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Bachelor Thesis

Influence of the single currency on the trading volumes of EMU members and the Czech Republic

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Abstract

In this thesis, we focus on the impact of the single European currency on the trade volumes of EMU countries and the Czech Republic. We built on Rose's gravity model, which explains to us, although not very accurately, possible impact of the single European currency on the trade volumes. We centre our research on trade among 25 countries, including EU countries, Switzerland, Russia, Ukraine, USA, Canada and Mexico.

We use gravity model and do regression, to compare and analyze data for 8 chosen EU countries, including those, that were in EMU and using Euro from the beginning, those that declined Euro and the Czech Republic, which has not adopted Euro yet. The main contribution of this thesis is a prediction of possible impact on trade in the Czech Republic, if we accepted Euro. This prediction will be based on analysis from other countries and its comparison.

Keywords	Gravity model of International Trade, European Currency, Panel Data

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Abstrakt

V této tezi se soustředíme na dopad jednotné evropské měny na objem obchodů mezi státy s členstvím v EMU a Českou republikou. Využíváme Roseového gravitačního modelu, který nám vysvětluje, ačkoliv ne velmi přesně, možný dopad jednotné evropské měny na objemy obchodu. Náš výzkum se soustředí na obchod mezi 25 státy, zahrnující státy EU, Švýcarsko, Rusko, Ukrajinu, USA, Kanadu a Mexiko.

Používáme gravitační model a regresy k porovnání a analýze dat pro osm států z EU, zahrnující ty, jenž jsou členy EMU a používají Euro od začátku, ty jenž Euro zamítli a Českou republiku, jenž ještě Euro nemá. Hlavním zaměřením této teze je odhad možného dopadu na obchod v České Republice, pakliže by přijalo Euro. Tento odhad vysvětlíme pomocí analýzy ostatních států a jejich porovnáním.

Klíčová slova Gravitační model mezinárodního obchodu, Evropská měna, Panelová data

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Acronyms

coeff.	coefficient
EMU	Economic and Monetary Union
est.	estimate
CU	currency union
EU	European Union
ERM	European Exchange Rate mechanism
EMS	European Monetary System
WW2	World War II
ECU	European Currency Unit
ECB	European Central Bank
OECD	Organization for Economic Co - operation and Development
WTO	World Trade Organization
NATO	North Atlantic Treaty Organization

Chapter 1

Introduction

We are going to discuss, in my bachelor thesis, possible impact on countries' trade volumes, if they had adopted Euro and in case of the Czech Republic, what may be the effect, if we accepted this currency. We are inspired by Andrew K. Rose, the economist, whose paper from 2000 has evoked many questions. He claimed, that the possible effect of single currency on the trade volumes is an increase of 300%. And this is going to be the main point of our interest in our research, whereas we decline this assertion or we accept it. In the chapter two, we are going to introduce topic of gravity model of trade. In addition, we describe in this chapter how it works and how Rose used this model. Furthermore, this part of our thesis also reveals the common mistakes of this model and shows us reactions of other economists. The following chapter introduces countries we used in this thesis for our regression and gives brief of EMU and its convergence criteria. Also this chapter brings you historical steps that led to the EMU, how we know it these days. Next part shows all steps we have done, how we collected the data and how we prepared them for regression. Moreover, we introduce in this chapter the regression methods we used for our research. Chapter called The Model will reveal the basics of the model we constructed for our regression and tells you where we would like to aim this results. The chapter six connects to the previous chapter and uncovers all the results we received from the regression of every country we introduced in chapter three. In Appendix you can examine all results from the regression.

Chapter 2

Gravity model

2.1 What is it?

When someone says a gravity model, everyone reminds the gravity effect, which was described in Isaac Newton's law of gravity. Which says, every point mass attracts every single other point mass by a force pointing along the line intersecting both points. The force is directly proportional to the product of the two masses and inversely proportional to the square of the distance between the point masses (Cohen and Whitman 1999).
Gravity model of trade works similarly. It is based on the idea, that two trading countries, which are closer than another pair of trading countries, trade more and if the country is larger, in mean of the population and GDP, its trade volumes are also larger.

2.2 History of Gravity Model

Firstly we are going to describe empirical foundation of the model, because in comparison to other economic models, this one was used, although it did not have any theoretical foundation.

2.2.1 Empirical foundation of gravity model

If we look back in 1960's Tinbergen and Poyhonen created model that used, as we mentioned above, just two variables, which were the distance and national income. It looked like this:

$$\ln(IT_{ij}) = \alpha + \beta_1 \ln(Y_i Y_j) + \beta_3 \ln(Dis_{ij}) + \varepsilon_{ij}$$

where

- IT stands for international trade between a pair of countries
- Ys are the national income of country i and j
- Dis is the distance between i and j countries

This model appeared consistent and statistically significant in an equation which describes amount of the cross-country trade. That fact was unusual for economics in that time.
Afterwards, this model became the matter of dispute. If the gravity model works empirically with great significance, does it work in theory? What is the closest model which can explain gravity model?

2.2.2 Theoretical foundation of the model

As the gravity model was unique and unusually accurate, it needed some theoretical support to be used by policy makers. Anderson (1979) described, with great excellence, how should theoretical foundation look like. We will present most of steps Anderson did. Firstly, he rearranged Cobb-Douglas expenditure system and received the simplest equation :

$$M_{ij} = \frac{Y_i Y_j}{\sum_j Y_j} \tag{2.1}$$

where

- M_{ij} is consumtion in value and quality term of good i in country j
- Y_i is income in country i
- Y_j is income in country j

The problem of this Cobb-Douglas based "gravity" model was, that it was not so sensible (on tariffs, transport costs) and it disregarded error structure, these conditions led to bias.
Second step, was appending first system by traded - non traded goods condition. Anderson separated the tradable and non-tradable goods and created the function. "Thus, for any consuming country j, Θ_i is the expenditure on country i's tradable good divided by total expenditure in j on tradables; i.e., Θ_i is an exponent of $g(\cdot)$. Let ϕ_j be the share of expenditure on all traded

goods in total expenditure of country j and $\phi_j = F(Y_j, N_j)$."(Anderson 1979, p.109) This results in a new, deterministic gravity equation, where for m and F are in *log* linear form :

$$M_{ij} = \frac{m_i \phi_i Y_i \phi_j Y_j}{\sum_i \sum_i M_{ij}}$$

where

- M_{ij} is consumtion in value and quality term of good i in country j
- Y_i is income in country i
- Y_j is income in country j
- m_i is the function of Y_i and N_i
- N_i is population in country i

The very last step for making the final equation, was to involve more variables, such as distance which was related to transport costs, differentiated goods etc. After few steps he derived this gravity equation:

$$M_{ij} = \frac{m_i \phi_i Y_i \phi_j Y_j}{\sum_j \phi_j Y_j} \frac{1}{f(d_{ij})} \left[\sum_j \frac{\phi_j Y_j}{\sum_j \phi_j Y_j} \frac{1}{f(d_{ij})} \right]^{-1} U_{ij}$$

where

- M_{ij} is consumtion in value and quality term of good i in country j
- Y_i is income in country i
- Y_j is income in country j
- m_i is the function of Y_i and N_i
- N_i is population in country i
- ϕ_j is the share of expenditure on all traded goods
- d is distance between two countries

This model had got three differences in comparison to the (2.1). Those differences are; it is an aggregate equation, function of distance is not *log* linear and the square bracket term is not included in equation (2.1). Although Anderson introduced and published the first theoretical foundation, economists claimed there is no theory of gravity model and continue to invent new ones.

Economists such as Bergstrand (1984), Deardorff A.V.(1998), Evenett S.J., Keller W. (1998) and many others were finding the proper model, but came with nothing new and the results were similar to Anderson's. Anderson's model used in his model Armington assumption, which works for differentiated goods by country of origin. Bergstrand (1990) added to Anderson's model monopolistic competition model. Van Wincoop (2003) showed how to estimate coefficient in cross sectional data and the recent theoretical development made Heplman (2006), who has derived gravity equation from an heterogenous forms model of trade. What everyone has to know, that gravity model is worth it in theoretical and also empirical way.

Moreover, gravity model or its deviation was used many times afterwards by Frankel J. or Engel C.M. etc., for various reasons, for example to refute the idea of Yen Block (Frankel, Wei 1993) or effect of national borders (McCallum 1995).

2.3 Common Mistakes in Gravity Model

As the gravity model does not have theoretical foundation, many errors have occurred. One of the problems, that may biased the results is how to gather countries, which do not belong to European currency union, into the currency unions.

Moreover, there are two types of bilateral trades between countries. First is *hub-spoke* trade, which is usually between highly developed country, that has its own currency and small country. They always trade goods from different industries (Baldwin 2006). The best way to imagine this kind of trade is via Heckscher-Ohlin model of trade, which basically says, that countries better endowed with labour should trade labour intensive goods and capital endowed countries should trade capital intensive goods (Pugel 2009).

Second kind of trade is *spoke-spoke* trade, where countries trade similar goods.

Another problem or error, which has become repeatable error and accepted during the usage of gravity model, is this "...most researches estimate what I call the 'value version' of the model - i.e. the dependent variable is the value of bilateral trade deflated by a common price index ..." (Baldwin 2006, p.11). Baldwin stressed, that it is important to measure trade in relative price and he

described it on the example of New Zealand and Australia trade. “Although these nations are far apart (it takes a jet airliner 3 hours to get from Sydney to Wellington) both nations are very far from other industrial nations (the Sydney flight to Tokyo, Los Angles and London take 9, 13 and 23 hours respectively). Thus the naive gravity model’s prediction is terrible. It under-predicts the bilateral trade. The reason is, that it ignores the fact, that the bilateral Australian-New Zealand trade costs are not high relative to the trade costs facing exporters from the rest of the world.” (Baldwin 2006, p.14)
In addition, there are more related mistakes to the previous ones. Many of the economists think that gravity model is about real GDPs and real trade to avoid the money illusion. But this approach is wrong (Baldwin 2006).
One of the most serious problems is omitted variables in a model, but there will always be few variables, which are very difficult to measure or to use it in gravity equation. These omitted variables might be correlated with any of the variables in gravity model, for example foreign direct investment correlated to CU dummy, etc.

2.4 Rose’s gravity model

Andrew K. Rose changed the gravity model to estimate possible effect of the single currency on trade volumes and also the impact of the currency exchange rate volatility. The equation Rose (2000) used was:

$$\begin{aligned}\ln(X_{ij}) &= \beta_0 + \beta_1 \ln(Y_i Y_j) + \beta_2 \ln\left(\frac{Y_i Y_j}{Pop_i Pop_j}\right) + \beta_3 \ln(Distance_{ij}) + \beta_4(Cont_{ij}) \\ &\quad + \beta_5(Lang_{ij}) + \beta_6(FTA_{ij}) + \beta_7(ComNat_{ij}) + \beta_8(ComCol_{ij}) + \\ &\quad + \beta_9(Colony_{ij}) + \gamma(CU_{ij}) + \delta(V_{ij}) + \varepsilon_{ij}\end{aligned}$$

where

- X_{ij} denotes average value of bilateral trade between countries i and j,
- Y is the countries’ i and j GDP
- $\left(\frac{Y_i Y_j}{Pop_i Pop_j}\right)$ stands for GDP per capita of countries i and j
- $Distance_{ij}$ describes the distance between countries i and j
- $V(_{ij})$ is volatility of bilateral exchange rate

and the rest are dummy variables:

- $Cont_{ij}$- contiguity dummy
- $Lang_{ij}$ - common language language dummy
- FTA_{ij} - regional trade agreement dummy - FTA
- $ComNat_{ij}$ - common nation dummy
- $ComCol_{ij}$ - dummy if i and j are colonies with the same colonizer
- $Colony_{ij}$ - dummy if i colonized j and vice versa
- CU_{ij} - common currency dummy

As we can see from this model, he used in his model average value of bilateral trade instead of bilateral trade value. Later on, he added more explanatory variables to his gravity model to got to know, if other variables affect the trade. Those were *Landl*, which shows the number of landlocked countries, *Island*, which counts island nations, *Area* stands for land mass of the country and *CurCol*, which is a binary variable which is unity if i and j are colonies at time t (Rose 2001).

He collected large data set, including 33 903 bilateral trade observations in five different years. He used OLS estimates of the gravity equation. As we may predict, results were quite obvious "... both higher GDP and higher GDP per capita increase trade. The coefficients are statistically significant and economically reasonable; both higher income per capita and larger country size increase trade less than proportionately. The greater the distance between two countries, the lower their trade." (Rose 2000, p.16) So called gravity effects worked. Furthermore, as he added even more variables to the gravity model, to measure sensitivity of those variables, the results of these also showed pretty reasonable and were significant.

In his paper he was comparing the effect of the volatility of the exchange rate to common currency, although many economic literature presume the effect to be just the same. Means, that with the same currency the exchange rate volatility disappears (e.g. Frankel, Rose 1998). He proved, that statement by using the results from his OLS estimates and came with two conclusions. "..., entering a currency union delivers an effect that is over an order of magnitude larger than the impact of reducing exchange rate volatility from one standard deviation to zero." But for us more important second conclusion. "... countries with the

same currency trade over three times as much with each other as countries with different currencies." (Rose 2000, p.37) He published few papers after that one in 2000; where he tried to lower this effect.
After Rose introduced his model in 2000 (there were more papers presented with corrections afterwards), it was just the matter of time when someone reacts on it. From our point of view, it was a quite audacious conclusions.

2.4.1 Rose's mistakes and its correction

As we mentioned in *Common mistakes of the gravity model*, also Rose made many mistakes in his model. We can definitely sort them by their magnitude, but as we see it, each of them is on the similar level.
First of these mistakes, he made, is that he forgot about the relative-price matter term. Luckily, he teamed up with another economist Eric von Wincoop. They found a way to correct this mistake, which leaded to reducing Rose's effect from 200% to 90% in case of boosting trade with single currency (Rose and van Wincoop 2001).
Rose (2001) found out that for avoiding problems with omitted variables, they need more data, which would help eliminate all cross sectional variation from the residuals, so it is purely dependent on time series variation. After Rose (2001) collected huge data set, he continued with improving his model. Glick and Rose (2002) used that comprehensive data set and added pair-dummies, which ate up the omitted variables. Some of them vary and even reduced the Rose's effect. This reduction was as similar as the one with Rose and van Wincoop did a year ago.
Persson (2001) introduced in his paper new technique, where he consciously matched countries, which helped correcting biases made by omitted variables. The matching technique changed the view on the linearity of the model, which helped to reduce the impact of the single currency. "Persson rightly points out that while there is only one way to be linear, there are an uncountable infinity of ways to be nonlinear. One cannot check them all, but Persson thinks he may have found one important nonlinearity - a nonlinearity that concerns the openness and output link." (Baldwin 2006, p.29)
Persson discovered, that CU countries have relationship between openness and output. If we count the ratios, the result better fits to curve line instead of linear line. This is the reason, why the regression numbers were overestimated, he assumed. Rose afterwards confess that this technique lowers the estimates

on the CU dummy, and the estimates showed quite significant and leveled on 20% up to 40% instead of previous 300% (Baldwin 2006). Which is still high number, but more satisfiable. Despite the fact, it does not treat the problem of reverse causality.

But Rose did not really agree with his diagnosis and his approach to the gravity model. "... a new larger data set confirms my results, using my linear regression technique, his matching technique, or the preferred fixed-effects technique that neither of us could use on the original data set. " (Rose 2001, p.456) Patrick Honohan supported Rose's conclusion "... Relying exclusively on matching the fitted value in a *logit* regression of currency membership on the other explanatory variables gives me very little confidence, that the matched pairs will be sufficiently similar in relevant respects. Bearing in mind that Persson's main estimates are obtained by simply averaging the difference in the value of trade between treatment and control pairs, this problem cannot be brushed aside." (Rose 2001, p.457)

In addition, Nitsch (2001) stressed in his paper more mistakes Rose made in 2000. He aimed on Rose's data set, where Rose had got some mistakes. These mistakes were mainly created by the statistical office, where Rose took his data from. The problem that appeared for instance in language dummy was, that there are more official languages in some countries.

Furthermore, Nitsch (2001) also pointed, that Rose ignored values of zero and unreported trade. That may cause the results biased, but it still remains unclear. Nitsch also complained about pooled data Rose used and the CU and its rate on the total observations. We suppose, that most of these problems raised by Nitsch are so compelling, therefore Rose (2000, 2001) stressed his inadequacies and had made some correction even before Nitsch published his paper.

2.4.2 Criticism and controversy

This paper has become matter of dispute for many economists. The main criticized problems were omitted variables, reverse causality and model misspecification.

Moreover Rose's conclusion, the one about common currency and currency union evoked mixed feelings. There arose arguments against his conclusion about the volatility of exchange rate, but for our thesis we do not need that.

Although Ben Lockwood in the discussion (Rose 2000) highlighted many points in Rose's paper, he complained that most of the currency union Rose used consist of one large developed country and smaller one (hub-spoke case), which may have led to biased results. This opinion was supported by Charles Wyposz and by Nitsch (2002).

Moreover, Nitsch (2005) extended this case and differentiated between joiners and leavers of the CU and made just alike regression that Rose did. The results showed very little difference in trade volumes for joiners, it was around 8% more.

Ben Lockwood also mentioned that common union, especially intra-national trade among Eurozone countries leads to specialization. Therefore he assumes, that the trade or the effect of single currency in Eurozone is underestimated (Rose 2000).

Marco Pagano pointed, that Rose's paper does not measure just the effect of currency union, but also the related factors, such as legal arrangements, tax treaties so the estimates cannot be accurate (Rose 2000).

Another group, including for instance Paul Klemperer, Jacob de Haan arose question of Euro currency, whether it is the relevant currency and if the Euro currency is defined properly, respectively (Rose 2000).
Bunch of economists look at the problem from a policy point of view. They complained, that this model was unable for policy makers.

Raquel Fernandez also stressed that the endogenous currency is also very important issue (Rose 2000). In addition, David Mayes emphasized the important role of the origin of the income and he showed the example on New Zealand (Rose 2000).

Pakko Michael R. and Wall Howard J. were arguing about the two methods, that Rose's used. "The difference between the two methods in their estimates of the trade-creating effect of a common currency is a separate issue. The proper conclusion to draw is that, when the statistically preferred fixed-effects specification is used, there is no statistically significant evidence of large trade effects (positive or negative). Although this means that Rose's results cannot be supported statistically, the small number of switches precludes us from saying much about the effects of common currencies on trade, although the tripling of trade found by Rose is well outside of a 95 percent confidence interval." (Pakko and Wall 2001, p.12)

In 2002, Devereaux and Lane came with an opinion, whether it is not the other way around. Whether countries do stabilize the bilateral exchange rate to countries, who they trade a lot, whereas the CU is the highest level of the stabilization. The reverse causality problem remains unsolved.

Chapter 3

Economic and Monetary Union of the European Union and its members

3.1 Economic and Monetary Union

Economic and Monetary union is the last but one stage of economic integration. It is a trade bloc, which put together a single market with a single currency. The specific features of the single market are freedom of movement of capital, labour and enterprise. It also involves the common policies among countries on the product regulation.

An Economic and Monetary union of the European Union, also known as Eurozone, was established in three phases; first was coordinating economic policy, second achieving economic convergence and the third culminating with the adoption of the euro.

3.2 Very beginning of Economic and Monetary Union of the European Union

3.2.1 First indication of EMU

At the beginning of the 19^{th} century; both silver and gold coins were cumulating. Exchange rate between them was dependent on the new field. On the European continent there had been prevailing bimetallism in most of the countries, some of them even preferred silver to gold. In 1865, four countries;

Belgium, France, Italy and Switzerland established so called Romanic - European Monetary union, which was far away ancestor of the EMU. This first attempt ended few years later, in 1878 due to many facts, such as the new silver fields founded or the war indemnity paid in gold after French - German war. The second monetary union was Scandinavian monetary union, which was established by Denmark, Norway and Sweden in 1873. It stopped its action officially in 1924. The only reason of these unions was to adjust coinage. There were no trade agreements or central bank to regulate that.

3.2.2 Short steps to EMU

There were many historical steps, that aimed to the establishment of Economic and Monetary Union of the European Union known from today.

Gold Standard

There are three types of Gold Standard. They differ from each other by a way gold is used. *The gold specie standard* is a system, where gold coins circulate, or circulation of the different unit of value defined in terms of one particular circulating gold coin in conjunction with another coinage made from a lesser valuable metal.
The gold exchange standard involves just silver coins, or coins made of other metals and authorities guarantee a fixed exchange rate with another country that is on the gold standard.
The last type is *the gold bullion standard*, system in which gold coins do not actually circulate as such. Authorities in this case sell gold bullion at fixed price, created by demand. The era of the Gold Standard is dated back to 1880 – 1914. Countries left Gold Standard System, because of transport of gold became dangerous and although many people thought, that Gold Standard was simple and the period with Gold Standard was better, in fact Gold Standard was the period of financial crises, imbalanced economic growth or armed warfare. The World War I also left economies of many countries devastated, despite they were convinced to return to Gold Standard as soon as possible, it appeared quite unrealistic due to the hyperinflation.

Period after WW2 and Bretton Woods

After WW2 no reparations and sanctions were imposed. The USA has become superpower country and ready to help Europe to find the right way. The be-

ginning of Cold war initiated making of Marshall Plan, officially the European Recovery Plan, which was created to support European countries with paying the imports from the USA. This approach lowered the pressure on the exchange rates, so it avoided the problems, that had arisen after the first World War. The Marshall Plan was very important for European integration and it linked into the Bretton Woods system, which was prepared in the same decade of the 20th century. Bretton Woods system was established to set the basic rules for financial sector and trade among the biggest and industrialized countries in Europe. It was a system based on regulated market and strict control of the value of currencies.
Furthermore, there had been established also two institutions - International Monetary Fund, International Bank for Reconstruction and Development, that were to help to stabilize economics of post-war countries, but they had not, so the Marshall Plan was introduced. Furthermore, these institutions have been one of the most powerful force in the worldwide economy.

Basics of the Bretton Woods system The main value unit of the Bretton Woods was gold, but the only currency fixed to the gold was US dollar, which was very strong currency after WW2. The rest of the exchange rates all around the world were pegged to US dollar. Exchange rates were pegged but adjustable. That should have made exchange rates and monetary system stable, and this was the main goal of Bretton Woods system. This basically means, that all of the countries involved in Bretton Woods, were reliant on the USA and its monetary policy. The problems arrived soon, because of many factors such as the fixed price of the gold, which made margin between US price and free trade price of gold. This fact deepened problems of other currencies, for instance British pound. After few years, when they tried do maintain the peg, the market situation forced the Bretton Woods to swap the current system to floating the gold peg mechanism.
Furthermore, another fact, that undercut the Bretton Woods system was the loss of worldwide power and supremacy. This evoked feeling in Japan and European Economic Community states, that privileged role of US dollar is a nonsense. Also the Vietnam War undermined monetary system of the Bretton Woods and high USA's expenditures on this war boosted inflation. In 1971, this system collapsed, due to the enormously overvalued US dollar with respect to gold. Afterwards in 1973 the Bretton Woods system was officially closed down.

This fact was initial and European countries' reaction built the basics of today monetary union.

Snake in the tunnel

Snake in the tunnel was the first reaction on the end of the Bretton Woods system. We may say that it was regional version of the Bretton Woods system. The main difference between them was, that in Bretton Woods system there was the fluctuation zone. After widening it in 1971, the Bretton Woods' fluctuation zone was $\pm 2,25\%$. But for other currencies, especially for Deutsche mark and French frank it caused, that in edge situation, they could have fluctuated to each other by 9%. For most of the countries this fact, was so exaggerated, that they decided to stay at the $\pm 2,25\%$ fluctuation zone in bilateral exchange rates. After Bretton Woods ended, this issue was the only left and used by European countries. But for volatile period of the 20th century, with very high inflation, caused by oil crisis, snake in the tunnel was not so prepared and most of the countries had to leave this system. This was pivotal point for establishing European Monetary System.

