedasticity or the test of normality will be employed to examine the error term or residuals.

By virtue of the results and Gretl output, it will be concluded whether the employed variables explained below are statistically significant and to what extent.

As for the equation, in this paper, I decided to employ one based on a work of Radiměšský and Hajko (2015) published in the Enterprise and Competitive Environment Conference Proceedings of the 18th annual international conference.³

² Macro Connections website that presents data for the Czech Republic based on MIT publications is as follows:

<http://atlas.media.mit.edu/en/profile/country/cze/>

³ RADIMĚŘSKÝ and HAJKO in *18th annual international conference: Enterprise and Competitive Environment Conference Proceedings* [online]. 1. Brno: Mendel University in Brno, 2015 [cit. 2016-03-31]. ISBN 978-80-7509-342-4. Available at: https://ece.pefka.mendelu.cz/sites/default/files/imce/ece_2015_final.pdf

The equation is built as follows:

$$\begin{aligned} GDPgrowth_{i,t} = & \alpha_i + \beta_1 partner_{i,t} + \beta_2 \log(GDP_{i,t-1}) + \beta_3 REER_{i,t} \\ & + \beta_4 capital_{i,t} + \beta_5 tradetogdp_{i,t} + \beta_6 (tradetogdp_{i,t} * partner_{i,t}) \\ & + \beta_6 GL_{i,t} + \beta_7 (GL_{i,t} * partner_{i,t}) + e_{i,t} \end{aligned}$$

Due to the fact that I am not focused on the structure of trade in the thesis, I am going to adjust the equation by leaving out the Grubel-Loyd index (GL) in my model. After running a few tests in Gretl and based on the criterion values, such as Akaike or Hannan-Quinn, I also decided to use the GDP variable instead of the logarithm of GDP in the equation. The final form the model takes is presented below:

$$\begin{aligned} GDPgrowth_{i,t} = & \alpha_i + \beta_1 partner_{i,t} + \beta_2 GDP_{i,t-1} + \beta_3 REER_{i,t} \\ & + \beta_5 openness_{i,t} + \beta_6 (partner_{i,t} * openness_{i,t}) \end{aligned}$$

The indicators used in my thesis are thus those explained below:

- **GDPgrowth:** GDP growth counted based on the GDP per capita of the Czech Republic
- **Openness:** Rate of openness defined as ratio of Export plus Import to GDP [(E+I)/GDP]
- **REER:** Real effective exchange rate, which is *“the weighted average of a country's currency relative to an index or basket of other major currencies adjusted for the effects of inflation”*⁴

⁴ Real Effective Exchange Rate - REER. *Investopedia* [online]. New York, NY: Investopedia, LLC, 2016 [cit. 2016-03-27]. Available at: <http://www.investopedia.com/terms/r/reer.asp#>

- **GFCF:** Gross fixed capital formation, which “*refers to the net increase in physical assets (investment minus disposals) within the measurement period. It does not account for the consumption (depreciation) of fixed capital, and also does not include land purchases.*”⁵
- **Partners:** The weights of annual GDP growth of the six most important export partners of the Czech Republic (Germany, Slovakia, Austria, Poland, the United Kingdom and France) based on the value of export relative to the overall export value.

⁵ Definition of gross fixed capital formation. *Financial Times*: [ft.com/lexicon](http://lexicon.ft.com/Term?term=gross-fixed-capital-formation) [online]. London: Financial Times, 2016 [cit. 2016-03-27]. Available at: <http://lexicon.ft.com/Term?term=gross-fixed-capital-formation>

4.3. Results of the analysis and testing

4.3.1. Test of significance of model parameters

As discussed above, the model is built in the following way:

$$GDPgrowth_{i,t} = \alpha_i + \beta_1 partner_{i,t} + \beta_2 GDP_{i,t-1} + \beta_3 REER_{i,t} + \beta_5 openness_{i,t} + \beta_6 (partner_{i,t} * openness_{i,t})$$

The Gretl econometric software shows the following results for the above model equation and data set used.