European Monetary System

Decision for establishing EMS was made in 1978. Members of EMS were mostly members of European Communities. When the Euro currency was accepted in 1999, new EMS was launched and called EMS 2. It recorded few changes. These were:

- in EMS 2, there is not matrix of bilateral exchange rates like in EMS, but the Euro is the only central currency
- fluctuation zone widen, similarly to EMS, but narrower zone is acceptable
- unlimited and automatic interventions of national central banks, but European Central Bank, may stop that

This system is more flexible and countries are free in decision making in comparison to EMS. The most important part of the EMS is Exchange Rates Mechanism, also known as ERM, which was in comparison to EMS voluntary to access. After the Euro was accepted and new EMS 2 was introduced, also new ERM II has come.

European Exchange Rate Mechanisms ERM is the system of commonly maintained fixed, but adjustable exchange rates, supported by members reciprocally. This system worked on four pillars, which were matrix of the bilateral exchange rates, common support, duty to accept decision of new adjustment of exchange rate and ECU. On 31^{st} December 1998, all ECU exchange rates were frozen and expressed in euro, which was it ratio one to one to ECU. Since 1999, EMR have been replaced by ERM II. Main goal of ERM II is to improve stability of all those ERM's currencies, as well as to obtain an evaluation mechanism for potential and future Eurozone members.

Treaties

When the Treaty of Rome was signed up in 1957, all involved were thinking of EMU already. Unfortunately, the result was negative. Many years later, Delors introduced his report in Madrid in 1989 and is was accepted and signed in 1991 in Maastricht. The ratification took approximately 14 months and has entered force on 1st November 1993. The Treaty of Maastricht has been the most intensive deepening of the European integration since Roman Treaty. The Treaty of Maastricht created, so called, pillar structure of the EU and led to the creation of the Euro currency. But the problem of those days was, that each country was on different economical level. Treaty of Maastricht makers described five compulsory criteria in order to avoid problems, that each country has to implement before it adapt Euro currency.

Convergence criteria As we mentioned above, there are five convergence criteria:

Inflation rates is a first criteria, which says, that country applying for membership in the EMU, should not have got inflation rate higher than 1.5 percentage points than the average inflation rate of the three best performing countries, which are part of the European Union

Long - term interest rate guarantees, that applicants are not able to cheat before entrance the EMU (frozen prices, etc.). It is compulsory to have long-term interest rate stable, and it should not exceed average of the three lowest long-term interest rates of EU members by 2%.

Membership in EMS is one of these criteria, country that wants to adopt Euro currency, has to be part of ERM II for two years, before it enters EMU.

Public accounts deficit criteria is the supportive for inflation. As long as country does not borrow money from other countries to cover its debts, inflation stays stable. The criteria says, that public account deficit should not be higher than 3% of the GDP.

Public debt is the last criteria, which implies each country, that they should not have got the public debt higher than 60% of the GDP.

If the country meets this criteria, it is allowed to entry Economic and Monetary Union of the European Union and adopt Euro currency, in EU known as the Eurozone.

3.3 Eurozone and its members

The Eurozone is the area of 16 countries, which are members of the EMU and have Euro currency as their sole legal tender. Those 16 countries are Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain. If another country wants to join the Eurozone, it has to fulfill all the criteria mentioned above. There are other countries, which are using the Euro currency but are not members of the Eurozone. We can separate these countries into two groups, those countries that have signed up the official agreement of usage the Euro currency, and those that have adopted the Euro currency but with no agreement.

To the first case belong these countries Monaco, San Marino, Vatican City; to second case Montenegro, Andorra and Kosovo. There is also one more case, which is opt out option. Countries like Great Britain, Denmark and Sweden are having exempt from usage of the Euro currency, whereas in Great Britain parliament made this decision and in Denmark people declined this option of having the Euro currency in referendum.

Furthermore, the European Central Bank is responsible for the monetary policy of the Eurozone, but those countries, which are using the Euro currency as the sole tender but are not the part of the Eurozone, do not participate on the monetary policy making in the ECB.

3.4 Introduction of countries used in my model

In our thesis, we are going to work with economic data of selected EU countries and try to measure possible effect of the single currency and try to predict the possible effect of single currency in those countries that have not adopted the Euro currency yet. We have chosen following countries:

1. Austria - we have chosen this country, because it has adopted the Euro currency in the first wave, and also because it has got border with our case study country, which is the Czech Republic.

2. Belgium - this country was one of those, that founded European Community and also has adopted the Euro currency in the 1999.

3. France - this country was picked, because of the same reason as the Belgium, plus the fact, that it is one of the most powerful countries in the EU.

4. Germany - this one was chosen for the same reason that France and also for its border with the Czech Republic and the biggest population in the EU.

5. Italy - we also involved this southern country, because of the its high population and because it has adopted the Euro currency in 1999.

6. Spain - another southern country, which on the other hand is not economically so strong as the previous ones, this is the reason why we chosen this country. It has adopted the Euro currency in 1999 as well.

7. Great Britain - we have chosen this country, for its opt - out option and for its strong economy.

8. the Czech Republic - this country is going to be in our case study, we chosen this one, because it is a former communistic country and fast developing. One of the main reason is also, that it has not adopted the Euro currency although it “wanted” it few years ago.

3.4.1 Austria

Austria is a Central European country and borders with the Czech Republic, Slovakia, Italy, Germany, Hungary, Slovenia, Lichtenstein and Switzerland. Its capital city is Vienna, which is also the largest city and commercial center of Austria. Linz, Innsbruck, Salzburg are other large cities in Austria. This country has around 8.2 million inhabitants and density of population is 99 people per square kilometer. Austria is a federal, representative democratic country which is a part of WTO and OECD, where Austria is a founder.

Main industries and economical facts

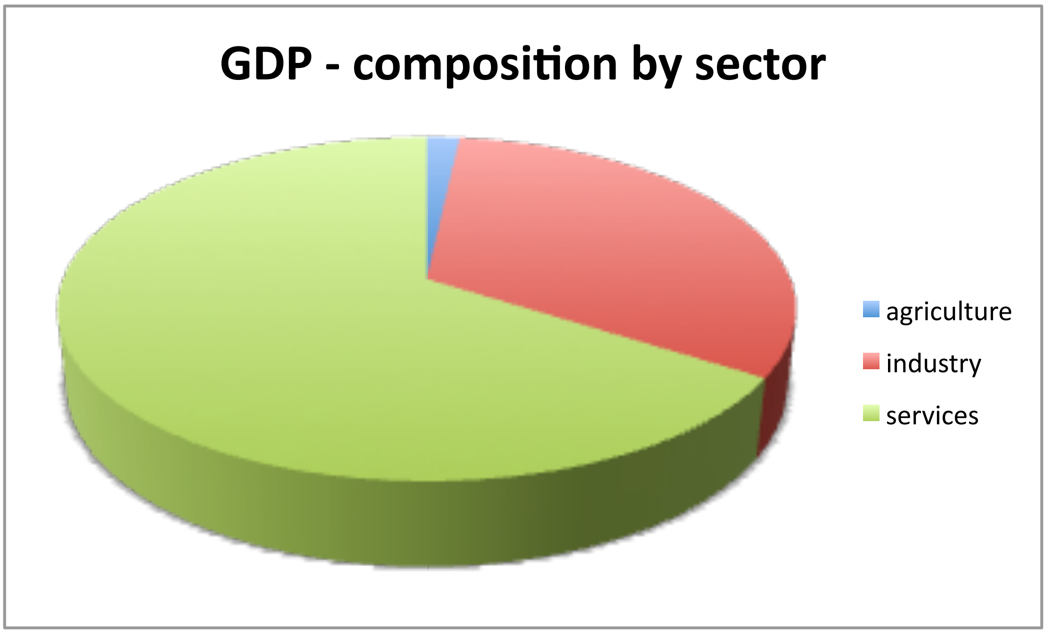
- GDP - 276 328 million of Euro
- GDP per capita - 33 800 euros per inhabitant
- Inflation rate - 3.2%
- Unemployment - 3.9%
- Public debt - 62.6% of GDP

Austrian economy is based on a quality banking and an insurance sector, which has got a long tradition. Its economy is highly developed and Austria belongs to countries with high standard of living. Industry has the second largest share of GDP, after services. In this country there are all types of industry, such as machinery, vehicles, metals, chemical, tourism and food. Agriculture, despite of a small share in making GDP, is highly developed. The main goods from agriculture are grains, potatoes, sugar beets, wine, fruit, dairy product, cattle, poultry and pigs. Erste Bank, OMV Group and Raiffeisen Bank are the most powerful, multinational Austrian companies.

3.4.2 Belgium

Belgium is a federal parliamentary democracy and constitutional monarchy. It lays on the northwest part of Europe and borders with Netherlands, Germany, Luxembourg and France. Roughly 10.5 million people are living there and the density is 354.7 people per square kilometer. The capital city is Brussels, which situates in one of the regions called Brussels-Capital Region. Those two left are Flemish Region and Walloon Region, they differ from each other by the spoken language in those regions. There are many not very large cities in this country such as Ghent, Bruges, Antwerp, Charleroi. This country is member of WTO, NATO, OECD.

Figure 3.1: Austria

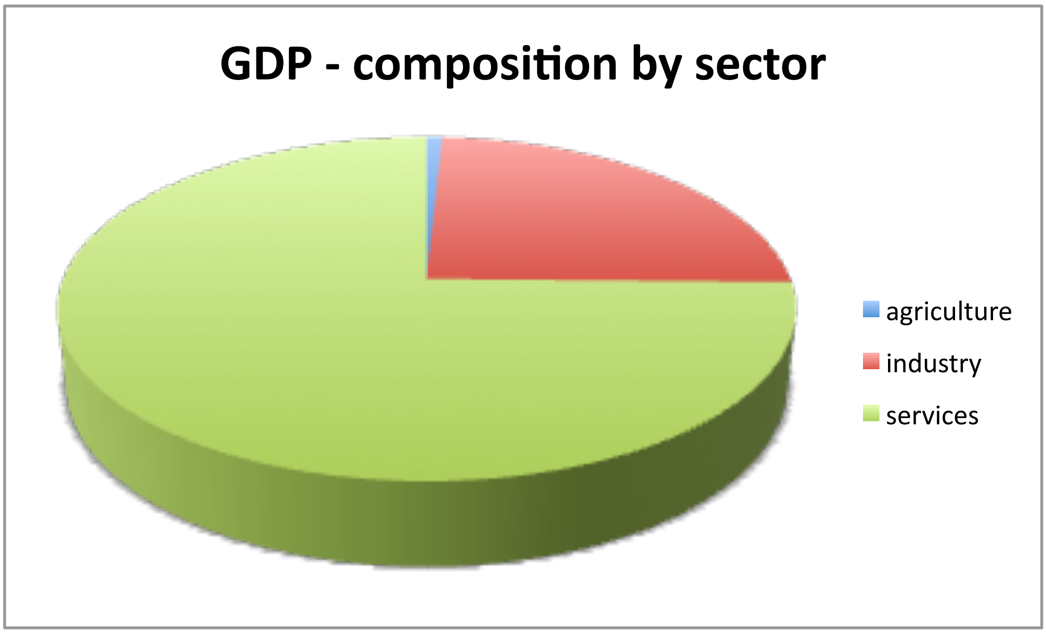


Main industries and economical facts

- GDP - 340 265 million of Euro
- GDP per capita - 32 200 euros per inhabitant
- Inflation rate - 4.5%
- Unemployment - 7%
- Public debt - 89.6% of GDP

Belgium lays at the center of the most industrialized regions so its economy benefits a lot out of that. Its economy is very developed with great transport infrastructure. Typical for every developed country is that main part of GDP is made from services and Belgium is not exception. The services sector covers around three quarters of GDP, whereas agriculture approximately 1%. For Belgium's industry are common these sectors - steel, refining, chemical industry, automobiles, electronics, food, textiles, beverages. Agriculture produces livestock, grain, potatoes, milk, tobacco, fruits and vegetables. In Belgium, there are not so many known large companies. The largest are KBC Group, Dexia and InBev.

Figure 3.2: Belgium



3.4.3 France

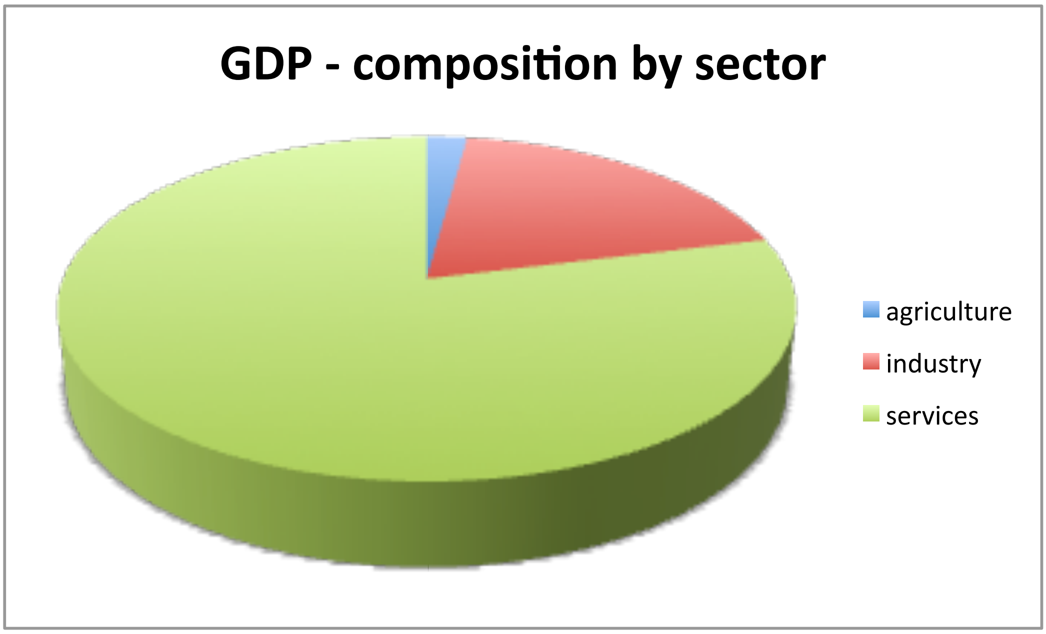
France is the Western European country and is a member of OECD, WTO, G8, G20 and NATO. It has borders with Andorra, Belgium, Germany, Italy, Luxembourg, Monaco, Spain and Switzerland. This unitary semi-presidential republic's capital city is Paris, which is also the largest city in France with its 11.8 million inhabitants. Other large cities are Lyon, Marseille, Lille, Nice, Toulouse and Bordeaux. Approximately 65,5 million people are living there and the density is 117 per square kilometer.

Main industries and economic facts

- GDP - 1 902 776 million of Euro
- GDP per capita - 30400 euros per inhabitant
- Inflation rate - 2.8%
- Unemployment - 7.4%
- Public debt - 68.1% of GDP

France as a G8 member has one of the most powerful economies with its highly developed industry. It combines of governmental companies, which control important segments such as railway, aircrafts, nuclear power, telecommunication and private enterprises. Likewise in previous countries, most of the GDP comes from services and industry. Due to the fertile land, French agriculture's share on GDP is 2.1%, which is quite a high number. Agriculture is subsidized like in other countries and it produces wheat, poultry, beef, pork and wine. On the other hand, industry as the second important GDP maker covers every branch from tourism to heavy industry. The main industries are automobiles, chemical, machinery, aircraft, tourism and pharmaceutical products. Many large multinational enterprises are from France, these are for example Renault Group, Carrefour, L'Oreal, BNP Paribas or Société Générale Group.

Figure 3.3: France



3.4.4 Great Britain

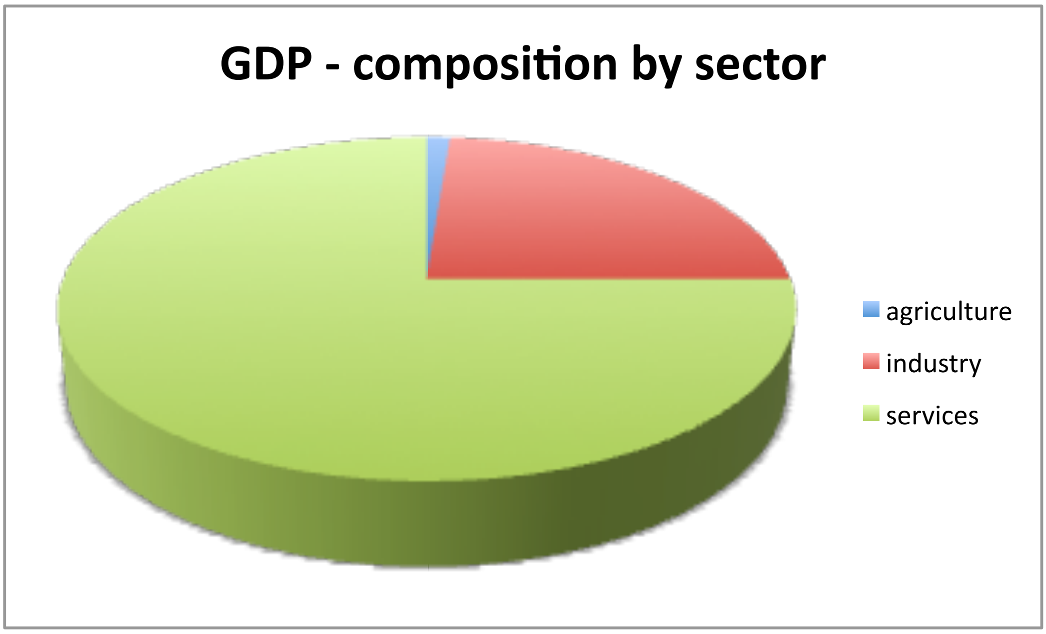
Great Britain is the only country in our thesis, which does not lay on the continent. It is the 9th largest island in the world. The term Great Britain consist of England, Wales and Scotland. There live around 62 million people and the density is 277 per square kilometer. Great Britain is the Kingdom made of three countries, which are England, Wales, Scotland and Northern Ireland. The Parliament is in London, which is the largest city and commercial center in the Great Britain. There many mid size cities like Manchester, Liverpool, Edinburgh, Newcastle, Glasgow. Great Britain is the part of G8, G20, WTO and NATO.

Main industries and economic facts

- GDP - 1 943 607 million of euro
- GDP per capita - 29 600 euros per inhabitant
- Inflation rate - 3.6%
- Unemployment - 5.6%
- Public debt - 51.8% of GDP

British economy is market based with extensive social welfare services. Its diversified, developed economy is the fifth largest in the world and we can say, that is financial center. The companies in Great Britain are more or less privatized or very common way is private public partnership. GDP is composed by services 75%, industry 23.8% and agriculture 1.2%. British agriculture is highly mechanized and intensive. Its main products are cereals, oilseed, potatoes, vegetables, cattle, sheep and poultry. You can meet in various branches in an industry, such as aircraft, motor vehicles, machine tools, clothing, electronics, coal, food processing. In London, there is one of the largest stock exchange. HSCB Group, Barclays and Tesco are well known companies with British origin.

Figure 3.4: Great Britain



3.4.5 Italy

Italy is a country located in Southern Europe, where Sicily and Sardinia is also part of this democratic republic. Its neighbours are France, Switzerland, Austria and Slovenia. Furthermore, on the Italian Peninsula lays two independent countries, these are San Marino and Vatican City. There live around 60 millions people in Italy and the density is 199,8 per square kilometer. The capital city is Rome with more than 2,7 million inhabitant and it is also the largest city. Other large cities with approximately million inhabitants are Milan, Naples and Turin. Italy is the founding member of the EU, and has also membership in many multinational organizations, such as NATO, OECD, WTO, G8, G20.

Main industries and economic facts

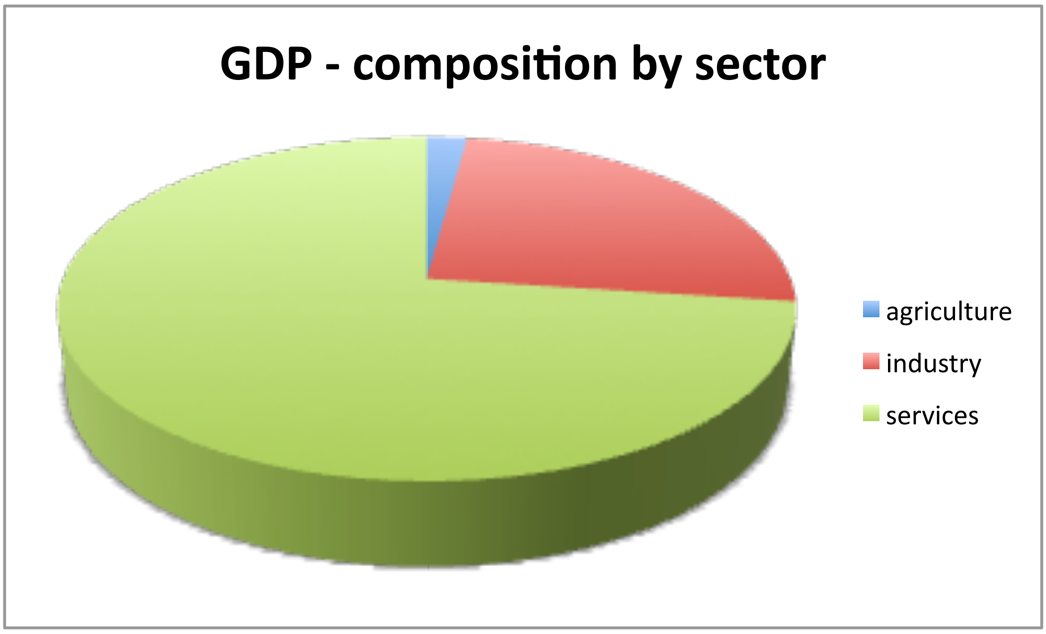
- GDP - 1 525 791.8 million of euro
- GDP per capita - 26 200 euros per inhabitant
- Inflation rate - 3.4%
- Unemployment - 6.8%
- Public debt - 105.8% of GDP

Italy's economy is considered to be the seventh largest worldwide. We can divide its economy to the highly developed industrial part on the north of the country and to welfare-dependent agricultural south of the country. Typical feature of business sector are small and medium-sized family-owned companies, which produce high quality goods well known worldwide. The largest part of the GDP makes services, industry covers one quarter of GDP and around 2% makes agriculture. Italian industry is diversified. They mostly profit from tourism, machinery, iron and steel manufacturing, chemical industry, clothing industry and food processing industry. Main agricultural products are fruit, potatoes, grapes, olives, vegetables, beef, fish and diary products. Pirelli, Fiat and for example Versace, from fashion industry, are typical Italian companies.

3.4.6 Spain

This is the second Southern country, we are using in our model. It situates on the Pyrenees Peninsula and has its borders with Portugal, France, Gibraltar

Figure 3.5: Italy



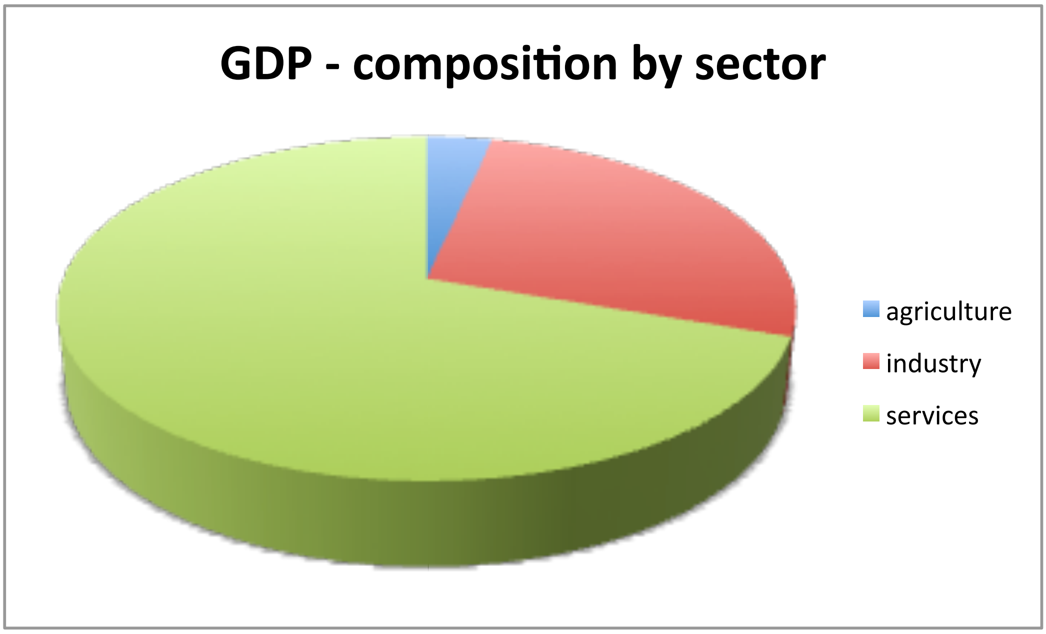
and Andorra. The capital of Spain is Madrid, which is one of the biggest cities, followed by Barcelona, Valencia, Sevilla and Zaragoza. In Spain there are around 45million inhabitant and the density of population is 91.2. Spain is Constitutional Monarchy with parliamentary democracy. It is member of NATO, WTO and OECD.

Main industries and economic facts

- GDP - 1 061 760 million of euro
- GDP per capita - 23 900 euros per inhabitant
- Inflation rate - 4.1%
- Unemployment - 11.4%
- Public debt - 40.7%

Spanish economy is the ninth largest according to the World Bank. Its economy is dynamic and the composition is 3.4% for agriculture, 26.9% for industry and the rest of GDP make services. Very important branch of GDP is tourism, which makes around 5% of the GDP. Agriculture in comparison to other countries in this thesis has got quite high share. This might be caused by the fact, that the climate is more suitable. They produce olives, wine grapes, citrus, beef, pork, fish and diary products. Industry manufactures textile and apparel, food and beverages, chemical products, automobiles. Seat, Telefónica, Iberia are ones of the well known Spanish enterprises.

Figure 3.6: Spain



3.4.7 Germany

Germany situates in the middle of the Europe and it has got borders with the Czech Republic, France, Poland, Switzerland, Belgium, Austria, Denmark, Luxembourg and Netherlands. Germany is a federal, parliamentary, representative democratic republic of 16 states, where more than 81 millions people live. There are many large cities, where more than million inhabitants live, these are for instance Munich, Hamburg, Berlin and Frankfurt, where European Central Bank has got its domicile. Density of population is around 229 per square kilometer. This country, where Berlin is the capital city, is the member of the United nations, NATO, G8, G20, OECD and the WTO. It is one the most developed countries in the EU.

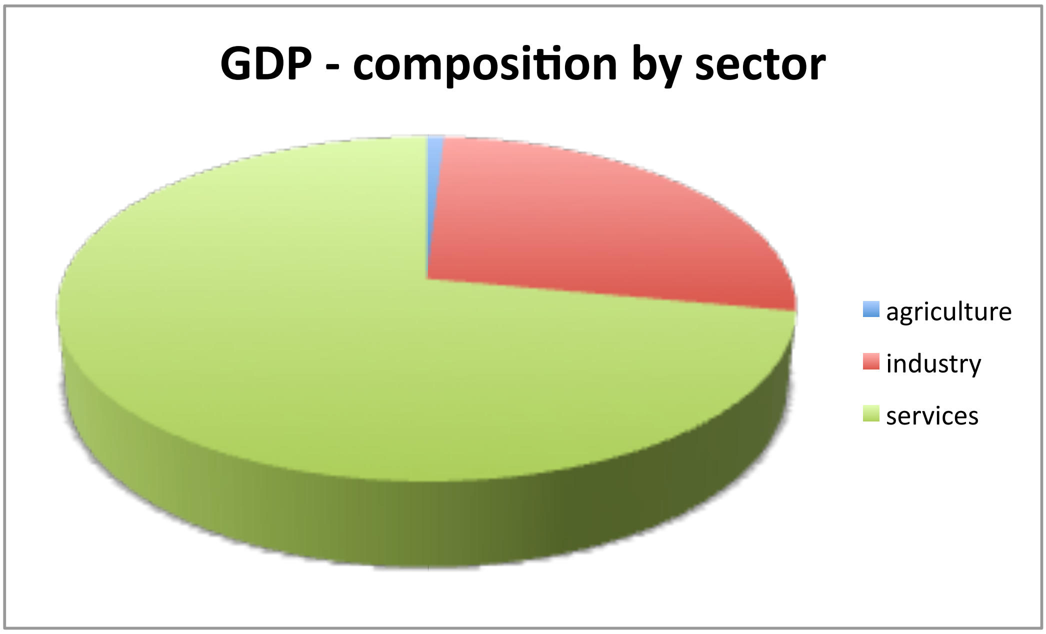
Main industries and economic indicators

- GDP - 2 458 680 million of euro

- GDP per capita - 30 400 euros per inhabitant
- Inflation rate - 2.7%
- Unemployment - 7.8%
- Public debt - 66%

German economy is one of the most powerful worldwide. It is on the second place as a exporter of the goods and third as an importer all around the world. Its economy is based on the service sector, which has got approximately 70% share of the total GDP. Next important branch is industry and less than 1% of the total GDP share is made from agriculture. The main products industry makes are automobiles, machinery, chemical products, optics, biotech and genetic engineering, nanotechnology etc. Agriculture produces mainly corn, wheat, hops, potatoes, poultry, pigs. A lot of huge corporates domicile in Germany, for instance Daimler, Volkswagen, Allianz, Siemens, Deutsche Bank. Germany is also centre of stock marketing.

Figure 3.7: Germany



3.4.8 Czech Republic

The Czech Republic situates in the central Europe and borders with Poland, Slovakia, Austria and Germany. The capital city is Prague, which is also financial center of the Bohemia. There are few more mid size cities, such as Brno, Ostrava or Liberec. In this country live around 10.5 million people and the density is 132 people per square kilometer. The Czech Republic is parliamentary republic. It is the member of NATO, WTO, OECD.

Main industries and economical facts

- GDP - 130 467.6 million of euro
- GDP per capita - 14 200 euros per inhabitant
- Inflation rate - 6.3%
- Unemployment - 5.4%
- Public debt - 26.8%

Czech economy is the most stable and prosperous among former communist countries. The cutting edge ,after fall of the communism, was the successful privatization, after which most of the enterprises turned from public to private. Czech composition of GDP is 62.3% services, 35% industry and the 2.8% agriculture. Heavy industry especially the coal, iron and steel is very common in the Czech Republic. Than there is glass and chemical industry. Furthermore, automobile industry also plays big role in republic, and employs many people. On of the important branch is tourism. Agriculture produces wine grapes, hops, corn, wheat, oats, potatoes, cattle, poultry, pigs. The most powerful company, with Czech roots is ČEZ and then also well known companies are from brewery, these are Pilsner Urquell and Budwaiser Budvar.

Furthermore, on the table 3.9, we compared GDP per capita for countries we have chosen for our model.

All data were collected from Eurostat, Forbes and CIA - The World Factbook websites and numbers used are for year 2008, because they were available for every country, we have chosen.

Figure 3.8: Czech Republic

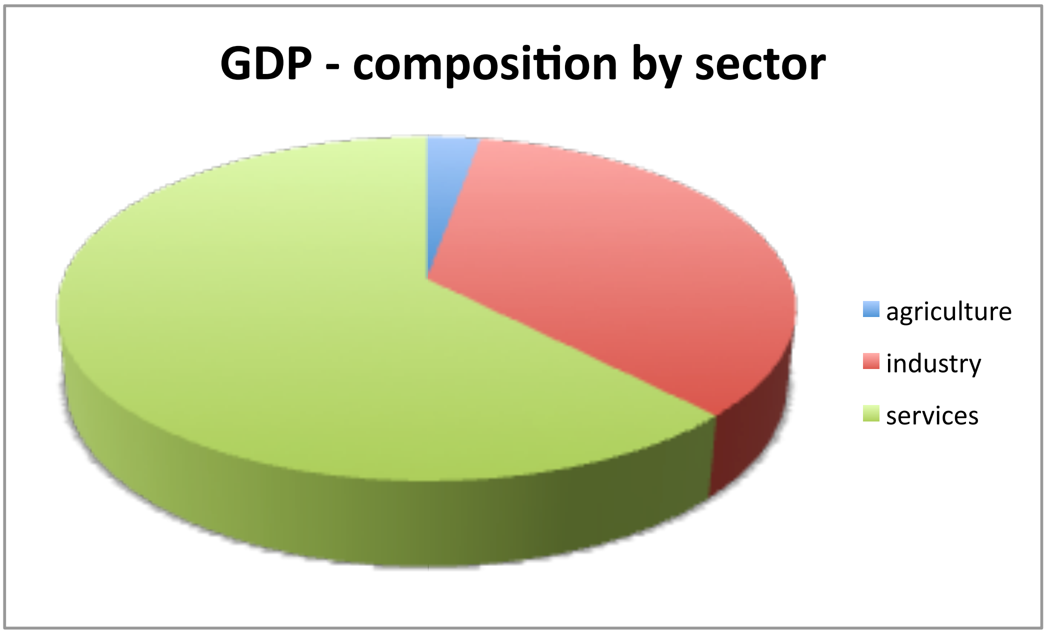
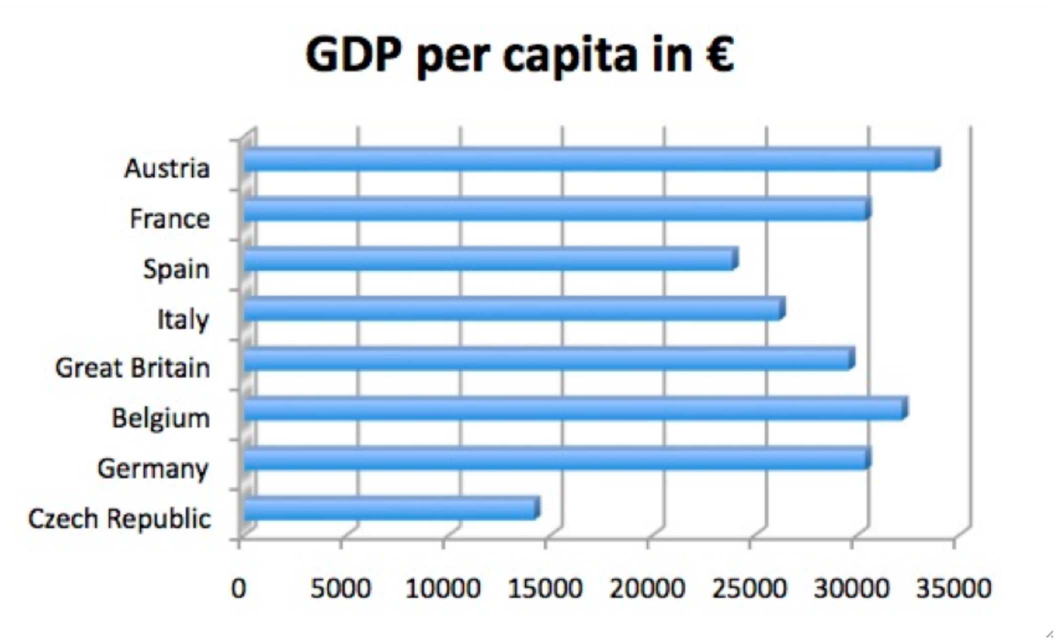


Figure 3.9: GDP per capita comparison



Chapter 4

Methodology

In this chapter we are going to describe, how we proceed with our model, how we collected data and how we made our model. We tried to make our model very easy to avoid all the problems we mentioned above in the first chapter.

4.1 Data set

As we have already mentioned, we are going to analyze data for 8 European countries, that are members of the European union. Some of them adopted Euro as a legal tender. As next section shows, we had to collect data for our model - GDP of every country from 1995 - 2008, exports between chosen country and other 24 countries and the distance between our case study country's capital city to the left 24 capital cities. For getting these data, we visited Geobytes website. We decided to use export data instead of average from import plus export data. Furthermore, when we were collecting exports for each country, we used Eurostat website and in available datasets we chose EU27 Trade 1995 By SITC. As a reporter we picked wanted country for our thesis. In Partner box, we picked rest of the countries, that means 24 countries. To outline basic idea, we provide an example.
Austria as a reporter has got these partners - Belgium, Czech Republic, France, Great Britain, Germany, Denmark, Finland, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, Swiss, Norway, Hungary, Poland, Slovakia, Russia, Ukraine, USA, Canada and Mexico. Moreover, to cover all products and not to miss any, I picked TOTAL-TOTAL option in flow box we ticked export.

We sorted all period options and mark just annual ones from 1995-2008. In case of Indicator box we picked value in euros. We have done this for every out of 8 chosen countries. When we were gathering data for GDPs at market prices, we used Econstats website and also European Central Bank website.

The problem that had revealed was, that some data were in US dollar. So we had to use annual average exchange rate of US dollar and Euro for data from 1999 - 2008 (except for the Czech Republic, we are having just date from 1999 - 2008) and for data before 1999 we found two possibilities to do that.
One of them was to use exchange rate US dollar to ECU or the second to use firstly annual average exchange rate US dollar to Deutsche Mark to convert data to DM and than to use ECU fixed exchange rate from 1999, when Deutsche Mark was fixed to ECU = Euro in exchange rate 1.99583 DM.
When we used the second approach, the data showed lower and biased especially for earlier years, than those derived via first approach. That was caused due to the fixed exchange rate DM to ECU. So we used average date from both approaches. After we gathered all data for every country, we transformed them with natural logarithm function. Moreover, to avoid problem with LN in dummy variables, instead of 0 and 1 values, we used values from 1 up to 2. Value one is for those countries or the period of the country, which has not had Euro currency, 1,5 value for the preliminary period of a country, that was preparing economy for launching banknotes and coins, means 1999 - 2001 and 2 is dummy value for country that has already adopted Euro as a legal tender. As long as we collected all necessary data, we had to prepare data for regression, so we made panel of these data. To avoid problem with the same trend in regression we used growth rate of GDP instead of GDP levels.

4.1.1 Explanatory statistics

In this section, we reported mean values, variance, maximum and minimum of data, which belongs to our research countries. These statistics are in the tables 4.1, 4.2 and 4.3.

Table 4.1: Explanatory statistics

	Austria	Belgium	France
GPD			
mean value	221244.89	266604.94	1527350.04
variance	1163387425.89	1898665104.80	64298028401.47
max	283097.36	338309.90	1939802.96
min	175153.67	207880.78	1147888.83
Growth rate of GDP			
mean value	7661.52	9799.56	57628.18
variance	20153221.57	24162182.42	333288412.39
max	14620.80	16755.00	88216.60
min	-1884.40	-285.10	17377.50
Total exports			
mean value	67087.33	183926.6456	253875.1539
variance	417777607.42	2783644080	1784510270
max	36924.99	266100.2651	300255.5757
min	98323.65	106893.9484	174935.5423

Source: Author's calculations

4.2 Regression

In our thesis, we used three different approaches for our regression. For our panel, we used both methods, the fixed effects and random effects. In fact, the first approach appeared better, and also we may say, that fixed effects method declines the random effects approach. But we discuss this later. The third method is OLS. The problem of this is, that it omits the time series. But we assume, that we may receive some benefits or different view on the problem from this method.

Table 4.2: Explanatory statistics

	Great Britain	Spain	Italy
GPD			
mean value	1525509.27	729997.86	1250338.54
variance	129088031984.50	47128265071.15	48688617503.30
max	2022641.30	1090681.40	1559021.01
min	834271.85	436312.72	823302.30
Growth rate of GDP			
mean value	71861.76	48615.95	54364.12
variance	13112421760.07	286730333.55	688661817.19
max	238441.70	75492.00	131034.60
min	-225186.10	14961.60	21673.80
Total exports			
mean value	215461.82	102769.37	196656.97
variance	1552128548.20	856322465.29	1650497814
max	280602.54	145694.82	263369.54
min	137470.94	56695.40	130678.10

Source: Author's calculations

Table 4.3: Explanatory statistics

	Germany	Czech Republic	25 countries
GPD			
mean value	2123396.40	79767.30	837093.81
variance	39343646218.79	1031681649.20	3268718225015.87
max	2483562.96	147188.81	11250446.63
min	1844533.08	40401.01	14314.77
Growth rate of GDP			
mean value	59893.00	10162.73	
variance	1075411892.39	32613035.67	
max	103100.00	20548.70	
min	-14414.40	920.50	
Total exports			
mean value	520260.76	50493.98	
variance	22650473649.45	509024026.54	
max	763062.13	22658.79	
min	315313.19	89227.25	

Source: Author's calculations

Chapter 5

The Model

5.1 Our Gravity model

In this thesis, we created variation on gravity model, which is based on the basic gravity model. Simple gravity model is using just distance and GDP, for our research we added currency union dummy. We are trying to describe possible effect of the single currency on the trade volumes of chosen 8 countries. In our model, you can meet with these variables:

- X_{ij} - stands for exports from chosen country to the rest of countries in our thesis
- Y_i - is domestic GDP
- Y_j - this variable is GDPs of the twenty four countries, with which the anchor domestic country is trading
- D_{ij} - distance between capital cities
- CU_{ij} - currency union between countries, whether these countries share the same currency

So our model looks like this:

$$X_{ij} = \alpha * Y_i^{\beta} * Y_j^{\gamma} * D_{ij}^{\delta} * CU_{ij}^{\sigma} * \epsilon_{ij}$$

After taking natural logarithms we get a linear model, which is:

$$\ln(X_{ij}) = \alpha + \beta \ln(Y_i) + \gamma \ln(Y_j) + \delta \ln(Distance_{ij}) + \sigma \ln(CU_{ij}) + \epsilon_{ij}$$

Moreover, when we were analyzing data through this model, we found out, that the coefficient of determinant is too high to accept this model, so we rather substituted the Y_i variable for GDP growth variable. Also we avoided multicollinearity by this transformation. We derived GDP growth from Y_i like this:

$$GDPgrowth96 = \left((lnY_i^{96}) - ln(Y_i^{95})\right),$$

whereas we are counting growth of GDP for year 1996, by deducting GDP of domestic country for 1995 from GDP of 1996. This is what we did for every year and it reduced our time series from 14 to 13 observations in each country except of the Czech Republic, which has 9 observations after this reduction.

So finally our model looks like this:

$$\ln(X_{ij}) = \alpha + \beta GDPgrowth + \gamma \ln(Y_j) + \delta \ln(Distance_{ij}) + \sigma \ln(CU_{ij}) + \epsilon_{ij}$$

In addition, for regression we are going to use various methods. Firstly, we have to approve the conditions of methods, especially for OLS, such as:

- Linearity - this condition is proved, due to the transformation of the model
- Homoscedasticity - tshis condition, we are going to test via Breusch-Pagan test, where H_0: homoscedasticity and also by White's test.
- Normality of residuals - we test this condition via normality test, which is included in Gretl and also via graphical test, also known as QQ-plot.
- Non-autocorrelation - for this we use Durbin- Watson test and Breusch-Godfrey test.

In case of the panel methods, we use special tests of residuals to approve these conditions, because Gretl does not offer so many tests for the panel analysis as for OLS method.

Furthermore, as we stated before, we lost one observation. Also we are going to analyze two periods for each of 8 countries. First part is going to be for period 1996-2008 and second for 1996-2007. The reason of reducing our data set for another observation is because of the world crisis, that has already influenced data for 2008 GDP and export, so we assume, that this move might make our regression more accurate.

Chapter 6

Empirical Results

6.1 Introduction to the problem

In this chapter, we are going to perform the regressions, which are the main contribution of writing this thesis. Using the regression analysis we would like to find out possible impact on the trade volumes among EMU members and we will look closer to the Czech Republic case, where we would like to compare results with the rest of 7 countries and based on this try to deduce the future of the Czech trade volumes, if they adopt Euro as the legal tender one day.

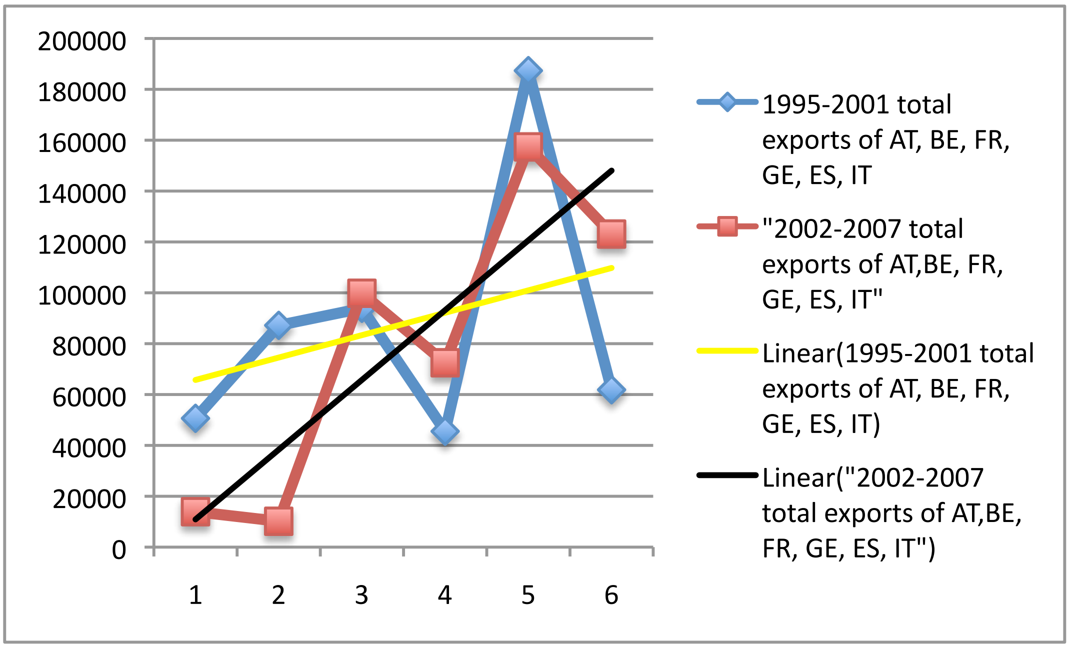
6.2 Analysis of countries

Before we analyze data for each country, we tried to do basic graphical analysis with comments, based on export data, whether single currency does have some influence on trade volumes.

Propensity of trend line analysis Firstly, we summarized exports for every year in 6 of 8 countries' data set and then made one data set from this sum. The reason, why we did this just for 6 countries is, that we wanted to use this approach just for those countries, that has already adopted Euro.

Moreover, we separated this data set on two period. First is 1995-2001, period with no Euro; and second is 2002- 2008, period with Euro as the legal tender. After we did this, we created the figure from this data and fitted a trend line and the results were very satisfiable. As we can see in figure 6.1, the propensity of the trend line in period 2002-2008 is steeper, so there must be some influence.

Figure 6.1: Comparison of trend lines-Eurozone



Secondly, we tried to do this analysis for the remaining countries: the Czech Republic and Great Britain. We assumed, that the propensity should had been opposite than in countries with Euro. That would mean, that propensity of trend line for 2002-2008 should had been lower than 1995-2001 propensity.