Model 1: OLS, using observations 1994-2013 (T = 20)

Dependent variable: GDPgrowth

HAC standard errors, bandwidth 2 (Bartlett kernel)

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	-145.533	13.709	-10.6158	<0.0001	***
Openness	0.430506	0.0878303	4.9016	0.0003	***
GFCF	0.00114892	0.000150201	7.6492	<0.0001	***
GDP_1	0.0495604	0.00557097	8.8962	<0.0001	***
Partners	9.51953	3.39893	2.8007	0.0150	**
PartnersOpenness	-0.106169	0.0436532	-2.4321	0.0302	**
REER	0.246225	0.251774	0.9780	0.3459	
Mean dependent var	147.4827	S.D. dependent var	77.47787		
Sum squared resid	157.0440	S.E. of regression	3.475674		
R-squared	0.998623	Adjusted R-squared	0.997988		
F(6, 13)	14907.59	P-value(F)	3.62e-24		
Log-likelihood	-48.98671	Akaike criterion	111.9734		
Schwarz criterion	118.9435	Hannan-Quinn	113.3341		
rho	0.108630	Durbin-Watson	1.644724		

Source: Gretl output

The statistical significance of the variables is decided using a p-value of $\alpha = 0.05$. For p-value lower than α , the variable is statistically significant and vice versa.

Using the Gretl output above, we can thus say that all variables employed in the model are statistically significant, apart from the Real Effective Exchange Rate, where the p-value of 0.3459 is higher than 0.05.

4.3.2. Coefficient of determination and adjusted R^2

The coefficient of determination is used to describe to what extent is the difference in the first variable caused by the second variable. The value falls in $(0; 1)$ the interval of where the closer the number is to one, the better the goodness of fit is. The value of R^2 close to zero then indicates the model failing to interpret the variability in the second variable.

The adjusted R^2 is used to make sure there is not a nonsense explanatory variable added in the model as the number would then be higher than the coefficient of determination. The following equation thus has to hold:

$$R_{adj}^2 \leq R^2$$

In the case of my model the value of R^2 is 0.998623 and R^2 adjusted is 0.997988 and it thus holds that:

$$0.997988 < 0.998623$$

4.3.3. RESET test of correct model specification

RESET test is a test used to assess whether a model is correctly specified. The null hypothesis would confirm the correct specification, while the alternative one would disprove it. The null hypothesis is not rejected when a p-value is higher than 0.05.

H_0 : model correctly specified

H_1 : model incorrectly specified

The outcome of this test can be seen in the following table and we can confirm the model is correctly specified.

Table 3: RESET test (source: Gretl)

Ramsay's RESET test	Test statistic	p-value
<i>Squares and cubes</i>	8.559062	0.00573
<i>Squares only</i>	0.059979	0.811
<i>Cubes only</i>	0.098318	0.759

4.3.4. Non-linearity test

The non-linearity test in Gretl examines the form of the model.

The null hypothesis in this case is not rejected for a p-value higher than 0.05 and it means the chosen form of the model is correct. If the p-value is lower than the significance level, the form of the employed model is incorrect.

H₀: form of the model is correct

H₁: form of the model is incorrect

The results of the non-linearity tests can be found in the following table and we can say that the null hypothesis was rejected indicating incorrect form of the model.

Table 4: Non-linearity test (Source: Gretl)

Non-linearity test	Test statistic	p-value
<i>Squares</i>	13.3272	0.0381251
<i>Logs</i>	13.1866	0.0103993

4.3.5. Test of heteroscedasticity

Test of heteroscedasticity is a test of residuals and appears when the error term does not have a constant variance – there is no homoscedasticity of the error term.

The hypotheses are as follows:

H₀: homoscedasticity

H₁: heteroscedasticity

In Gretl, there are two tests that can be used for assessing this problem. These are the White's and the Breusch-Pagan tests. If the p-value is lower than α , the null hypothesis is rejected. For values higher than 0.05, there is homoscedasticity.

The values calculated for my model are displayed in the following table.

Table 5: Heteroscedasticity tests (Source: Gretl)

Model	Test statistic	p-value
<i>White's test</i>	12.2227	0.427967
<i>Breusch-Pagan test</i>	5.318928	0.503606

Based on the above numbers we can say that both p-values amount to more than 0.05 and it can thus be said that there is no heteroscedasticity in the model, the error term being homoscedastic.

4.3.6. Test of serial correlation

For the purpose of serial correlation examination, again, two tests can be employed in Gretl: the Ljung-Box and Durbin-Watson tests. The Durbin-Watson test investigates the presence of correlation of the first order, while the Ljung-Box test assesses correlation of a higher order. The null hypothesis states there is no autocorrelation of the first nor higher order.

The Durbin-Watson statistic takes value between zero and four, the ideal number being 2. In my case the value of the statistic is 1.64472, which is relatively close to the ideal number of two, however, it may indicate a slight autocorrelation.

The results are again visible in the table below.

Table 6: Durbin-Watson test (source: Gretl)

Model	Test statistic	p-value
<i>Durbin-Watson test</i>	1.64472	0.0381956

4.3.7. Test of normality

For testing normality, we use the Chi-quadrat test in Gretl, where the hypotheses are:

H_0 : normal distribution

H_1 : not normal distribution

For a p-value higher than the significance level of 95%, the null hypothesis is not rejected and we may observe normal distribution in our model. In the below figure the results of the Chi-quadrat test are displayed as well as the distribution itself.

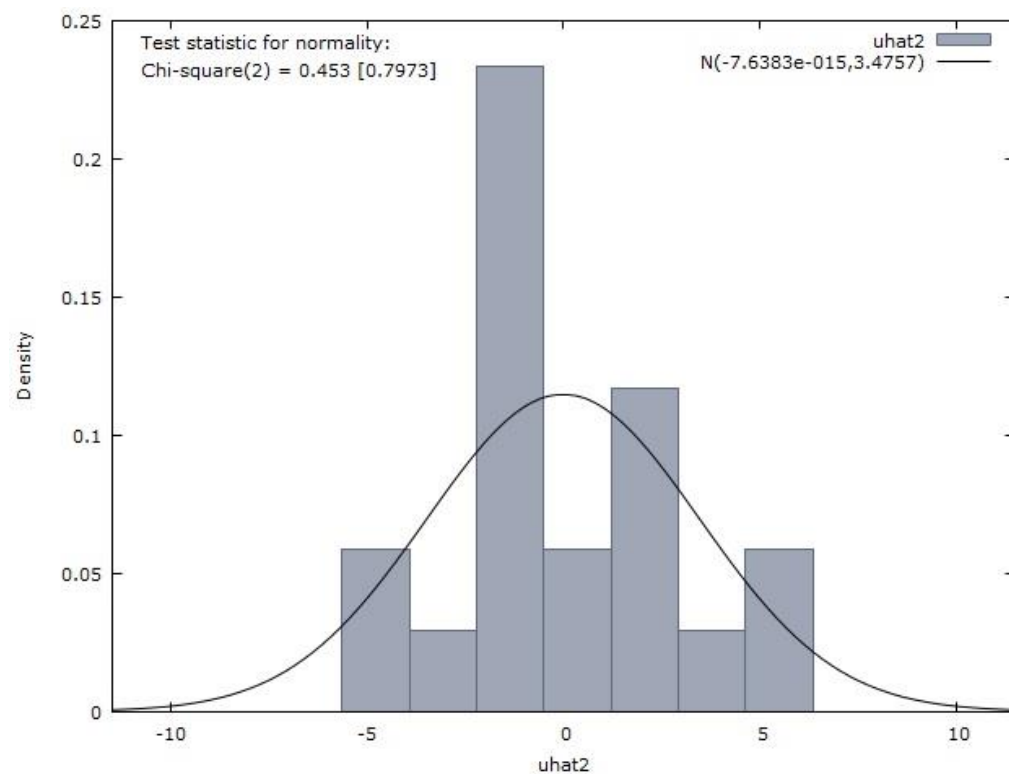


Figure 7: Normality of residual (Source: Gretl output)

As we can see in the above figure, the p-value is higher than the significance level, which implies normal distribution of the residual.

4.3.8. Analysis of variance (ANOVA table)

The ANOVA table is used for an analysis of variance explained or unexplained by the model. The explained variance is represented by the regression sum of squares, whereas the part that the model failed to explain is represented by the error sum of squares. The sum of the two components is then described as the total sum of squares.

The ANOVA table calculated by Gretl is presented below.

Table 7: ANOVA table (source: Gretl)

	Sum of squares	Degrees of freedom	Mean square
<i>Regression</i>	113897	6	18982.8
<i>Residual</i>	157.044	13	12.0803
<i>Total</i>	114054	19	6002.82
$F(6,13) = 18982.8/12.0803 = 1571.38$ [p-value 8.04e-018]			

Based on the p-value lower than 0.05 displayed in the ANOVA table above, a null hypothesis of the model insignificance is rejected. The table thus suggests the model significance on the 95% significance level.

4.4. Discussion

Based on the Ordinary Least Squares method run in Gretl and displayed above, it can be said that three of the variables employed in the model: the Openness, the Gross Fixed Capital Formation and the lagged GDP together with the constant are significant on a 99% significance level or higher. Two stars by the variables of Partners and Partners*Openness suggest the null hypothesis of significance was accepted on the 95-99% level of significance, while no star next to the Real Effective Exchange Rate indicates it is not statistically significant.

There may be several reasons for the insignificance of the real effective exchange rate in the model. One of the reasons may be simply the fact that other factors are much more significant than REER. On the other hand, international trade of the Czech Republic is mostly concluded in Euros and with the, more or less, constant exchange rate of Euro and the Czech Crown, it is possible that exporters managed to secure themselves against the exchange rate risk.