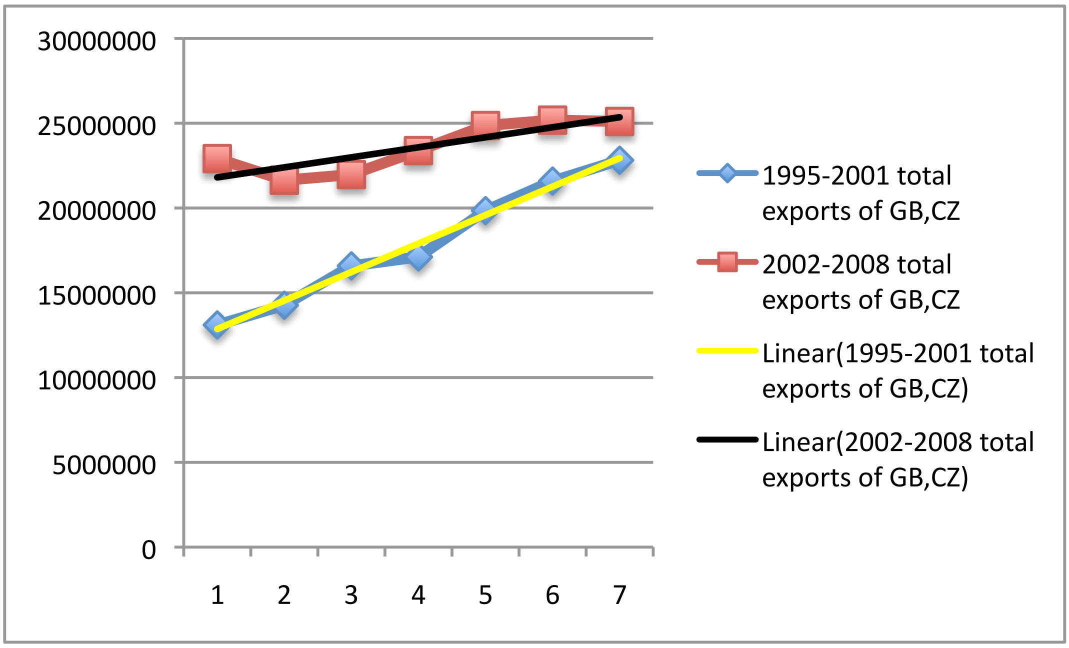
The assumption was correct, but we have to keep in mind, that for the Czech Republic we are missing data for exports from 1995-1998. It may have affected this analysis, but the result would be the same. (figure 6.2)

Trade volumes of 8 countries before and after adopting of the Euro
As we can see on the figure 6.3, most of the 7 countries' trade volumes have been increasing since 1994. Volatility of the trade volumes is noticeable in case of France, Italy and Great Britain. If we look closer to the France figure (Appendix, page XVII) , we can see that decline of trade is from 2001 up to 2003. This might be caused by the awareness of people about what would single currency do with the trade.

Furthermore, the volatility of trade is also visible in Great Britain (Appendix, page XXXVI). This is not very stable trend of exports, it could be done by the fact that Great Britain has not adopted Euro, so its trading partners rather choose another country to trade with.

In addition, in case of Italy we may say, that there is just a little decrease in

Figure 6.2: Comparison of trend lines-Czech Republic, Great Britain



trade volumes from 2001-2003, but it recovered well (Appendix, page XXXI). All of these seven countries has noticed decrease of trade volumes or slowing down of the trade growth in 2008, this is caused by the beginning of the world crisis. The largest percentage decrease appeared in Great Britain. This is quite obvious, when we realize that it trades with USA, country where the crisis has begun.

Czech Republic and its trade volumes trend The trend of the Czech trade volumes is surprisingly rising every year, even in those years other countries has adopted Euro. If we look on figure 6.4, which shows composition of the exports, we can see that it trades mostly with Germany. And even after Germany has adopted Euro, trade between these two countries has not decreased.

Before we start our analysis, we would like to inform you, that most of the Gretl results and figures for my thesis are included in Appendix.

In addition, in each of next subsection, we are going to interpret the results, we received. We are testing all hypothesis on 5% significance level and all results used are from fixed effects panel method, which is the most suitable. Why? That is explained below.

Figure 6.3: Exports in million Euros-AU,BE,FR,GE,GB,IT,SP

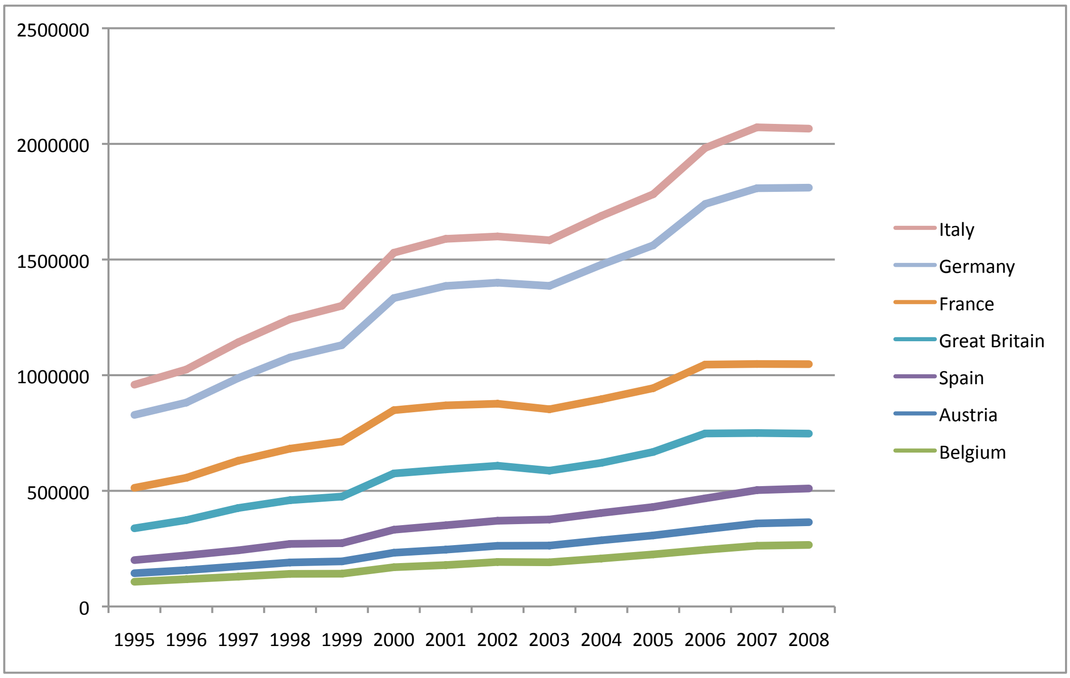
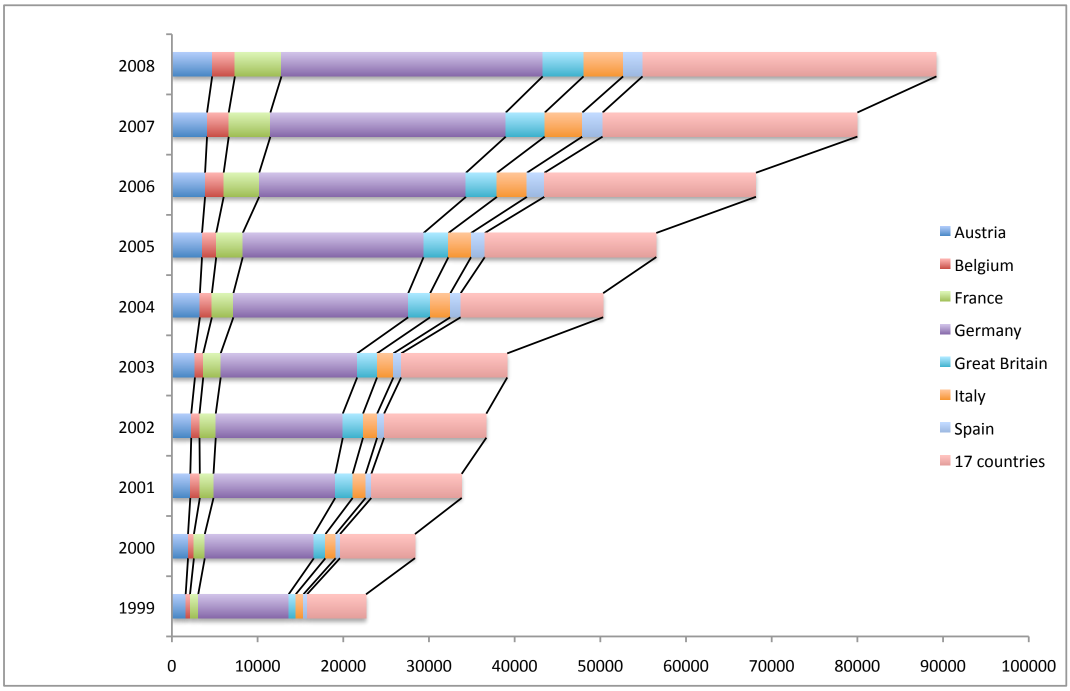


Figure 6.4: Exports in million Euros-Czech Republic



Austria

As we mentioned before, we used three methods for our regression. For Austria, all of the coefficients are significant and R^2 is 0.98, which is quite high number and it does not mean anything good. But for panel data analysis, we had better to compare criterion such as Schwarz and very similar Akaike.
Schwarz criterion measures the efficiency of the model with parameters in terms of fitting the data, whereas Akaike criterion measures the goodness of fit of an estimated model. So if we look closer to these numbers, we can see that fixed effects method is the better than random. This argument is also supported by fixed effects test for differing group intercepts, whose p-value is $1.76062\ 10^{-117}$, so it means that we decline the H_0 hypothesis for the common intercept. From this conclusion, we may say, that there exist more variables, that may influence the regression. We suppose that, these might be some institutional issue or something similar. Another supportive fact for using fixed effects method is the graphical analysis of the residuals. If we compare these figure (see Appendix), we can see that in random effects method, we can recognize each country.
Both tests for homoskedasticity declined on the 5% level of significance the H_0, so the data are heteroskedastic. It was quite obvious, that for not so many observations, the data set will not be normal.

In addition, to our thesis the most important variable is the common currency, whose coefficient is in case of these two methods similar, approximately 0.208.

On the other hand, we tried also OLS method. The most of the conditions are fulfilled such as normality, linearity of the model; however, this method generated the most important variable, common currency, not significant. Despite the coefficient of determinant has decreased, for our thesis, this approach is not very suitable.

Result From the results we get, we may say, that single currency boosted Austria's exports to chosen 24 countries by 23% ($exp^{0.2074} = 1.23$).

Analysis for 1996-2007 When we reduced the number of observations, we received almost the same coefficient for common currency dummy variable. That means, that single currency would boost trade volumes in this country by 25%.

Belgium

For this country we found out, that if we do regression via fixed effects, common currency variable is not significant. In case of the random effects, it is significant and the coefficient of this variable doubled. Anyway, we use for our thesis results from fixed effects method, just because the Schwarz and Akaike criterion have got better value. OLS method's result differs a lot from those panel data approaches. Coefficients of variables are just unlikely.

Result Belgium's trade volumes has risen up by 6% ($exp^{0.05827} = 1.06$), which is not large number in comparison to Austria. It's maybe because of the location of Belgium, which forced this country to trade with most of the Western European countries even before the Euro.

Analysis for 1996-2007 For this shorter period, common currency dummy variable is not significant again, and the coefficient lowered so the boost slowed down a little bit in comparison to period 1996-2008.

France

Fixed effects method in this country's dataset counted all variables significant. If we compare coefficient of common currency with random effects method, we discover, that both are very similar as well as in Austria's case, but they are negative. R^2 is very high again, but Schwarz criterion is good enough and again better in fixed effects method. We decline hypothesis of common intercept, so there exist other variables that influence trade volumes. Also it showed that in model there is heteroskedasticity and data are not normal, see results in Appendix, page X.

OLS generated results, which are again not very accurate, although it meets some of the conditions of OLS. The problem of these data is that they are heteroskedastic and also we can meet autocorrelation. The common currency's coefficient is very high in comparison to the one, the fixed effects generated.

Moreover, for OLS the coefficient of determinant is too high, what is not so probable that it would be so good in the real world. As well as in the case of Austria, QQ- plot suggests normally distributed data, this is caused by the fact, that OLS does omit time series condition.

Result As long as France adopted Euro as their legal tender, its exports to my thesis countries has decreased by 10% ($exp^{-0.1022} = 0.901$). It does not have to necessarily mean, that the Euro has slowed down French economy. As we stated before, there exist more variables, that are not involved in the model, that may influence exports, such as finding other countries to export than those involved in our thesis.

Analysis for 1996-2007 For this period, the coefficient in common currency is slightly smaller. This means, that it makes the rise up of trade volumes from minus 10 to minus 7%. We can definitely say, that the beginning of crisis is noticeable.

Germany

Testing German dataset did not uncover anything special. All variables are significant in both approaches and coefficients are almost the same. Schwarz and Akaike criterion tell us, that fixed effects method is better way to predict that. As well as in other countries, there are more variables, that may have the effect on trade volumes. Dataset is heteroskedastic and not normal suggested by the Wald test and normality of residuals test respectively.

For OLS method coefficient of determinant is acceptable, nevertheless we will not use these results despite all coefficients are significant.

Result Germany with the one of the most powerful economy has noticed increase of 6% ($exp^{0.590} = 1.06$) as soon as they adopted Euro currency.

Analysis for 1996-2007 The coefficient of common currency is almost similar and it does not change the influence of the single currency. This might be the sign, that German economy is stable and powerful.

Italy

Italian regression via panel methods generated almost similar results in both cases, except of significance of one variable in fixed effects, not important for us, and that is GDP growth. Criterion are again better for fixed effects method. Moreover, as in other countries, there exist more variables that affect trade volumes of this country. OLS methods' results differ a lot again. They do not meet the condition of normality, homoscedasticity and autocorrelation.

Result Italy was influenced due to the results from our model in negative way, its trade volumes decreased by 9% ($exp^{-0.895} = 0.91$) with single currency.

Analysis for 1996-2007 Italy seems to be quite affected by the crisis, because when we reduced observations, we got lower coefficient in common currency dummy variable.

Spain

Regression of our model with Spanish dataset generated results, which are not very pleasant. The reason is, that our common currency dummy variable is not significant in fixed effects method, which we have chosen as the best method for this research. If we compare this with random effects method, this way made common currency dummy significant, but the coefficients differ a lot. But to analyze the quality of these two methods, still the random effects method is better due to the criterions. Even though, they are not as persuasive as in other countries. If we compare plot of residuals in these methods, we can see again, that despite of fixed effects method gave us common currency not significant, the residual plot seems better.

On the other hand, just to compare OLS results with the panel methods. Before we try to interpret OLS results, we found out, that this data does not meet most of the OLS conditions, such as normality, homoscedasticity and there is autocorrelation, which was proved by Durbin-Watson test, where we declined null hypothesis.

Result This Southern European country's trade volumes have risen up by 9% ($exp^{0.888} = 1.09$) when they adopted Euro currency.

Analysis for 1996-2007 It is quite interesting, that with one less observation, we got the lower coefficient for common currency dummy variable. We supposed that this would be vice versa with the fact in mind, that year 2008 was the beginning of world crisis.

Great Britain

Both panel methods generated all variables significant, and their coefficients are alike. As we can see the coefficient in common currency dummy variable is negative. On the other hand, as well as in other countries tested criterion are better in case of fixed effects method. Furthermore, there are more variables that influence trade volumes, this conclusion we can get from common intercept test.

OLS again did not give us some important information.

Result As we mentioned its coefficient is negative, Great Britain is one of two countries in our thesis, which has not adopted Euro. As long as other countries have adopted Euro, British trade volumes has decreased by 11% ($exp^{-0.105692} = 1.11$).

Analysis for 1996-2007 Shorter period decreased the fall down of the trade volumes.

Czech Republic

The last country of our research is the Czech Republic. For this country we collected data for exports just for period 1999-2008, hopefully regression seems well.
All explanatory variables are significant in panel data methods. The regression got rather expected results so fixed effects method results were more accurate due to Schwarz and Akaike criterion. We declined null hypothesis of common intercept, so there are more variables that might influence trade volumes.

OLS method gives us common currency as not significant. Coefficient of determinant is pretty useable but the coefficient in common currency is just opposite.

Result Although we assumed, that single currency would decrease trade volumes of the country with its own currency, it has not. Czech trade volumes have risen up by 113% ($exp^{0.757} = 2.13$) . It is quite a huge number, it may be caused by two facts: the first is that we have less observations for this country and the second fact is, that the Czech Republic is relatively small and not very developed in comparison with the rest of tested countries (*hub-spoke trade*).

Analysis for 1996-2007 Czech case is the same as the Spanish, one would assume, that number rose even more, but this might be caused by the fact, that the Czech Republic has its own currency and also the world crisis was noticeable in this country later.

Summary

Table 6.1: Comparison of the results

Country	△ trade volumes until 2008	△ trade volumes until 2007
Austria	23%	25%
Belgium	6%	5%
France	-10%	-7%
Germany	6%	5.5%
Italy	-9%	-7.8%
Spain	9%	7.3%
Great Britain	-11%	-10%
Czech Republic	113%	95%

Source: Author's calculations

As we can see from the table 6.1 there is no definite conclusion whether single European currency has influenced trade volumes of European countries. The average boost of Euro currency for period 1996-2008 is 15.875% and for period 1996-2007 it is 14.125%, but both periods are mainly influenced by the Czech Republic boost.

Furthermore, if we divide countries to two groups on those who have already adopted Euro as legal tender and those that have not. Then we get average growth of trade app. 4% for countries with Euro and 51% boost of trade for countries with its own currency. For the period 1996-2007 result for Eurozone countries is slightly higher and it is 4.6%. And for non-Eurozone countries the boost of trade is 42.5%. Furthermore, if we look closer to the data for the second tested period, we can not definitely say, that most of the countries are influenced by the world economic crisis. But as we stated before, world economic crisis has begun in 2008 in the USA, so it is possible that most of the countries' exports would be influenced in next years.

Chapter 7

Conclusion

To conclude this thesis, we would like to say, that Rose's paper, published in 2000, presented results, that are quite unbelievable in comparison with our results. The fact is, that he used in his research huge dataset and especially most of the currency union he has got in his research were between large country and its colonies. This might be the reason, why the Rose's effect is so high. Furthermore, if we look at our model, it is based on the same roots as Rose's. Definitely it is simpler than Rose's. So was Rose right? From our point of view, we can not say, he was wrong even though, our model and regression generated totally different results except for one country, the Czech Republic, which is the best example of small country trading with large ones. There is definitely some influence of the single currency, but we do not think, that the impact is so huge. Generally, countries are not so aware of exchange rate volatility so they trade more. Based on our regression, we may say, that single currency boosts trading in most of the countries. On the other hand, in case of the Czech Republic, we are not sure, whether adopting Euro will have some other effects. If adopting of the Euro by Czech co-members of the EU had already boosted Czech trade volumes, we do not think, that sharing the same currency would lead the Czech Republic to trade even more. But trade volumes may stay at the same level. We also assume, that this rapid growth, which we noticed in the Czech Republic, is mainly caused by the membership in the EU and having common market. The Czech Republic as a former communist country still have products, whose price are lower than prices in other Western European countries, so its goods are competitive and wanted. In addition, Czech economy still receives grants from EU, so this may also encourages exports.

Chapter 8

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Appendix A

Appendix

A.1 Results from Gretl

Austria

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	−9.95565	1.72888	−5.7584	0.0000
GDPgrowth	2.27809	0.634815	3.5886	0.0004
LnYj	1.07958	0.0404444	26.6929	0.0000
LnDistance	0.470006	0.230826	2.0362	0.0427
LnC	0.207418	0.0562753	3.6858	0.0003

Mean dependent var	7.131846	S.D. dependent var	1.238091
Sum squared resid	7.606154	S.E. of regression	0.163653
R^2	0.984045	Adjusted R^2	0.982528
$F(27, 284)$	648.7389	P-value(F)	4.4e–238
Log-likelihood	136.6823	Akaike criterion	−217.3646
Schwarz criterion	−112.5605	Hannan–Quinn	−175.4776
$\hat{\rho}$	0.489407	Durbin–Watson	0.923642

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 284) = 92.4609$

with p-value = $P(F(23, 284) > 92.4609) = 1.76062\text{e-}117$

Distribution free Wald test for heteroskedasticity –
Null hypothesis: the units have a common error variance
Asymptotic test statistic: $\chi^2(24) = 937.054$
with p-value = 2.0344e-182

Model 2: Random-effects (GLS), using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	0.300242	0.697087	0.4307	0.6670
GDPgrowth	2.74931	0.659831	4.1667	0.0000
LnYj	1.01324	0.0383407	26.4273	0.0000
LnDistance	−0.878830	0.0883422	−9.9480	0.0000
LnC	0.208364	0.0589648	3.5337	0.0005

Mean dependent var	7.131846	S.D. dependent var	1.238091
Sum squared resid	81.06553	S.E. of regression	0.513030
Log-likelihood	−232.4605	Akaike criterion	474.9211
Schwarz criterion	493.6361	Hannan–Quinn	482.4009

$$\hat{\sigma}^2_\varepsilon = 0.0267822$$
$$\hat{\sigma}^2_u = 0.211840$$
$$\theta = 0.901384$$

Breusch-Pagan test –
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: $\chi^2(1) = 1333.09$
with p-value = 7.27709e-292

Hausman test –
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: $\chi^2(4) = 42.9582$
with p-value = 1.05564e-08

Model 3: Pooled OLS, using 312 observations
Included 24 cross-sectional units
Time-series length = 13

Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	2.26685	0.253953	8.9262	0.0000
GDPgrowth	4.05591	1.53432	2.6435	0.0086
LnYj	0.926727	0.0233672	39.6593	0.0000
LnDistance	−1.00533	0.0283794	−35.4248	0.0000
LnC	0.0566886	0.0921626	0.6151	0.5389

Mean dependent var	7.131846	S.D. dependent var	1.238091
Sum squared resid	64.56124	S.E. of regression	0.458582
R^2	0.864573	Adjusted R^2	0.862808
$F(4, 307)$	489.9746	P-value(F)	7.0e–132
Log-likelihood	−196.9481	Akaike criterion	403.8963
Schwarz criterion	422.6113	Hannan–Quinn	411.3761
$\hat{\rho}$	0.940261	Durbin–Watson	0.126020

White's test for heteroskedasticity –
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 109.499
with p-value = $P(\chi^2(14) > 109.499) = 6.99677\text{e-}17$

Test for normality of residual –
Null hypothesis: error is normally distributed
Test statistic: $\chi^2(2) = 1.14341$
with p-value = 0.564563

Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	−6.38576	0.574953	−11.1066	0.0000
GDPgrowth	2.31212	0.647803	3.5692	0.0004
LnYj	1.05663	0.0464344	22.7552	0.0000
LnC	0.223536	0.0582125	3.8400	0.0002

Mean dependent var	7.092528	S.D. dependent var	1.238142
Sum squared resid	7.047719	S.E. of regression	0.164325
R^2	0.983981	Adjusted R^2	0.982386
$F(26, 261)$	616.6348	P-value(F)	3.8e–218
Log-likelihood	125.6226	Akaike criterion	−197.2453
Schwarz criterion	−98.34535	Hannan–Quinn	−157.6122
$\hat{\rho}$	0.464601	Durbin–Watson	0.964835

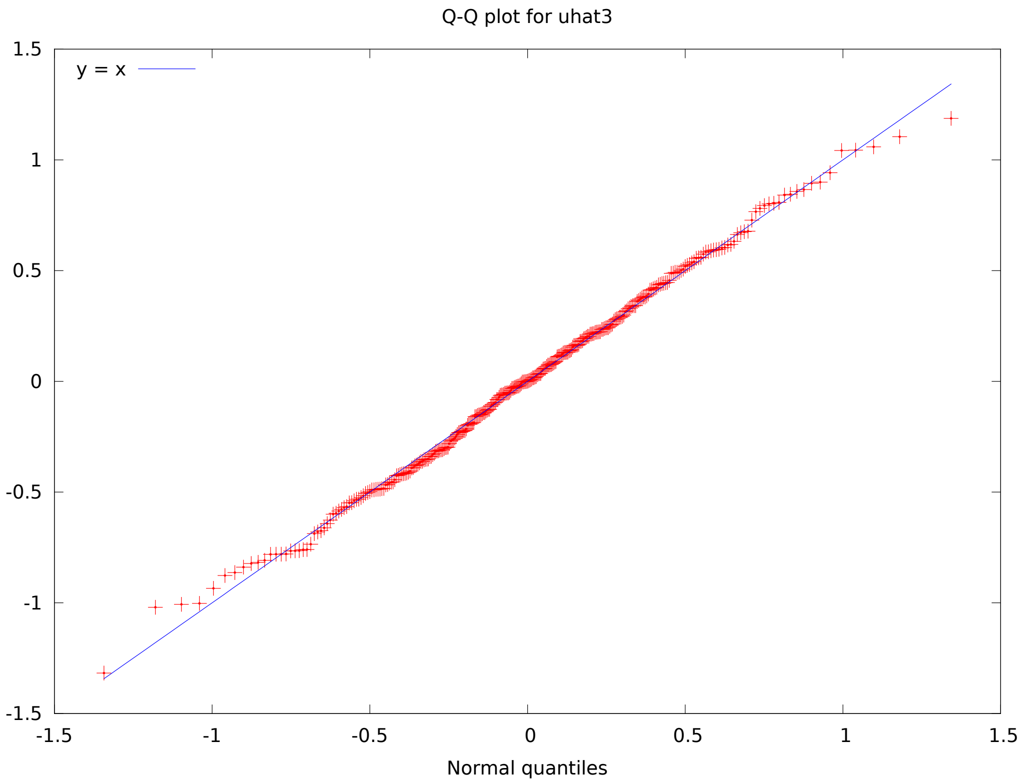
Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 261) = 83.1672$

with p-value $= P(F(23, 261) > 83.1672) = 4.15567\text{e-}106$

Figure A.1: Austria-OLS - QQ plot

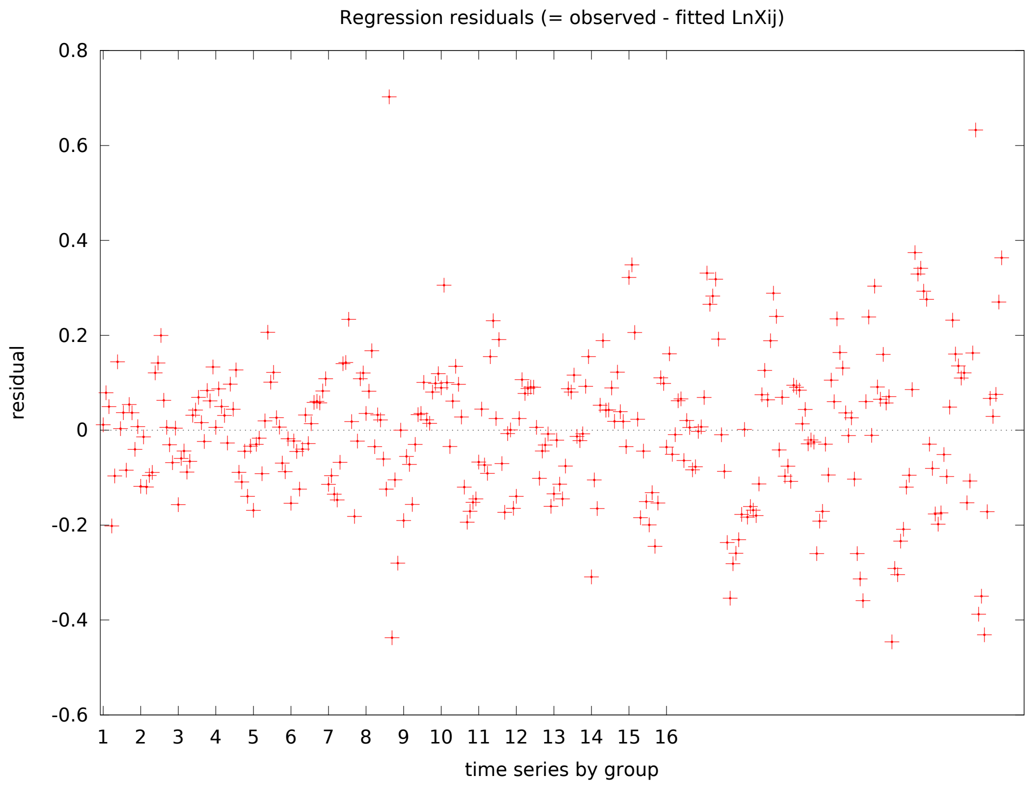


Belgium

Model 1: Fixed-effects, using 312 observations

Included 24 cross-sectional units

Figure A.2: Austria-Residual plot for Fixed effects



Time-series length = 13

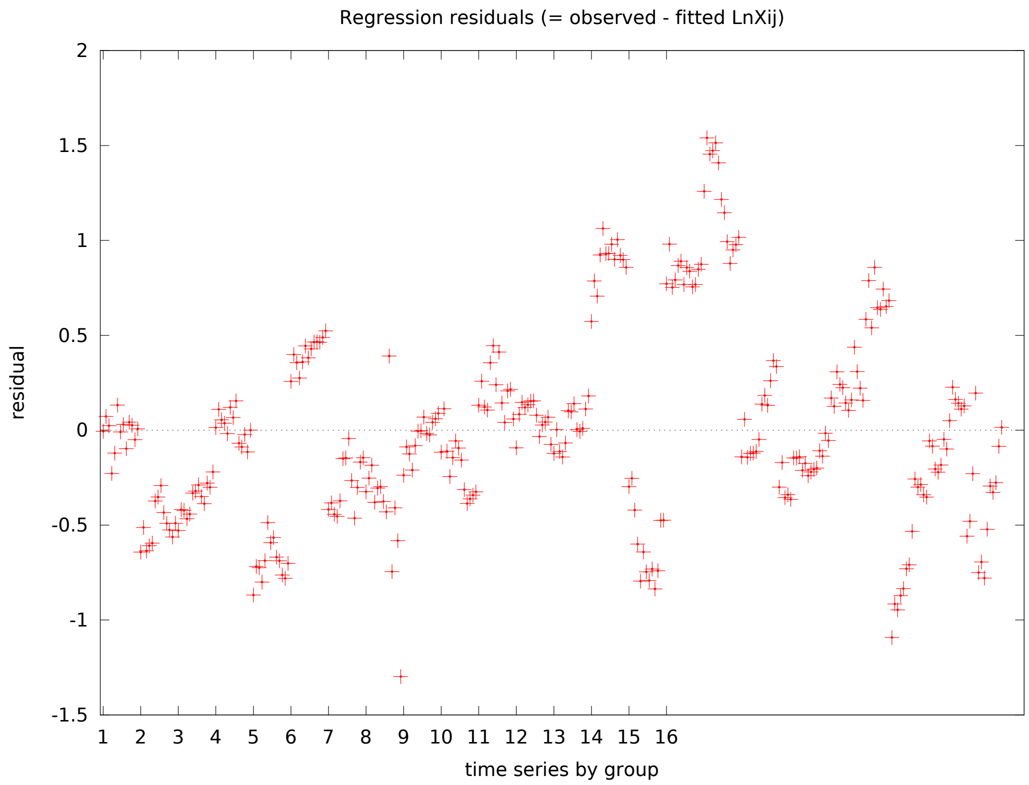
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	−7.16041	0.442095	−16.1965	0.0000
GDP_Growth	2.34653	0.598598	3.9200	0.0001
LnYj	1.18230	0.0356676	33.1478	0.0000
LnC	0.0582799	0.0500221	1.1651	0.2450

Mean dependent var	7.914250	S.D. dependent var	1.452111
Sum squared resid	6.091419	S.E. of regression	0.146196
R^2	0.990711	Adjusted R^2	0.989864
$F(26, 285)$	1169.122	P-value(F)	6.1e–273
Log-likelihood	171.3262	Akaike criterion	−288.6525
Schwarz criterion	−187.5914	Hannan–Quinn	−248.2614
$\hat{\rho}$	0.695068	Durbin–Watson	0.552833

Test for differing group intercepts –

Figure A.3: Austria-Residual plot for Random effects



Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 285) = 61.8685$

with p-value = $P(F(23, 285) > 61.8685)$ = 1.20132e-96

Model 2: Random-effects (GLS), using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	0.449089	0.613096	0.7325	0.4644
GDP_Growth	2.91397	0.615026	4.7380	0.0000
LnYj	1.07252	0.0302284	35.4804	0.0000
LnD	−0.884669	0.0717057	−12.3375	0.0000
LnC	0.122989	0.0513638	2.3945	0.0172

Figure A.4: Austria-Exports

Mean dependent var	7.914250	S.D. dependent var	1.452111
Sum squared resid	62.35173	S.E. of regression	0.449934
Log-likelihood	−191.5158	Akaike criterion	393.0316
Schwarz criterion	411.7466	Hannan–Quinn	400.5114

$$\hat{\sigma}_{\varepsilon}^2 = 0.0213734$$
$$\hat{\sigma}_{u}^2 = 0.0937001$$
$$\theta = 0.867537$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 901.735$

with p-value = 4.11707e-198

Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 36.4624$

with p-value = 5.9787e-08

Model 4: Pooled OLS, using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	2.43955	0.230741	10.5727	0.0000
GDP_Growth	1.97594	1.27116	1.5544	0.1211
LnYj	0.870092	0.0149327	58.2674	0.0000
LnD	−0.814615	0.0220314	−36.9752	0.0000
LnC	0.713862	0.0718357	9.9374	0.0000

Mean dependent var	7.914250	S.D. dependent var	1.452111
Sum squared resid	36.50524	S.E. of regression	0.344833
R^2	0.944333	Adjusted R^2	0.943608
$F(4, 307)$	1301.992	P-value(F)	4.1e–191
Log-likelihood	−108.0034	Akaike criterion	226.0068
Schwarz criterion	244.7219	Hannan–Quinn	233.4867
$\hat{\rho}$	0.920779	Durbin–Watson	0.134809

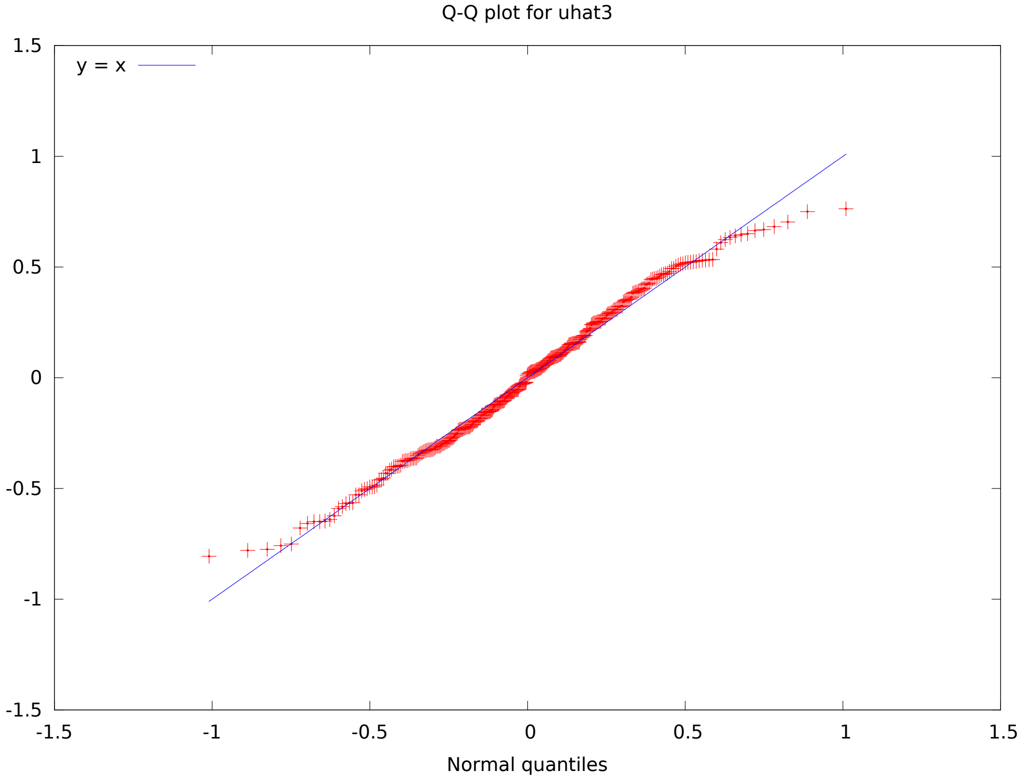
Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	−6.96406	0.525165	−13.2607	0.0000
GDP_Growth	2.69526	0.641307	4.2028	0.0000
LnYj	1.16554	0.0425902	27.3665	0.0000
LnC	0.0454766	0.0508011	0.8952	0.3715

Mean dependent var	7.872989	S.D. dependent var	1.458160
Sum squared resid	5.379138	S.E. of regression	0.143561
R^2	0.991185	Adjusted R^2	0.990307
$F(26, 261)$	1128.760	P-value(F)	5.8e–252
Log-likelihood	164.5280	Akaike criterion	−275.0559
Schwarz criterion	−176.1560	Hannan–Quinn	−235.4228
$\hat{\rho}$	0.679444	Durbin–Watson	0.587255

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 59.2832$
with p-value = $P(F(23, 261) > 59.2832)$ = 8.20534e-90

Figure A.5: Belgium-OLS - QQ plot

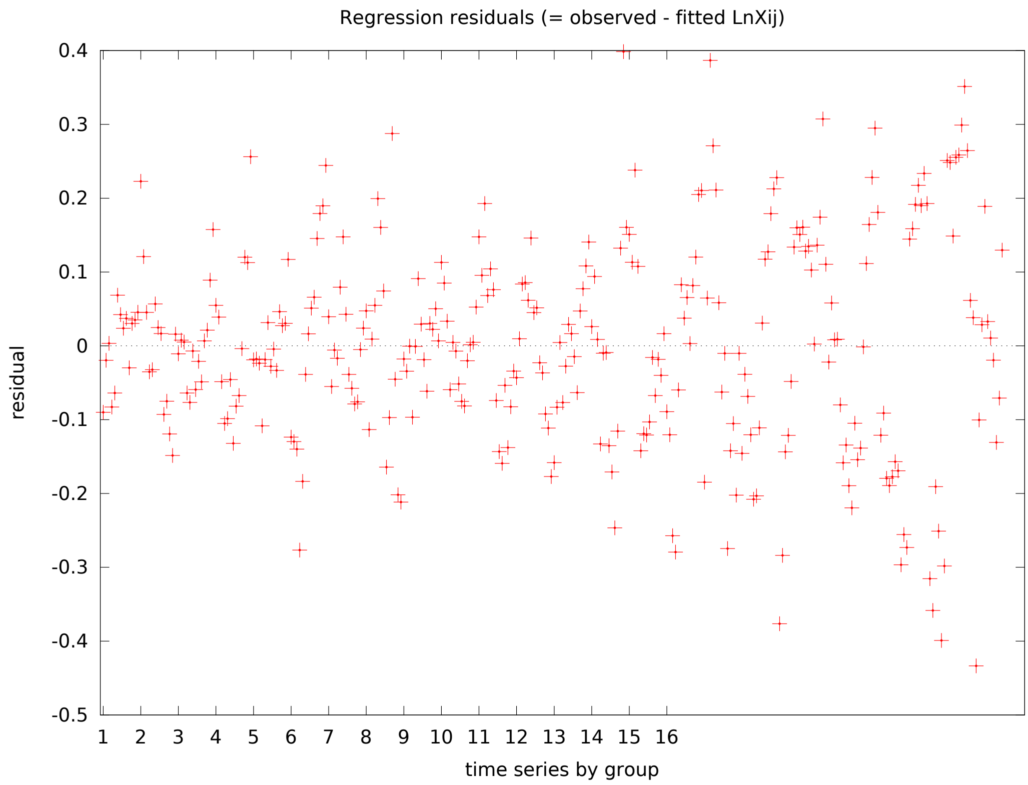


France

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	−3.47042	0.386662	−8.9753	0.0000
GPDcum_LN	2.21818	0.817561	2.7132	0.0071
LN_Yj	0.942019	0.0312721	30.1233	0.0000
LN_Cij	−0.102256	0.0452157	−2.2615	0.0245

Figure A.6: Belgium-Residual plot for Fixed effects



Mean dependent var	8.460111	S.D. dependent var	1.333880
Sum squared resid	5.187109	S.E. of regression	0.134909
R^2	0.990626	Adjusted R^2	0.989771
$F(26, 285)$	1158.376	P-value(F)	2.2e–272
Log-likelihood	196.3961	Akaike criterion	−338.7923
Schwarz criterion	−237.7312	Hannan–Quinn	−298.4012
$\hat{\rho}$	0.662465	Durbin–Watson	0.559472

Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 285) = 114.075$

with p-value $= P(F(23, 285) > 114.075) =$ 3.08948e-129

Distribution free Wald test for heteroskedasticity –

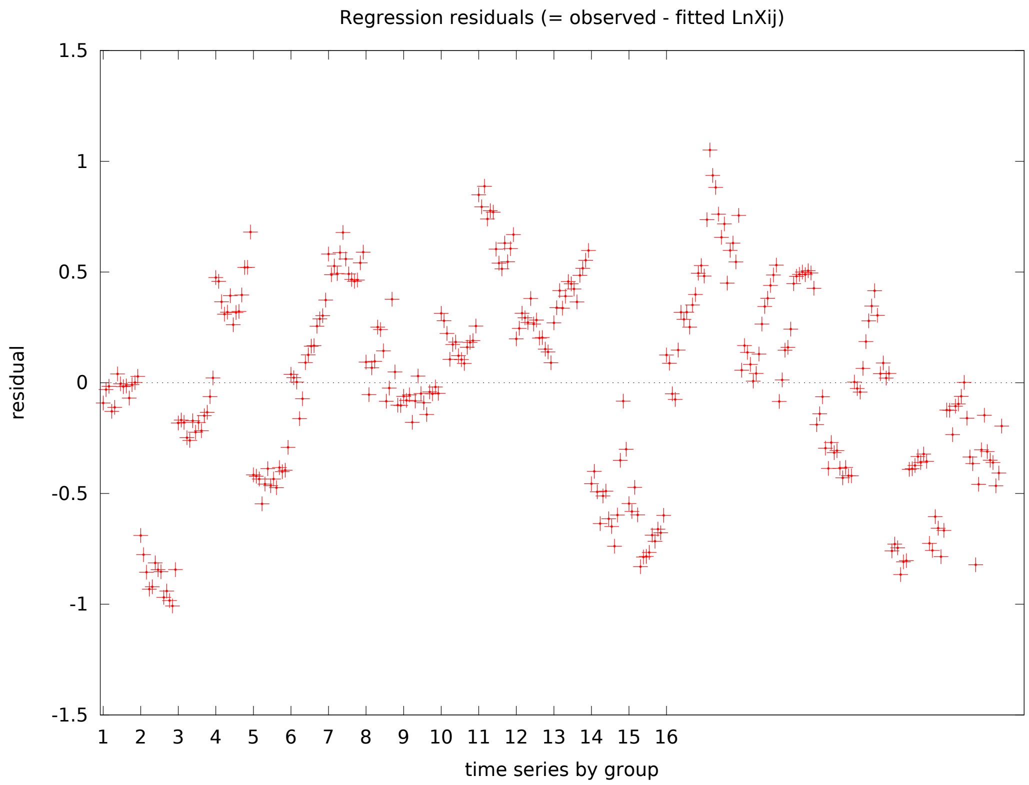
Null hypothesis: the units have a common error variance

Asymptotic test statistic: $\chi^2(24) = 3575.67$

with p-value = 0

Test for normality of residual –

Figure A.7: Belgium-Residual plot for Random effects



Null hypothesis: error is normally distributed

Test statistic: $\chi^2(2) = 26.6439$

with p-value = 1.63812e-06

Model 2: Random-effects (GLS), using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNXij

	Coefficient	Std. Error	*t*-ratio	p-value
const	3.07696	0.770037	3.9959	0.0001
GPDcum_LN	2.23171	0.824434	2.7070	0.0072
LN_Yj	0.930259	0.0285119	32.6270	0.0000
LN_Dij	−0.891609	0.0994416	−8.9662	0.0000
LN_Cij	−0.0828979	0.0448944	−1.8465	0.0658

Figure A.8: Belgium-Exports

Mean dependent var	8.460111	S.D. dependent var	1.333880
Sum squared resid	63.33338	S.E. of regression	0.453462
Log-likelihood	−193.9527	Akaike criterion	397.9054
Schwarz criterion	416.6204	Hannan–Quinn	405.3852

$$\hat{\sigma}_{\varepsilon}^2 = 0.0182004$$
$$\hat{\sigma}_u^2 = 0.155413$$
$$\theta = 0.905087$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 1220.94$

with p-value = 1.71598e-267

Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 9.21952$

with p-value = 0.0265102

Test for normality of residual –

Null hypothesis: error is normally distributed

Test statistic: $\chi^2(2) = 1.57749$

with p-value = 0.454415

Model 3: Pooled OLS, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	3.16841	0.296893	10.6719	0.0000
GPDcum_LN	0.622813	2.46371	0.2528	0.8006
LN_Yj	0.873547	0.0187014	46.7103	0.0000
LN_Dij	−0.813661	0.0304362	−26.7333	0.0000
LN_Cij	0.563345	0.0852698	6.6066	0.0000

Mean dependent var	8.460111	S.D. dependent var	1.333880
Sum squared resid	52.93998	S.E. of regression	0.415262
R^2	0.904327	Adjusted R^2	0.903080
$F(4, 307)$	725.4606	P-value(F)	5.0e–155
Log-likelihood	−165.9891	Akaike criterion	341.9782
Schwarz criterion	360.6932	Hannan–Quinn	349.4580
$\hat{\rho}$	0.961603	Durbin–Watson	0.073297

Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LNXij

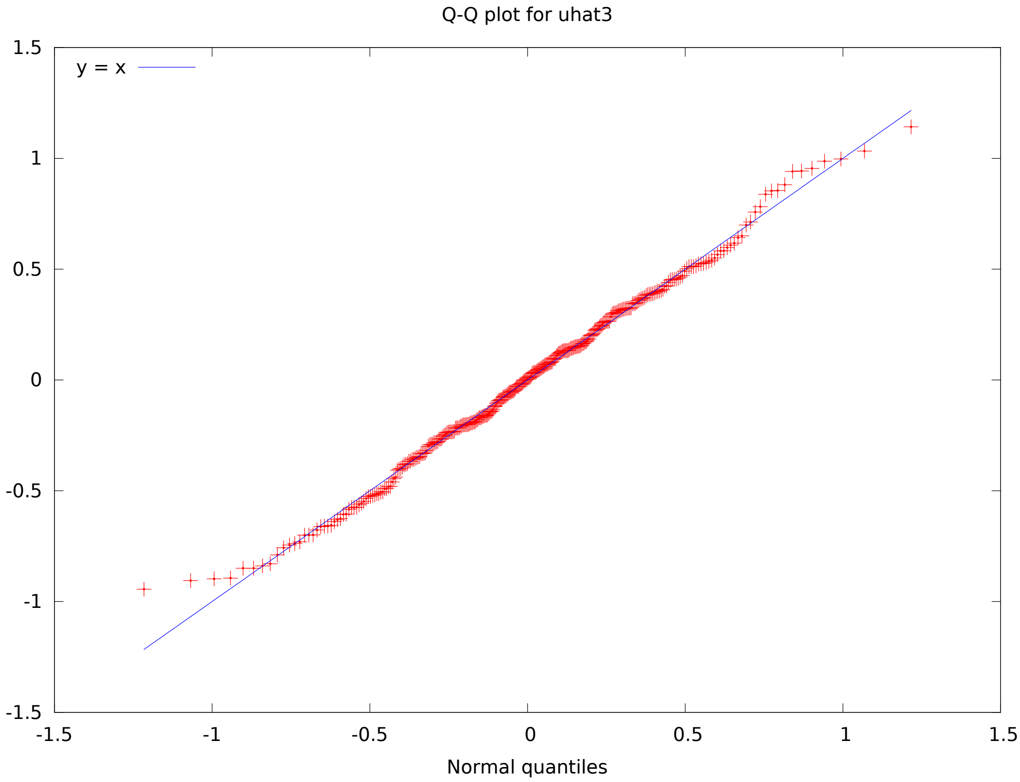
	Coefficient	Std. Error	t-ratio	p-value
const	−3.28729	0.447707	−7.3425	0.0000
GPDcum_LN	2.06037	0.877395	2.3483	0.0196
LN_Yj	0.927645	0.0366432	25.3156	0.0000
LN_Cij	−0.0731229	0.0462615	−1.5806	0.1152