A number of tests was processed to make sure the employed model is correctly built and specified. Based on the knowledge of the results presented above, it can be said that variability in the model is explained well and there is no nonsense explanatory variable added as suggested by the determinant of variability and adjusted R^2 .

With the knowledge of the p-value of a RESET test it was confirmed that the model is, indeed, correctly specified and the test of heteroscedasticity then implied a constant variance of the error term, the so called homoscedasticity.

Based on the Durbin Watson statistic, it was revealed that even though the result was rather close to the ideal number of two, there may appear a slight serial autocorrelation in the model as a result of the equation employed and the dataset used.

One of the last tests conducted in Gretl was the Chi-quadrat test that examines the normality of the residual. Based on the results and the graph, it was confirmed that the residuals are normally distributed.

As a result, it can be said that all the above mentioned tests brought up positive outcomes, the only test that did not is the one of non-linearity. Using this test we examine the form of the model employed and the result of this test indicated an incorrect form. The reason for this outcome may be, for example, a missing variable in the model and it would thus be necessary to process a more in-depth analysis of the effects on the economic growth to correct this drawback.

Even though the model confirmed the influence of trade on growth of the economy being significant, it needs to be mentioned that the results of such model highly depend on the dataset used and, most importantly, the methodology of acquiring and calculating the data. An example of this possible difference-making setback may even be the dataset of export and import that is decided to be used as it may result in huge disparities in the outcome when, for example, either figures from the Czech Statistical Office or from the Czech National Bank are applied on the same variable. The employed equation of growth, however, confirmed a positive effect of trade on the Czech economy.

To conclude with, the outcome of the study says there *is* a positive influence of international trade and openness on the Czech economy, which correlates with the majority of papers written on this topic, such as the work of Sun and Heshmati (2003) on China or Deme (2002) and Edoumiekumo and Opukri (2013) on Nigeria. Out of the studies based on panel data that came to the same conclusion, Dollar (1992) or Aksoy and Salinas (2004) are the noteworthy representatives.

5 Conclusion

The economy of the Czech Republic is rather small, the most important and influential trade partners being the neighbouring countries – Germany, Slovakia, Austria and Poland. The sum of the shares of the Czech export to these countries amount to around 50 to 60 percent of the overall export conducted. Import share of neighbour countries, on the other hand, slightly decreased – from around 53 % to 39 %, which may be a result of the significant rise of import from China that reached around 12 % in the last years.

The Czech Republic economy is a very open one that relies on import and export to a great extent. One of the possible calculations of openness, the share of export to GDP, indicates more than 70% rate of openness, which is almost twice the rate of the year 1993.

It is evident that the amount of international trade of the Czech Republic is constantly growing, apart from a slight downswing in the years 2008 and 2009 caused by the great recession. The overall amount has, from the formation of the independent Czech Republic, increased to approximately five times the original size.

Similar trend to the one of trade can be observed with the variable of Gross Domestic Product. The increase has not been as significant as in the case of trade, however, the amount of GDP rose in the examined time-frame approximately to about triple its original size.

There are many theories and econometric models that confirm the positive influence of international trade on economy and its growth. Many theories find no influence or even a negative one, though. These disparities may be caused by a wrong specification of the model or by varying methodology employed for calculating particular variables.

In this paper, I decided to use a model based on an equation that employs economy openness, gross fixed capital formation, real effective exchange rate, lagged gross domestic product and a variable of trade partners constructed using weights of the share of export of the partners multiplied by GDP growth of those most important export partner countries.

As a result, the outcomes of the model confirm a positive influence of trade on growth of the gross domestic product and thus the Czech economy as every variable employed in the model shows statistical significance (apart from REER as discussed in the previous chapter).

If we take a look into the latest statistics of the economy of the Czech Republic, we can witness a rapid growth in the last year (2015) when the Czech growth was the highest among all European countries, GDP growing by 4.2 % in the first quarter.

As for the foreign trade in the year 2015, the volume of trade in the first half of the year was the largest in the history of the independent Czech Republic – as the statistics of the Czech statistical office suggest – with the annual growth of both import and export by around eight percent.

Even though there are other factors that intensively influence growth of an economy, based on the above calculations as well as the latest statistics, it can be concluded there is a positive effect of international trade on the economic growth of the Czech Republic.