Mean dependent var	8.434906	S.D. dependent var	1.345462
Sum squared resid	4.636468	S.E. of regression	0.133283
R^2	0.991076	Adjusted R^2	0.990187
$F(26, 261)$	1114.838	P-value(F)	2.9e–251
Log-likelihood	185.9228	Akaike criterion	−317.8456
Schwarz criterion	−218.9457	Hannan–Quinn	−278.2125
$\hat{\rho}$	0.647500	Durbin–Watson	0.586485

Test for differing group intercepts –

Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 107.823$
with p-value = $P(F(23, 261) > 107.823)$ = 4.04532e-119

Figure A.9: France-OLS - QQ plot

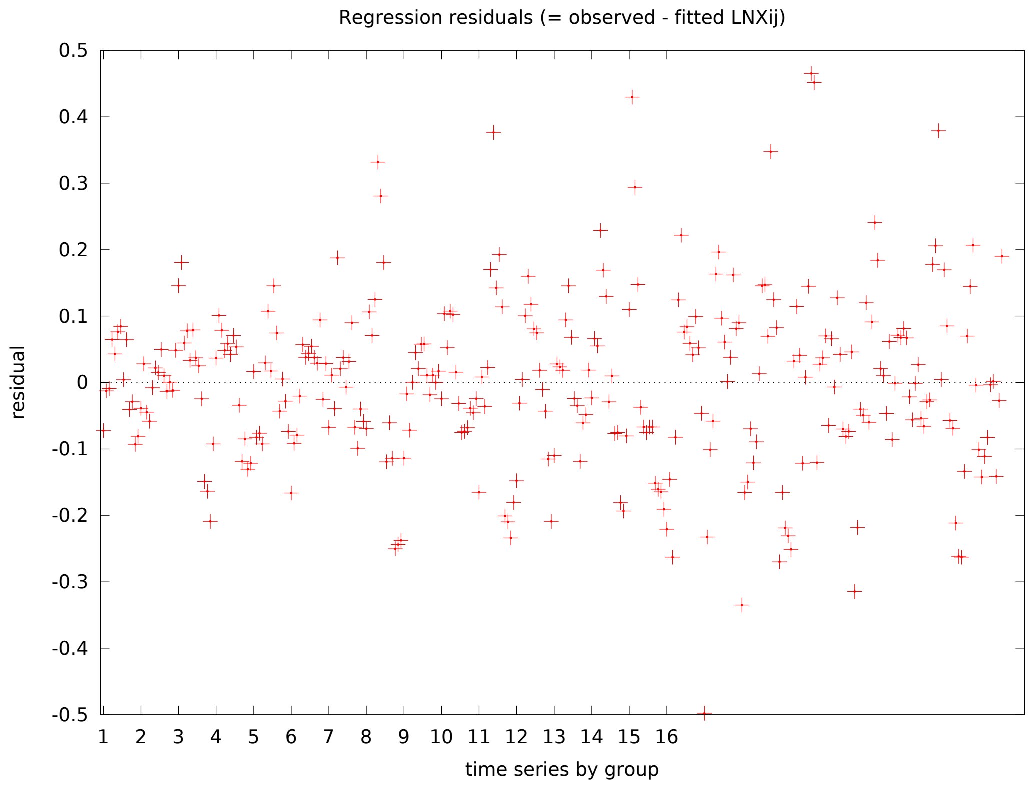


Germany

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−4.04690	0.301958	−13.4022	0.0000
GDP_cum	3.36598	0.458319	7.3442	0.0000
LNYJ	1.07184	0.0244743	43.7945	0.0000
LNC	0.0590813	0.0318740	1.8536	0.0648

Figure A.10: France-Residual plot for Fixed effects



Mean dependent var	9.519122	S.D. dependent var	1.053238
Sum squared resid	2.519760	S.E. of regression	0.094028
R^2	0.992696	Adjusted R^2	0.992030
$F(26, 285)$	1489.849	P-value(F)	8.2e–288
Log-likelihood	309.0301	Akaike criterion	−564.0602
Schwarz criterion	−462.9991	Hannan–Quinn	−523.6692
$\hat{\rho}$	0.618756	Durbin–Watson	0.610825

Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 285) = 219.418$

with p-value = $P(F(23, 285) > 219.418) = 1.61582\text{e-}166$

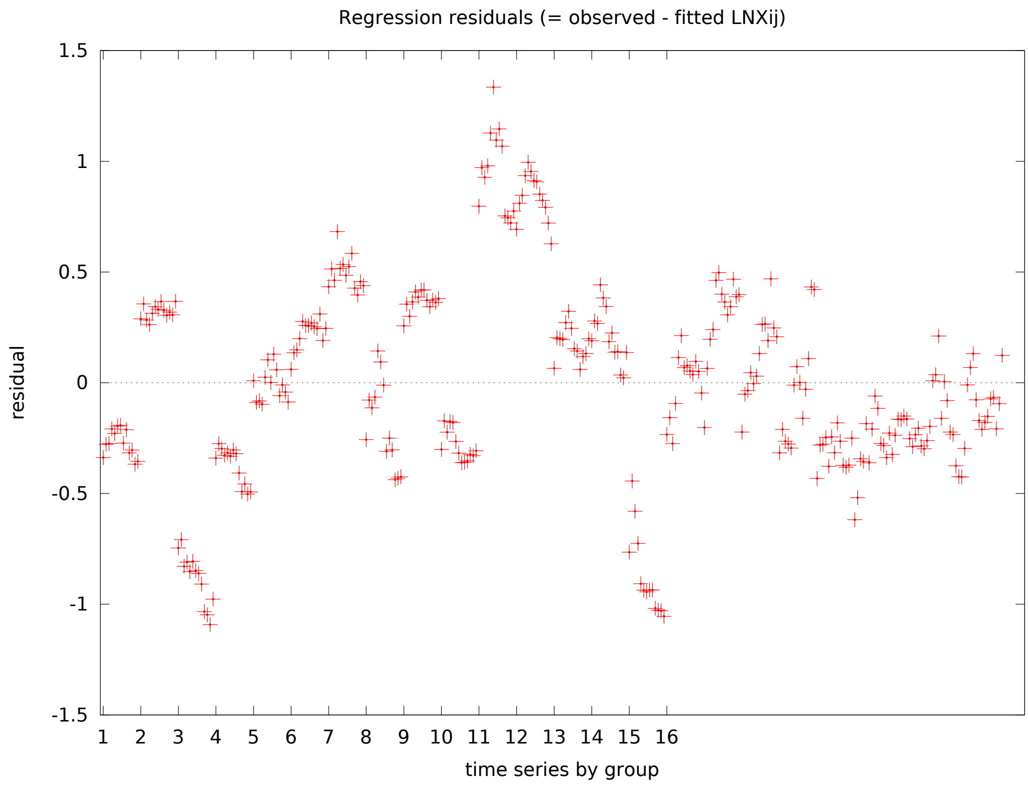
Model 2: Random-effects (GLS), using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LNX

Figure A.11: France-Residual plot for Random effects



	Coefficient	Std. Error	t-ratio	p-value
const	3.19033	0.699513	4.5608	0.0000
GDP_cum	3.56863	0.460854	7.7435	0.0000
LNYJ	1.04760	0.0236997	44.2033	0.0000
LND	−0.987778	0.0973223	−10.1496	0.0000
LNC	0.0718641	0.0321700	2.2339	0.0262

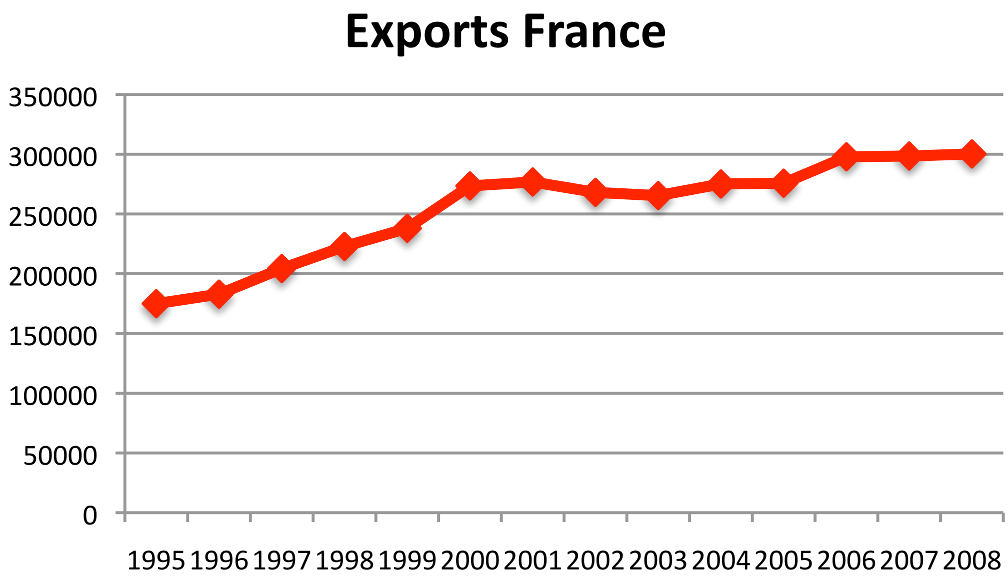
Mean dependent var	9.519122	S.D. dependent var	1.053238
Sum squared resid	68.69542	S.E. of regression	0.472268
Log-likelihood	−206.6308	Akaike criterion	423.2616
Schwarz criterion	441.9766	Hannan–Quinn	430.7414

$$\hat{\sigma}_{\varepsilon}^2 = 0.00884126$$
$$\hat{\sigma}_u^2 = 0.162371$$
$$\theta = 0.935281$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Figure A.12: France-Exports



Asymptotic test statistic: $\chi^2(1) = 1516.97$
with p-value = 0

Hausman test –
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: $\chi^2(3) = 12.6206$
with p-value = 0.00553318

Model 3: Pooled OLS, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNX

	Coefficient	Std. Error	*t*-ratio	p-value
const	4.79606	0.234218	20.4769	0.0000
GDP_cum	4.30367	1.63140	2.6380	0.0088
LNYJ	0.818964	0.0202305	40.4817	0.0000
LND	−0.819447	0.0293561	−27.9140	0.0000
LNC	0.462723	0.0781680	5.9196	0.0000

Mean dependent var	9.519122	S.D. dependent var	1.053238
Sum squared resid	47.13813	S.E. of regression	0.391847
R^2	0.863366	Adjusted R^2	0.861586
$F(4, 307)$	484.9696	P-value(F)	2.7e–131
Log-likelihood	−147.8811	Akaike criterion	305.7623
Schwarz criterion	324.4773	Hannan–Quinn	313.2421
$\hat{\rho}$	0.972941	Durbin–Watson	0.047969

Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−4.16050	0.344872	−12.0639	0.0000
GDP_cum	3.22948	0.463206	6.9720	0.0000
LNYJ	1.08103	0.0279650	38.6568	0.0000
LNC	0.0543143	0.0328085	1.6555	0.0990

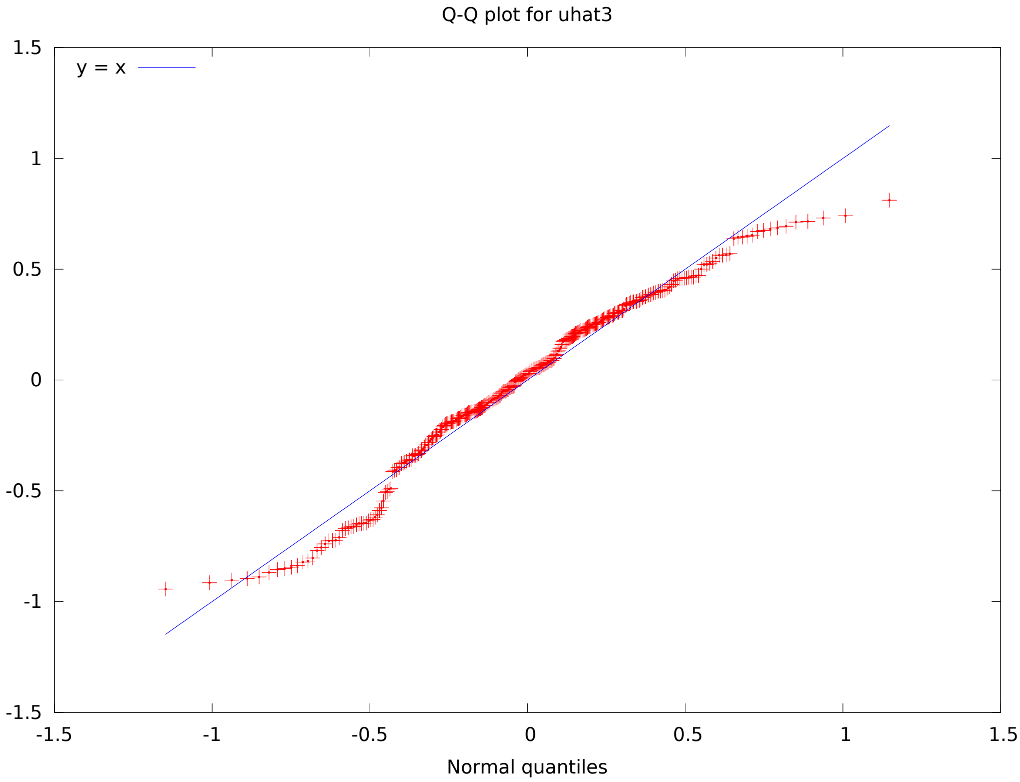
Mean dependent var	9.481035	S.D. dependent var	1.053576
Sum squared resid	2.286406	S.E. of regression	0.093596
R^2	0.992823	Adjusted R^2	0.992108
$F(26, 261)$	1388.672	P-value(F)	1.3e–263
Log-likelihood	287.7267	Akaike criterion	−521.4535
Schwarz criterion	−422.5535	Hannan–Quinn	−481.8203
$\hat{\rho}$	0.592429	Durbin–Watson	0.639268

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 204.135$
with p-value = $P(F(23, 261) > 204.135)$ = 1.75699e-152

Spain

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LnXij

Figure A.13: Germany-OLS - QQ plot



	Coefficient	Std. Error	t-ratio	p-value
const	−7.16041	0.442095	−16.1965	0.0000
GDP_Growth	2.34653	0.598598	3.9200	0.0001
LnYj	1.18230	0.0356676	33.1478	0.0000
LnC	0.0582799	0.0500221	1.1651	0.2450

Mean dependent var	7.914250	S.D. dependent var	1.452111
Sum squared resid	6.091419	S.E. of regression	0.146196
R^2	0.990711	Adjusted R^2	0.989864
$F(26, 285)$	1169.122	P-value(F)	6.1e–273
Log-likelihood	171.3262	Akaike criterion	−288.6525
Schwarz criterion	−187.5914	Hannan–Quinn	−248.2614
$\hat{\rho}$	0.695068	Durbin–Watson	0.552833

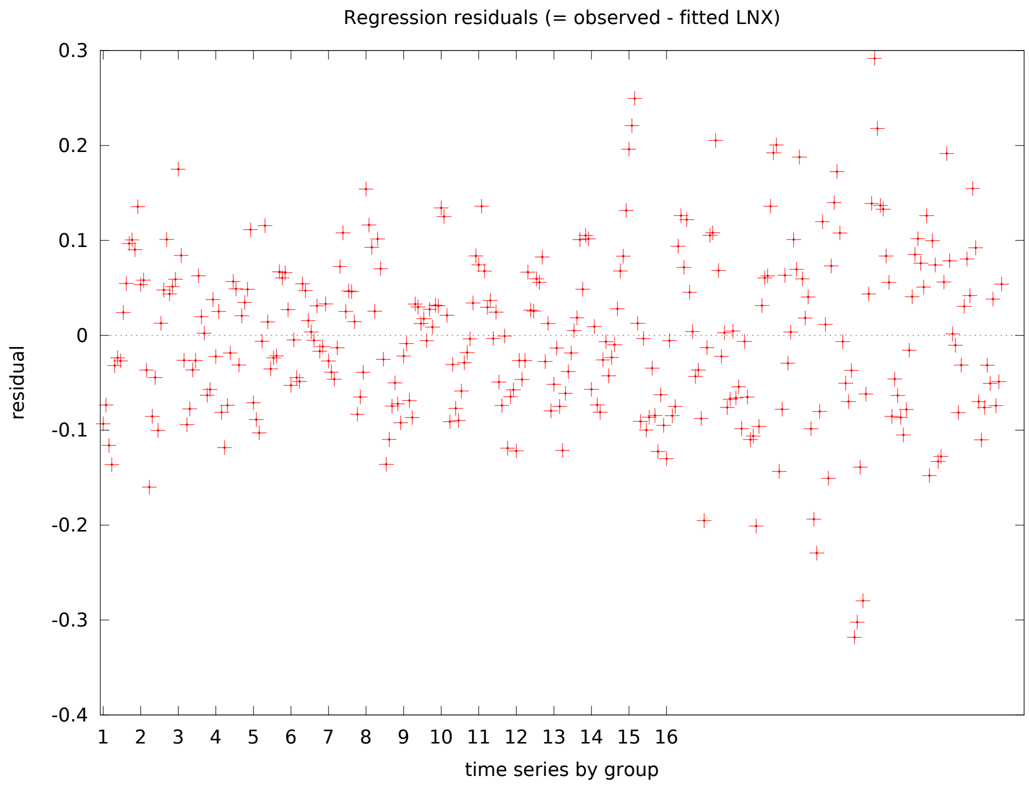
Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 285) = 61.8685$

with p-value = $P(F(23, 285) > 61.8685)$ = 1.20132e-96

Figure A.14: Germany-Residual plot for Fixed effects



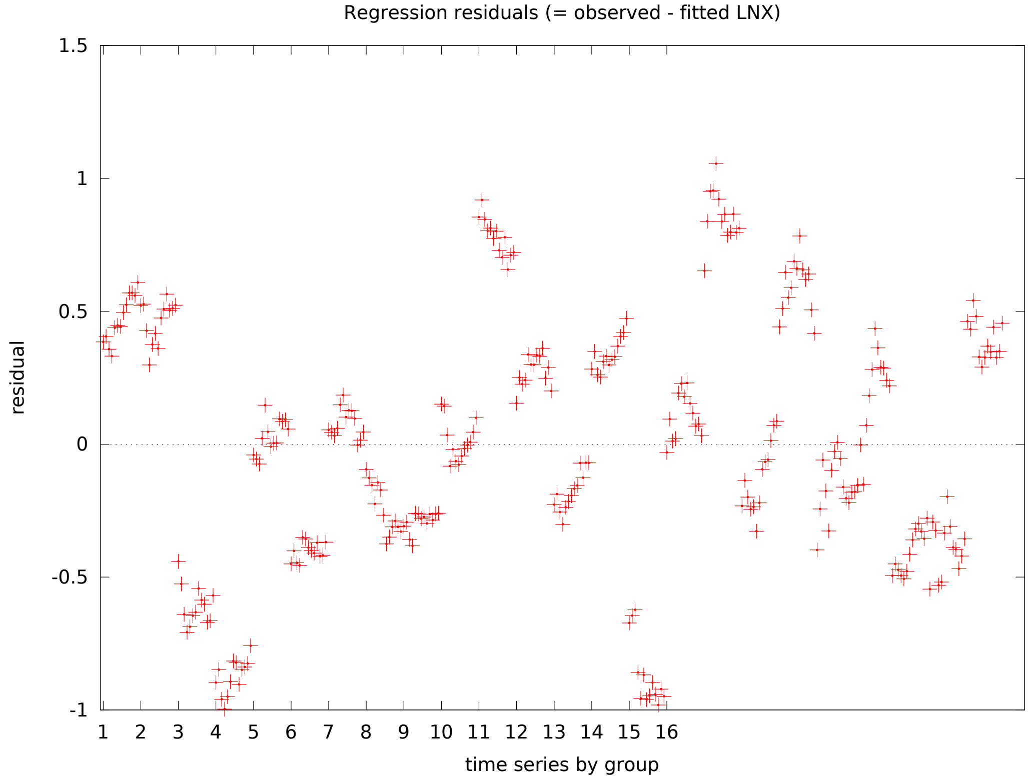
Model 2: Random-effects (GLS), using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LnXij

	Coefficient	Std. Error	t-ratio	p-value
const	0.449089	0.613096	0.7325	0.4644
GDP_Growth	2.91397	0.615026	4.7380	0.0000
LnYj	1.07252	0.0302284	35.4804	0.0000
LnD	−0.884669	0.0717057	−12.3375	0.0000
LnC	0.122989	0.0513638	2.3945	0.0172

Mean dependent var	7.914250	S.D. dependent var	1.452111
Sum squared resid	62.35173	S.E. of regression	0.449934
Log-likelihood	−191.5158	Akaike criterion	393.0316
Schwarz criterion	411.7466	Hannan–Quinn	400.5114

$$\hat{\sigma}_{\varepsilon}^2 = 0.0213734$$

Figure A.15: Germany-Residual plot for Random effects



$$\hat{\sigma}_u^2 = 0.0937001$$
$$\theta = 0.867537$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 901.735$

with p-value = 4.11707e-198

Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 36.4624$

with p-value = 5.9787e-08

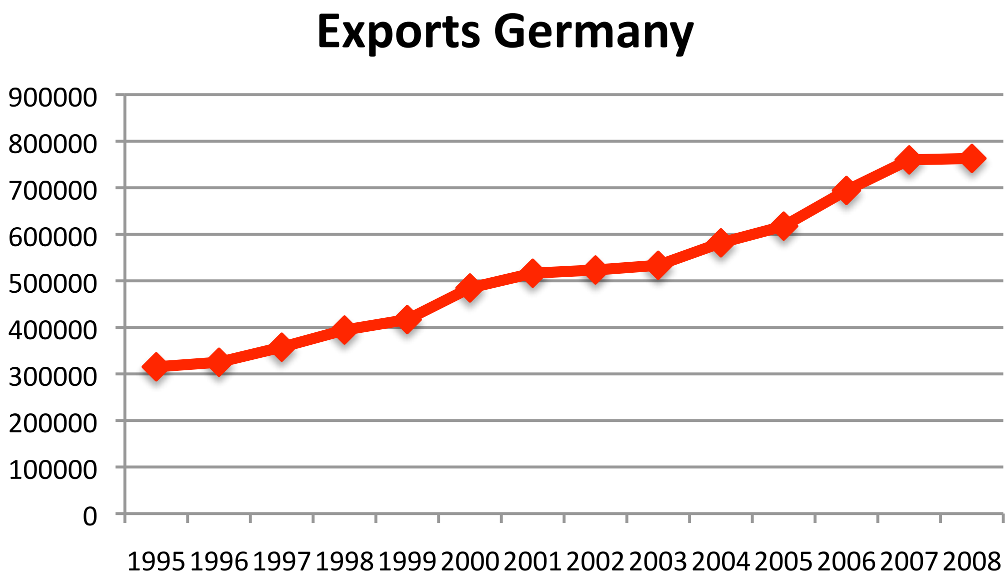
Model 3: Pooled OLS, using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LNX

Figure A.16: Germany-Exports



	Coefficient	Std. Error	t-ratio	p-value
const	5.66926	0.445337	12.7303	0.0000
GDPcum	0.522471	1.78256	0.2931	0.7696
LNYj	0.871124	0.0225039	38.7100	0.0000
LN_D	−1.22611	0.0534773	−22.9276	0.0000
LNC	0.609916	0.108942	5.5985	0.0000

Mean dependent var	7.450554	S.D. dependent var	1.407418
Sum squared resid	77.18228	S.E. of regression	0.501406
R^2	0.874712	Adjusted R^2	0.873079
$F(4, 307)$	535.8365	P-value(F)	4.6e–137
Log-likelihood	−224.8028	Akaike criterion	459.6057
Schwarz criterion	478.3207	Hannan–Quinn	467.0855
$\hat{\rho}$	0.948220	Durbin–Watson	0.088765

Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−9.30983	0.557841	−16.6890	0.0000
GDPcum	2.27296	0.809949	2.8063	0.0054
LNYj	1.31359	0.0453807	28.9460	0.0000
LNC	0.0711130	0.0593341	1.1985	0.2318

Mean dependent var	7.410576	S.D. dependent var	1.413485
Sum squared resid	7.441570	S.E. of regression	0.168854
R^2	0.987022	Adjusted R^2	0.985729
$F(26, 261)$	763.4730	P-value(F)	4.6e–230
Log-likelihood	117.7922	Akaike criterion	−181.5845
Schwarz criterion	−82.68453	Hannan–Quinn	−141.9513
$\hat{\rho}$	0.551434	Durbin–Watson	0.721403

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 96.4383$
with p-value = $P(F(23, 261) > 96.4383)$ = 1.7674e-113

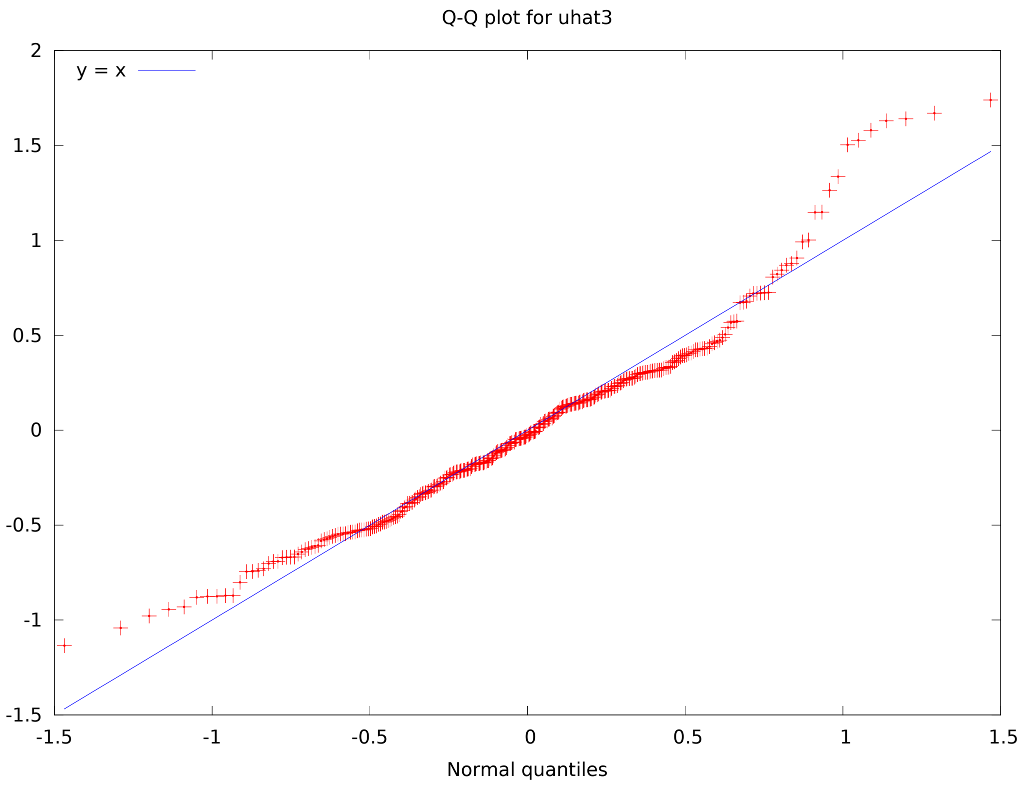
Italy

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−4.41104	0.392843	−11.2285	0.0000
GDP_cum	−0.400552	0.277754	−1.4421	0.1504
LN_Yj	1.01731	0.0308434	32.9829	0.0000
LNC	−0.0895056	0.0412812	−2.1682	0.0310

Mean dependent var	8.377320	S.D. dependent var	1.149062
Sum squared resid	4.157394	S.E. of regression	0.120778
R^2	0.989875	Adjusted R^2	0.988952
$F(26, 285)$	1071.713	P-value(F)	1.3e–267
Log-likelihood	230.9171	Akaike criterion	−407.8342
Schwarz criterion	−306.7731	Hannan–Quinn	−367.4431
$\hat{\rho}$	0.686047	Durbin–Watson	0.531192

Figure A.17: Spain-OLS - QQ plot



Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 285) = 56.486$

with p-value $= P(F(23, 285) > 56.486) = 4.62274\text{e-}92$

Model 2: Random-effects (GLS), using 312 observations

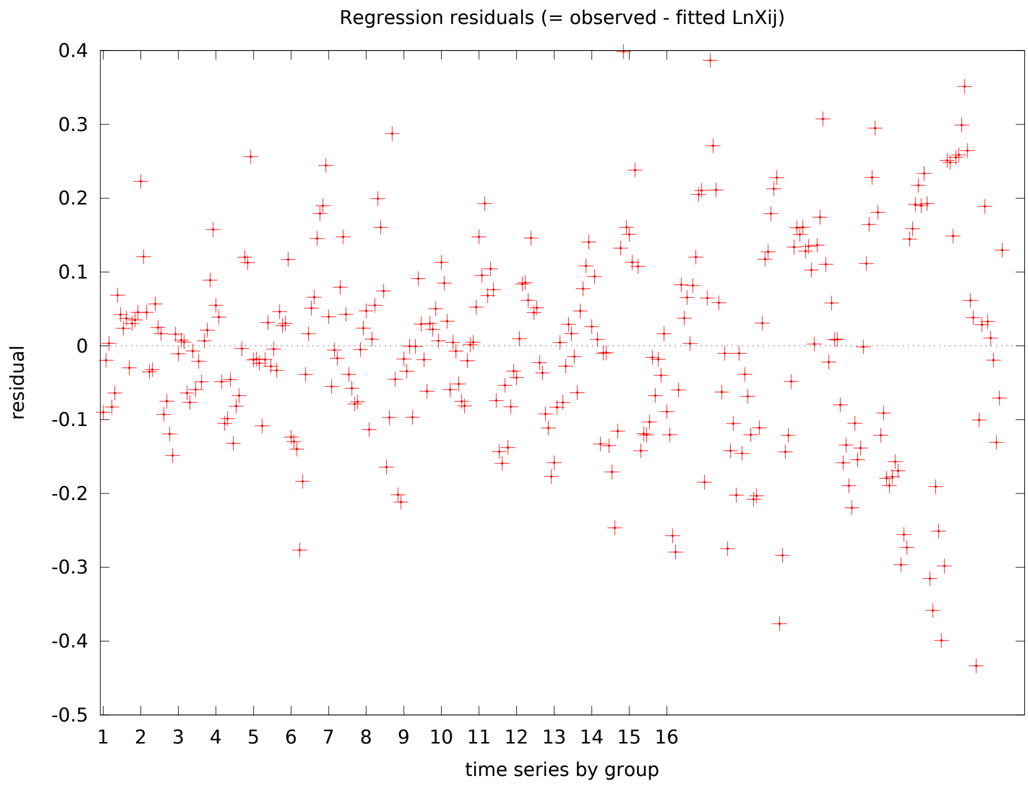
Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	4.52802	0.629040	7.1983	0.0000
GDP_cum	−0.464263	0.270326	−1.7174	0.0869
LN_Yj	0.993915	0.0260044	38.2211	0.0000
LND	−1.17029	0.0863551	−13.5520	0.0000
LNC	−0.0684070	0.0408226	−1.6757	0.0948

Figure A.18: Spain-Residual plot for Fixed effects



Mean dependent var	8.377320	S.D. dependent var	1.149062
Sum squared resid	26.63686	S.E. of regression	0.294080
Log-likelihood	−58.83850	Akaike criterion	127.6770
Schwarz criterion	146.3920	Hannan–Quinn	135.1568

$$\hat{\sigma}^2_{\varepsilon} = 0.0145873$$
$$\hat{\sigma}^2_{u} = 0.0656891$$
$$\theta = 0.869302$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 1054.41$

with p-value = 2.67266e-231

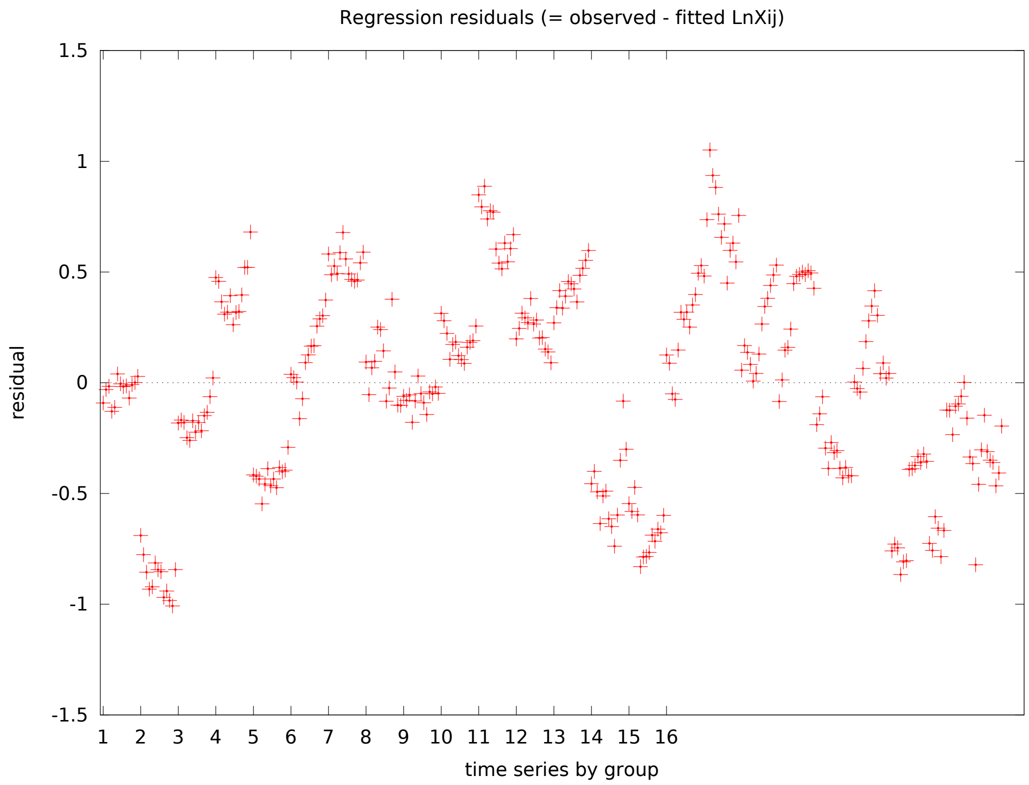
Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 7.15182$

with p-value = 0.067213

Figure A.19: Spain-Residual plot for Random effects



Model 3: Pooled OLS, using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LNX

	Coefficient	Std. Error	*t*-ratio	p-value
const	4.55589	0.201705	22.5869	0.0000
GDP_cum	0.0498704	0.539440	0.0924	0.9264
LN_Yj	0.929907	0.0138687	67.0507	0.0000
LND	−1.07700	0.0287175	−37.5033	0.0000
LNC	0.278788	0.0576802	4.8333	0.0000

Figure A.20: Spain-Exports

Mean dependent var	8.377320	S.D. dependent var	1.149062
Sum squared resid	23.10895	S.E. of regression	0.274360
R^2	0.943723	Adjusted R^2	0.942990
$F(4, 307)$	1287.034	P-value(F)	2.2e–190
Log-likelihood	−36.67465	Akaike criterion	83.34930
Schwarz criterion	102.0643	Hannan–Quinn	90.82912
$\hat{\rho}$	0.947738	Durbin–Watson	0.104512

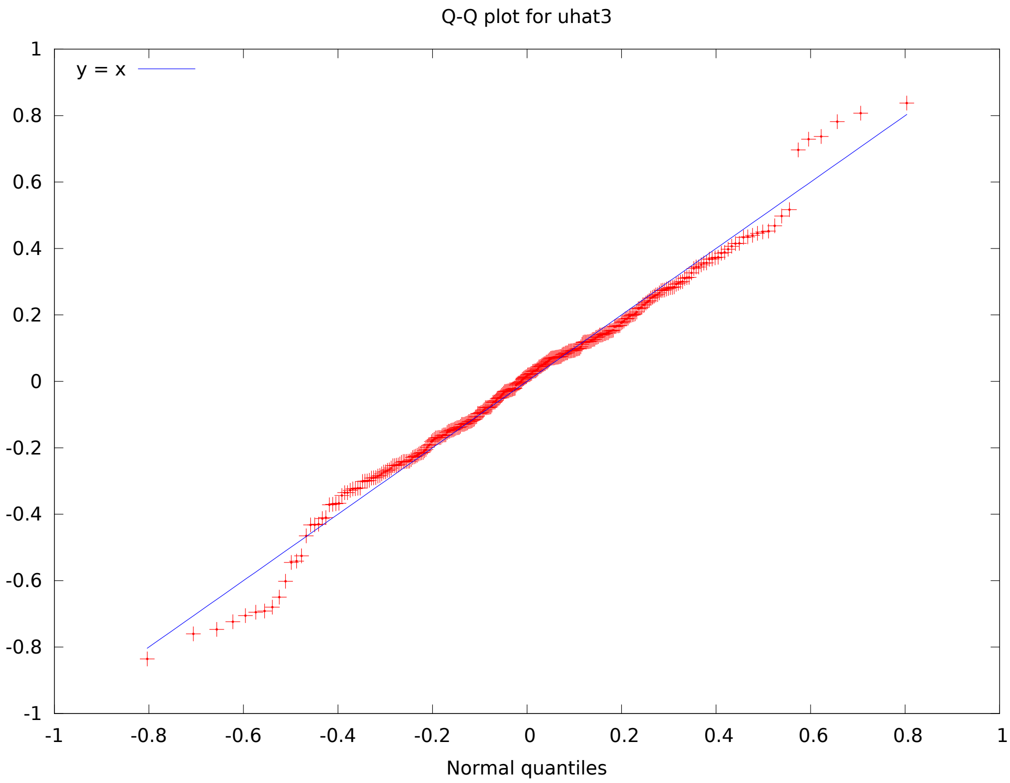
Model 2: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−4.57172	0.428893	−10.6594	0.0000
GDP_cum	−0.408151	0.278926	−1.4633	0.1446
LN_Yj	1.03014	0.0338349	30.4460	0.0000
LNC	−0.0799579	0.0421466	−1.8971	0.0589

Mean dependent var	8.347169	S.D. dependent var	1.154135
Sum squared resid	3.716622	S.E. of regression	0.119331
R^2	0.990278	Adjusted R^2	0.989310
$F(26, 261)$	1022.519	P-value(F)	2.0e–246
Log-likelihood	217.7666	Akaike criterion	−381.5332
Schwarz criterion	−282.6333	Hannan–Quinn	−341.9001
$\hat{\rho}$	0.697277	Durbin–Watson	0.524279

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 53.4988$
with p-value $= P(F(23, 261) > 53.4988) = 4.77393\text{e-}85$

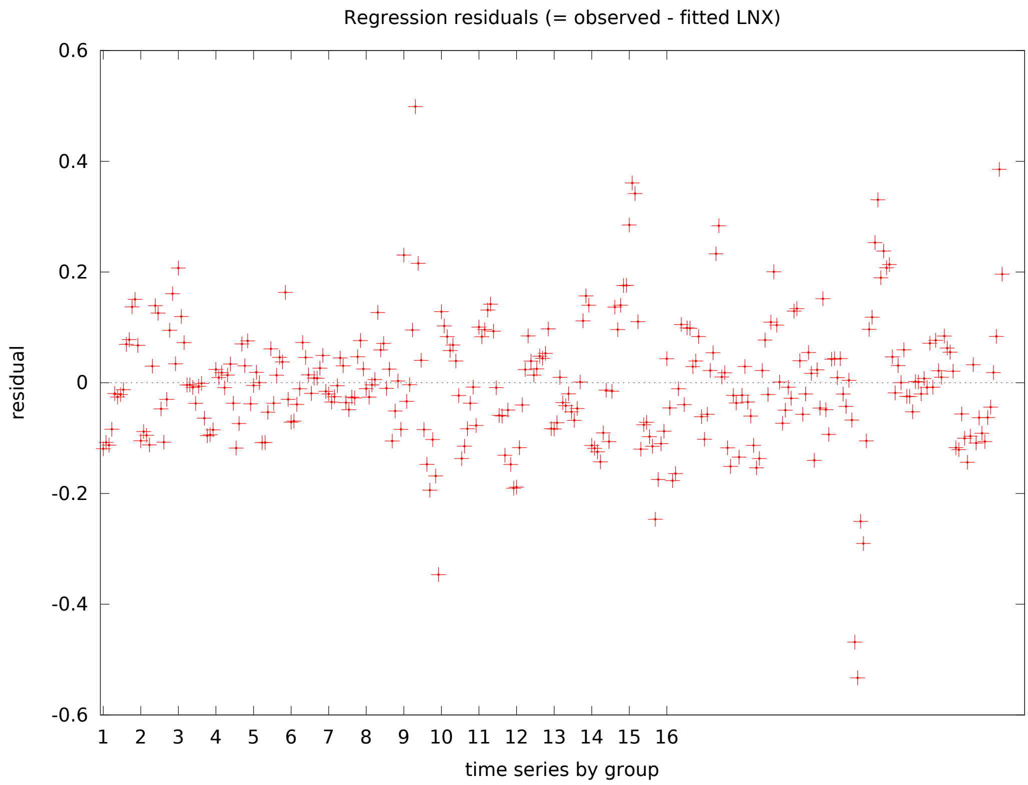
Figure A.21: Italy-OLS - QQ plot



Great Britain

Model 1: Fixed-effects, using 312 observations
Included 24 cross-sectional units

Figure A.22: Italy-Residual plot for Fixed effects



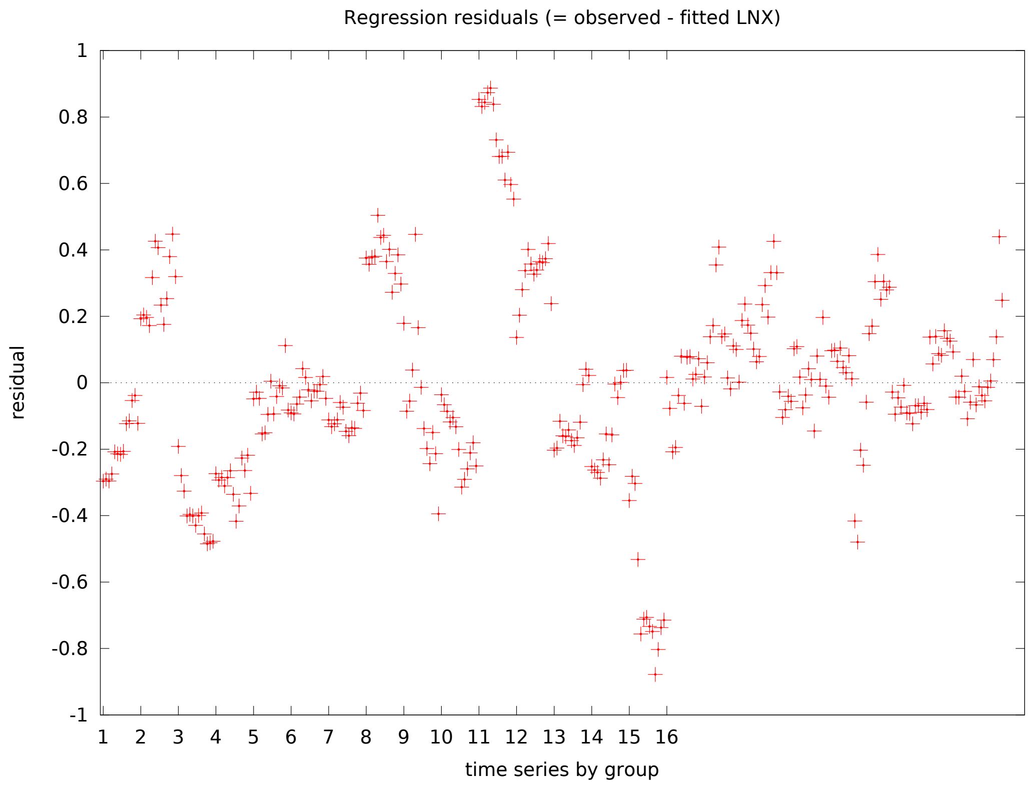
Time-series length = 13
Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	−2.69045	0.461262	−5.8328	0.0000
GDPcum	0.502762	0.129105	3.8942	0.0001
LN_Yj	0.872928	0.0365357	23.8925	0.0000
LN_CU	−0.105692	0.0465038	−2.2728	0.0238

Mean dependent var	8.311431	S.D. dependent var	1.386725
Sum squared resid	5.626785	S.E. of regression	0.140510
R^2	0.990592	Adjusted R^2	0.989733
$F(26, 285)$	1154.110	P-value(F)	3.8e–272
Log-likelihood	183.7037	Akaike criterion	−313.4074
Schwarz criterion	−212.3463	Hannan–Quinn	−273.0164
$\hat{\rho}$	0.427986	Durbin–Watson	0.991947

Test for differing group intercepts –

Figure A.23: Italy-Residual plot for Random effects

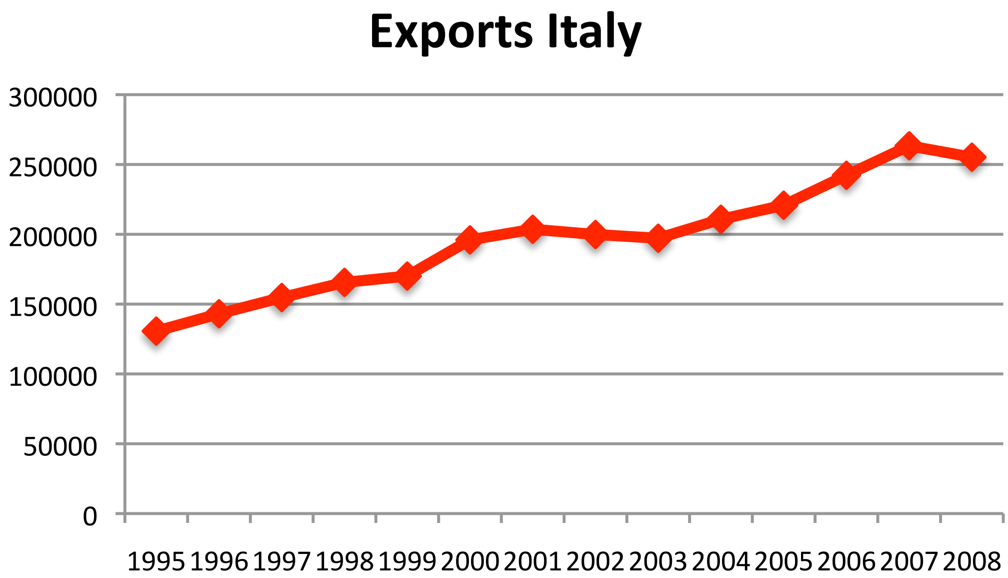


Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 285) = 164.754$
with p-value $= P(F(23, 285) > 164.754) = 5.92753\text{e-}150$

Model 2: Random-effects (GLS), using 312 observations
Included 24 cross-sectional units
Time-series length = 13
Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	3.68416	1.01620	3.6254	0.0003
GDPcum	0.520370	0.126809	4.1036	0.0001
LN_Yj	0.880524	0.0337037	26.1255	0.0000
LN_Dij	−0.897492	0.131918	−6.8034	0.0000
LN_CU	−0.103111	0.0462144	−2.2312	0.0264