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Attachments

Table 8: GDP of the Czech Republic in billion CZK (1993-2014)

Year	GDP
1993	1195,811
1994	1364,823
1995	1580,115
1996	1812,622
1997	1953,311
1998	2142,587
1999	2237,3
2000	2372,63
2001	2562,679
2002	2674,634
2003	2801,163
2004	3057,66
2005	3257,972
2006	3507,131
2007	3831,819
2008	4015,346
2009	3921,827
2010	3953,651
2011	4022,511
2012	4041,61
2013	4077,109
2014	4260,886

Table 9: Openness of the Czech economy (1993-2014)

Year	E/GDP	I/GDP	(E+I)/GDP
1993	30,67207	41,04829	71,72036384
1994	31,02893	36,28309	67,31202508
1995	30,05731	39,42181	69,47912019
1996	26,69503	36,00916	62,70419315
1997	32,15668	41,49979	73,65647355
1998	27,59655	35,20464	62,8011838
1999	35,3426	42,96429	78,30688777
2000	38,19812	47,03515	85,23326435
2001	35,17413	43,42643	78,60055824
2002	34,50678	40,86353	75,37031235
2003	40,07336	47,17398	87,24733263
2004	44,54079	47,06949	91,61028368
2005	43,09782	43,63383	86,73165392
2006	43,54497	44,21945	87,76441485
2007	41,34987	42,64925	83,99911374
2008	34,4451	36,53623	70,98133013
2009	37,90927	37,77558	75,684853
2010	44,52237	44,74054	89,26291167
2011	46,57598	47,11219	93,68817139
2012	45,9411	45,8206	91,76169893
2013	52,59021	53,02483	105,6150326
2014	55,60017	54,85432	110,4544923

Table 10: Gross fixed capital formation in mil. CZK (1993-2014)

Year	GFCF
1993	33052,8948
1994	39749,03859
1995	52854,4
1996	61664,6
1997	62578,9
1998	65278,5
1999	65928,8
2000	72796,4
2001	78333,2
2002	78418,8
2003	80764,5
2004	86092,8
2005	92181,9
2006	98295,1
2007	113239,2
2008	116533,2
2009	106347,2
2010	106600,5
2011	106899,2
2012	105211
2013	102479,1
2014	106546,4

Table 11: Import and Export of the Czech Republic in mil. CZK (1993-2014)

Year	Export	Import
1993	36678	49086
1994	42349	49520
1995	47494	62291
1996	48388	65271
1997	62812	81062
1998	59128	75429
1999	79072	96124
2000	90630	111597
2001	90140	111288
2002	92293	109295
2003	112252	132142
2004	136190,6	143922,5
2005	140411,5	142157,8
2006	152717,9	155083,4
2007	158445,2	163424,2
2008	138309	146705,6
2009	148673,6	148149,3
2010	176025,9	176888,5
2011	187352,4	189509,3
2012	185676	185189
2013	214416	216188
2014	236906	233728

Table 12: Real Effective Exchange Rate of the Czech Republic (1993-2014)

Year	REER
1993	51,150814
1994	53,990767
1995	55,939068
1996	59,62234
1997	60,39566
1998	65,804737
1999	64,661422
2000	65,699738
2001	69,81217
2002	77,78037
2003	76,292062
2004	77,167047
2005	81,665306
2006	86,20273
2007	88,884352
2008	102,58079
2009	98,427526
2010	100
2011	102,1558
2012	99,052516
2013	97,112548
2014	91,412643

Table 13: The most important partner countries for Czech export and their share in percent (1993-2013)

Year	Germany	Slovakia	Austria	Poland	UK	France
1993	27	21	5,7	2,6	2,5	2,2
1994	34	13	6,6	3,3	2,7	2,3
1995	36	13	6,4	4,6	2,5	2,4
1996	36	12	6,5	5,5	2,8	2,8
1997	38	9,3	6,2	5,7	3,7	3,6
1998	38	9,3	6,2	5,7	3,7	3,6
1999	41	7	6	5,7	3,6	4
2000	40	6,5	6,1	5,3	4,1	4
2001	39	6,8	5,8	5,2	4,8	4,2
2002	40	6,6	5,7	4,6	4,8	4,2
2003	40	6,6	6,2	4,7	4,6	4
2004	36	6,8	6	5,5	3,9	4,3
2005	32	6,8	5,8	5,2	4,8	5,8
2006	33	6,5	5	5,1	4,8	6,1
2007	33	6,5	4,8	5,1	5,2	5,6
2008	32	6,9	4,9	5,7	4,8	5,2
2009	34	6,5	4,6	5,1	5	5,6
2010	33	6	4,7	5,4	5,1	5,4
2011	31	8,6	4,6	6,2	4,3	5,3
2012	31	8,7	4,6	6	4,6	4,9
2013	29	7,6	4,5	5,2	4,9	5,1