Figure A.24: Italy-Exports



Mean dependent var	8.311431	S.D. dependent var	1.386725
Sum squared resid	84.33863	S.E. of regression	0.523285
Log-likelihood	−238.6354	Akaike criterion	487.2707
Schwarz criterion	505.9857	Hannan–Quinn	494.7505

$$\hat{\sigma}_{\varepsilon}^2 = 0.0197431$$
$$\hat{\sigma}_u^2 = 0.277572$$
$$\theta = 0.926031$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 1532.35$

with p-value = 0

Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 1.91178$

with p-value = 0.590917

Model 3: Pooled OLS, using 312 observations

Included 24 cross-sectional units

Time-series length = 13

Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	2.96219	0.362052	8.1817	0.0000
GDPcum	0.959007	0.397991	2.4096	0.0166
LN_Yj	0.905136	0.0237436	38.1213	0.0000
LN_Dij	−0.854503	0.0397460	−21.4991	0.0000
LN_CU	0.266420	0.112725	2.3635	0.0187

Mean dependent var	8.311431	S.D. dependent var	1.386725
Sum squared resid	80.44019	S.E. of regression	0.511879
R^2	0.865497	Adjusted R^2	0.863745
$F(4, 307)$	493.8696	P-value(F)	2.4e–132
Log-likelihood	−231.2525	Akaike criterion	472.5050
Schwarz criterion	491.2200	Hannan–Quinn	479.9848
$\hat{\rho}$	0.939590	Durbin–Watson	0.082114

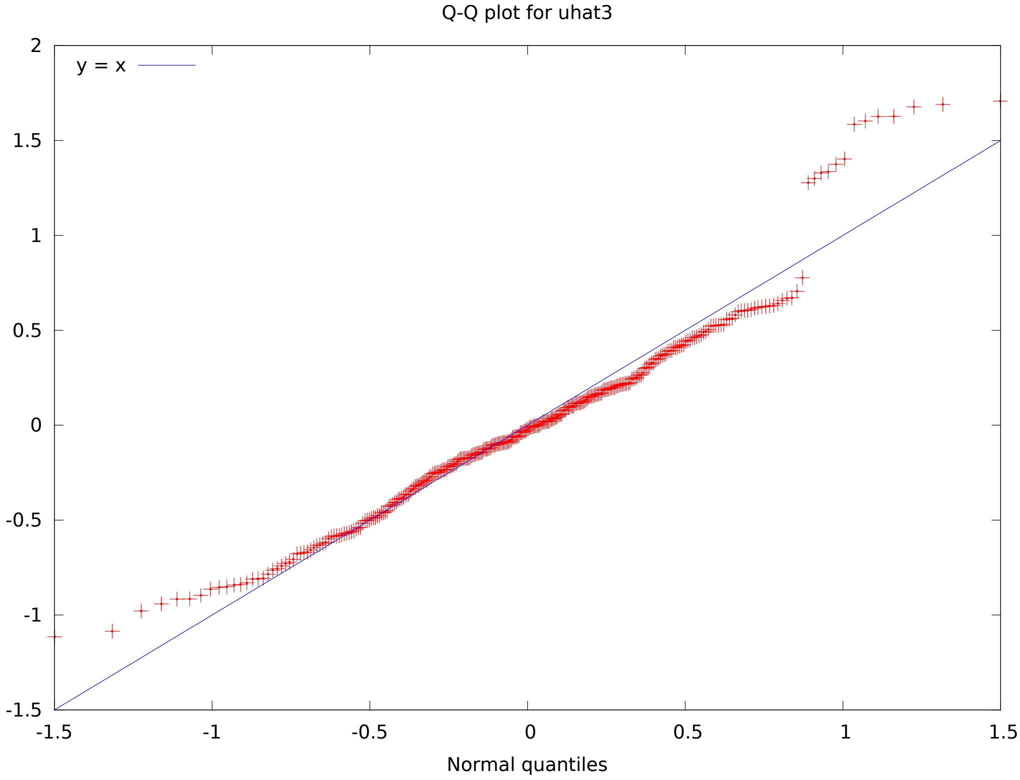
Model 1: Fixed-effects, using 288 observations
Included 24 cross-sectional units
Time-series length = 12
Dependent variable: LNXij

	Coefficient	Std. Error	t-ratio	p-value
const	−2.50723	0.483704	−5.1834	0.0000
GDPcum	0.248682	0.157364	1.5803	0.1152
LN_Yj	0.860103	0.0384442	22.3727	0.0000
LN_CU	−0.105026	0.0481791	−2.1799	0.0302

Mean dependent var	8.296530	S.D. dependent var	1.397812
Sum squared resid	5.002235	S.E. of regression	0.138440
R^2	0.991080	Adjusted R^2	0.990191
$F(26, 261)$	1115.298	P-value(F)	2.7e–251
Log-likelihood	174.9886	Akaike criterion	−295.9772
Schwarz criterion	−197.0772	Hannan–Quinn	−256.3440
$\hat{\rho}$	0.363346	Durbin–Watson	1.093074

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 261) = 158.503$
with p-value = $P(F(23, 261) > 158.503)$ = 4.60524e-139

Figure A.25: Great Britain-OLS - QQ plot

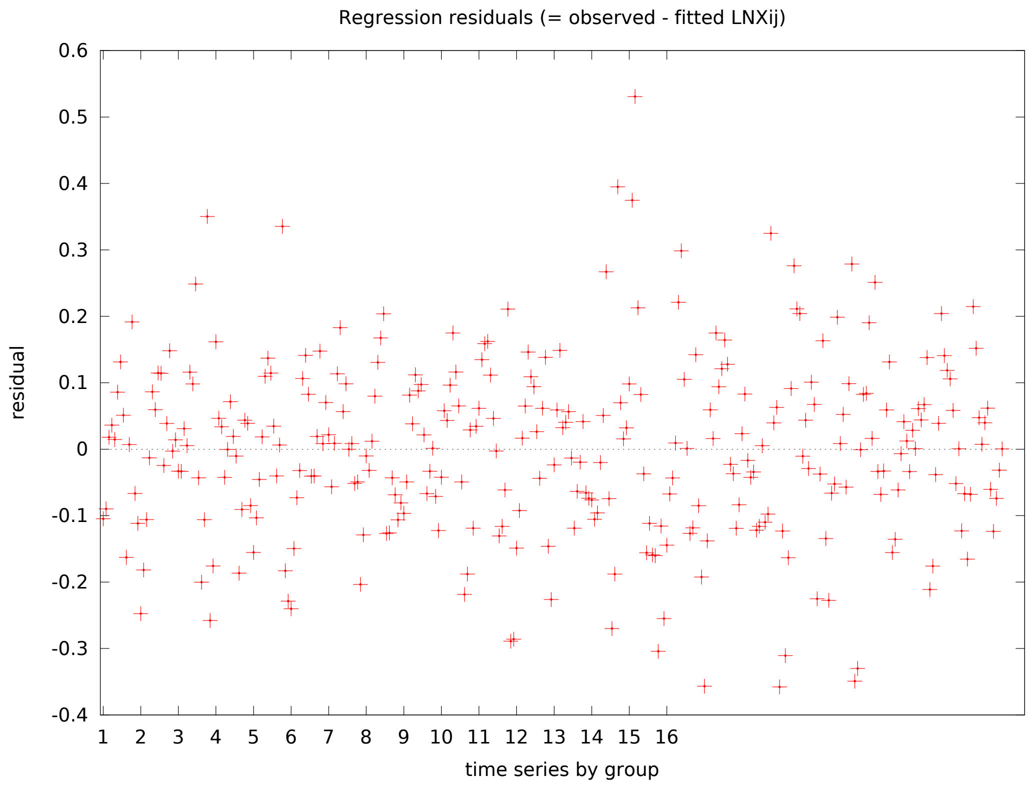


Czech Republic

Model 1: Fixed-effects, using 216 observations
Included 24 cross-sectional units
Time-series length = 9
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−16.1765	1.37946	−11.7267	0.0000
GDPgrowth	1.85764	0.506519	3.6675	0.0003
LNYj	1.75246	0.109915	15.9438	0.0000
LNC	0.777758	0.203586	3.8203	0.0002

Figure A.26: Great Britain-Residual plot for Fixed effects



Mean dependent var	6.758494	S.D. dependent var	1.409457
Sum squared resid	14.63565	S.E. of regression	0.278276
R^2	0.965733	Adjusted R^2	0.961020
$F(26, 189)$	204.8686	P-value(F)	5.4e–124
Log-likelihood	−15.77440	Akaike criterion	85.54880
Schwarz criterion	176.6813	Hannan–Quinn	122.3666
$\hat{\rho}$	0.703859	Durbin–Watson	0.479183

Test for differing group intercepts –

Null hypothesis: The groups have a common intercept

Test statistic: $F(23, 189) = 42.3005$

with p-value $= P(F(23, 189) > 42.3005) = 3.98467\text{e-}62$

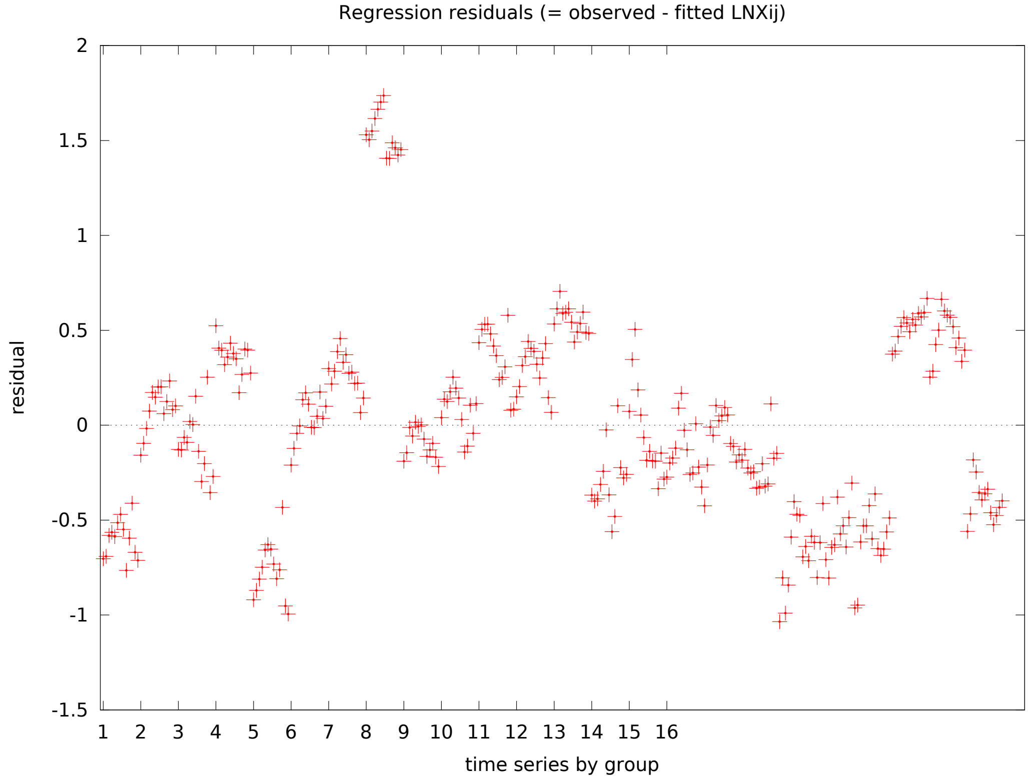
Test for normality of residual –

Null hypothesis: error is normally distributed

Test statistic: $\chi^2(2) = 4.93295$

with p-value $= 0.0848835$

Figure A.27: Great Britain-Residual plot for Random effects



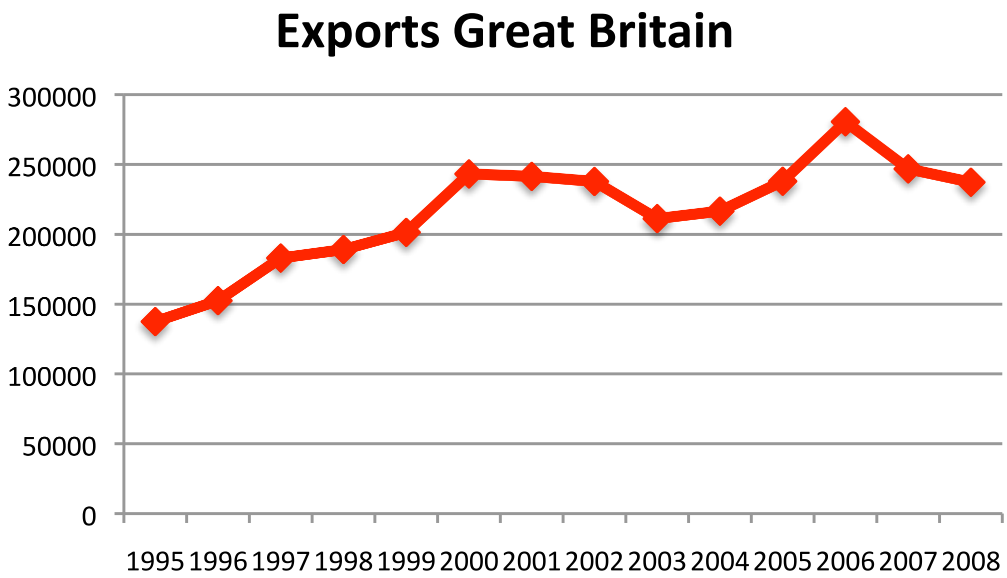
Model 2: Random-effects (GLS), using 216 observations
Included 24 cross-sectional units
Time-series length = 9
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	1.99096	1.31530	1.5137	0.1316
GDPgrowth	2.76804	0.556278	4.9760	0.0000
LNYj	1.19680	0.0875970	13.6626	0.0000
LND	−1.58869	0.159774	−9.9433	0.0000
LNC	0.757079	0.205497	3.6841	0.0003

Mean dependent var	6.758494	S.D. dependent var	1.409457
Sum squared resid	195.1086	S.E. of regression	0.959335
Log-likelihood	−295.5047	Akaike criterion	601.0094
Schwarz criterion	617.8858	Hannan–Quinn	607.8276

$$\hat{\sigma}_{\varepsilon}^2 = 0.0774373$$

Figure A.28: Great Britain-Exports



$$\hat{\sigma}_u^2 = 0.370871$$
$$\theta = 0.847685$$

Breusch-Pagan test –

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: $\chi^2(1) = 394.489$

with p-value = 8.72161e-88

Hausman test –

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: $\chi^2(3) = 64.9053$

with p-value = 5.25564e-14

Model 3: Pooled OLS, using 216 observations

Included 24 cross-sectional units

Time-series length = 9

Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	7.12522	0.494458	14.4102	0.0000
GDPgrowth	3.70120	1.11794	3.3107	0.0011
LNYj	0.692060	0.0385348	17.9593	0.0000
LND	−1.37561	0.0534049	−25.7582	0.0000
LNC	−0.0892309	0.141824	−0.6292	0.5299

Mean dependent var	6.758494	S.D. dependent var	1.409457
Sum squared resid	89.97531	S.E. of regression	0.653011
R^2	0.789340	Adjusted R^2	0.785347
$F(4, 211)$	197.6538	P-value(F)	3.66e–70
Log-likelihood	−211.9105	Akaike criterion	433.8209
Schwarz criterion	450.6973	Hannan–Quinn	440.6390
$\hat{\rho}$	0.910527	Durbin–Watson	0.125538

Model 1: Fixed-effects, using 192 observations
Included 24 cross-sectional units
Time-series length = 8
Dependent variable: LNX

	Coefficient	Std. Error	t-ratio	p-value
const	−17.5258	1.55751	−11.2525	0.0000
GDPgrowth	1.26434	0.506051	2.4985	0.0135
LNYj	1.86360	0.123662	15.0701	0.0000
LNC	0.668893	0.199441	3.3538	0.0010

Mean dependent var	6.678976	S.D. dependent var	1.396844
Sum squared resid	11.67866	S.E. of regression	0.266045
R^2	0.968663	Adjusted R^2	0.963725
$F(26, 165)$	196.1640	P-value(F)	2.9e–110
Log-likelihood	−3.661946	Akaike criterion	61.32389
Schwarz criterion	149.2763	Hannan–Quinn	96.94525
$\hat{\rho}$	0.719170	Durbin–Watson	0.473156

Test for differing group intercepts –
Null hypothesis: The groups have a common intercept
Test statistic: $F(23, 165) = 41.4866$
with p-value = $P(F(23, 165) > 41.4866)$ = 1.10115e-56

Figure A.29: Czech Republic-OLS - QQ plot

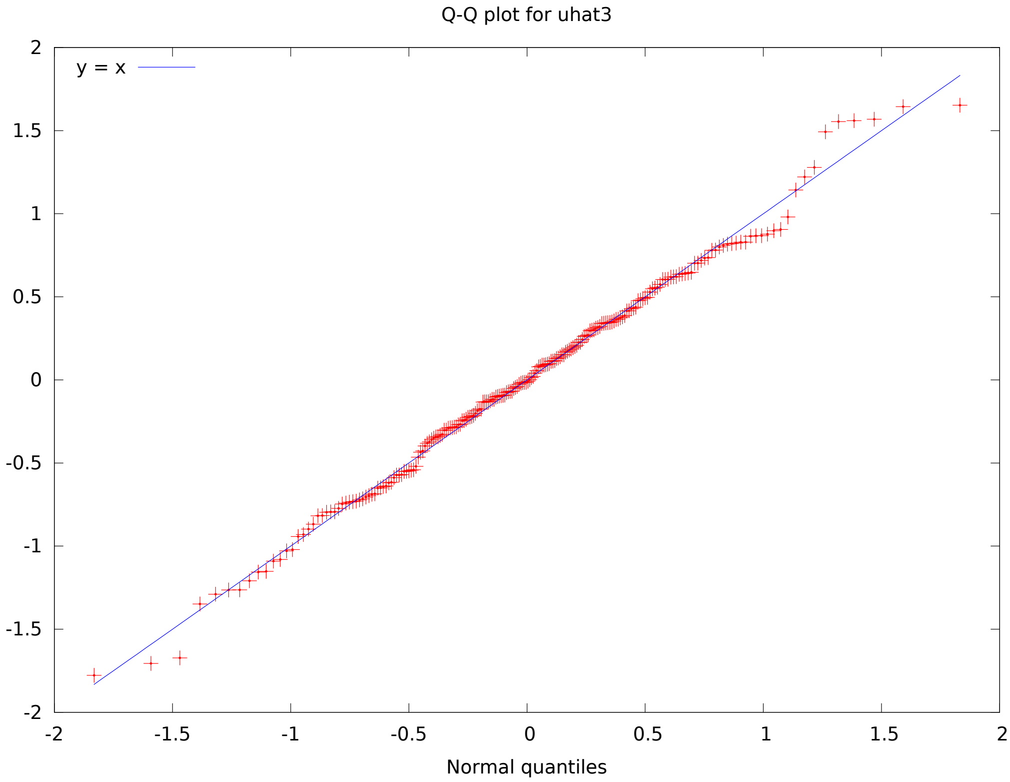


Figure A.30: Czech Republic-Residual plot for Fixed effects

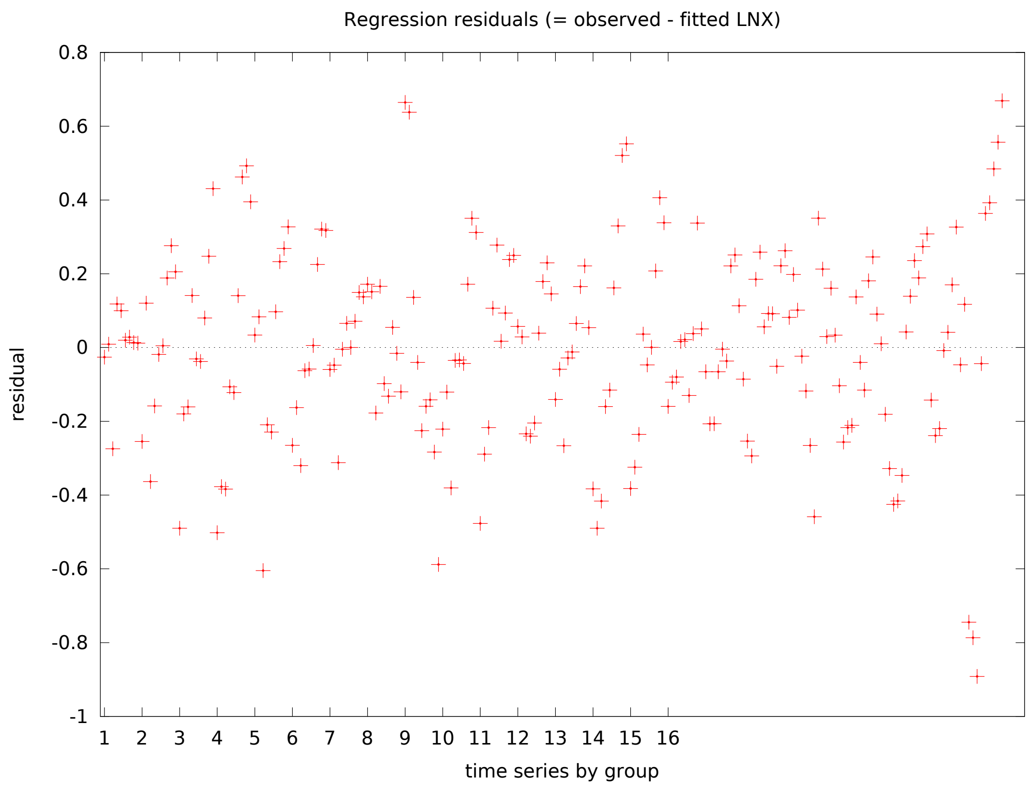


Figure A.31: Czech Republic-Residual plot for Random effects

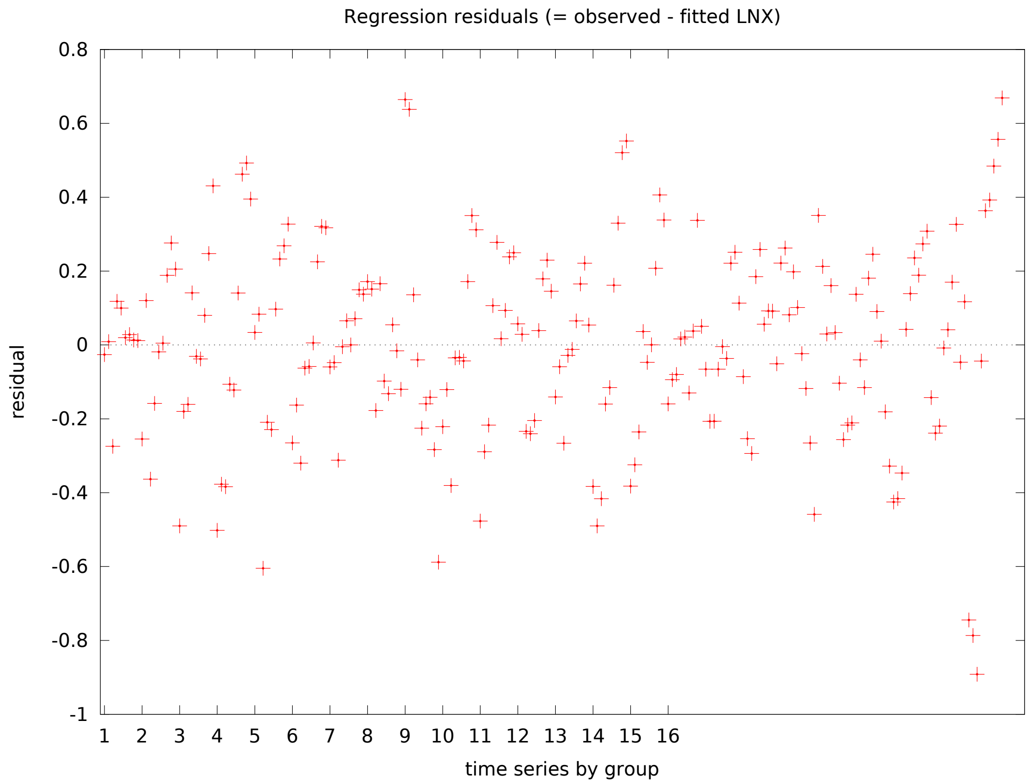


Figure A.32: Czech Republic-Exports