
# DIFFERENTIAL EFFECTS OF THE RECENT ECONOMIC RECESSION ON ROAD FREIGHT TRANSPORT AMONG EU COUNTRIES

## DOES THE CURRENCY MATTER?

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## Abstract

The recent economic recession had an impact on the entire world economy. The European Union though was one of the mostly affected regions, with road freight transport being one of the sectors that were severely hit, since it is highly dependent on the economic activity. However, trade of physical goods is also affected by the national currency and being a part of a monetary union seems to have positive effects. This research shows first that indeed the economic activity has positive effects the road freight transport. Second, having euro as a national currency does not significantly affect the tonnes per kilometer transported in countries of the European Union. Finally, the recent economic recession does not affect differently the road freight transport depending on whether a country has the euro or a local currency as national currency.

# 1. Introduction

## 1.1 Background

The economic recession of 2008-2009 affected the entire world economy, its effects thought were severe in European Union. There were, though, diverse results depending on the regions. While several countries were benefited from the recession, other were fiercely hit. Overall, the recent recession was the worst global recession of the recent decades in terms of countries affected as well as Global GDP decline (IMF, 2009).

One of the sectors that was significantly affected in Europe was road freight transport. Road Freight transport in European Union has grown significantly over the years but a sharp fall was observed in the majority of the countries from the beginning of the economic crisis in 2008. Road haulage had been growing at high rates before 2008. According to Meersman and Van de Voorde (2005) from 1990 to 1999, it had grown 18% more than all the other modes combined. In addition, a decrease of the transportation of bulk further advantaged road freight transport compared to the other modes (Meersman and Van de Voorde, 2005). As observed, despite this decline in the recent years, road freight transport has a noticeably high modal share amongst all transport modes (road, rail, air and barge) and is still the most frequently used mode. The dominance of road freight transport is illustrated by the fact that while several years ago its size was less than twice of the size of rail transport, it grew to be five times greater than rail transport in 2010 (Meersman and Van de Voorde, 2013).

The most obvious factor that caused the aforementioned decline is the decrease of economic activity, and as a result GDP. The level of road freight transport though, also depends on several causes, policies and country-specific characteristics. As Manheim (1979) states, the socioeconomic system of a region is interconnected with the transportation system. The level of technological development of a country as well as the international trade play an important role (Hilferink, 2005).

As mentioned above, road freight transport also depends on international trade. As a result, road freight transport of countries that are involved in trading with Asia (and especially China) which has not been affected by the crisis may have been less affected. On the other hand, road haulage of several countries depends on domestic trade or trade with negatively affected economies (e.g. Portugal, Greece, and Ireland). In these countries road freight transport may be stirred negatively. Additionally, European Commission through the White Paper on Transport (Commission, 2001) and several public policy measures such as POSSUM (Banister et al., 2000) and SPRITE (Tight et al., 2004) aimed in stimulating the decoupling of GDP and road freight transport. Decoupling is identified as “a decrease in transport intensity of GDP that will allow the volume of transport to increase at a lower rate than the economy at large” (Banister and Berechman, 2001).

Contrary to the above policies that are related to the transport sector, Stead and Banister (2001) add that there can also be instruments outside the transport sector that significantly influence transport volumes and that various changes in transport trends in the past few decades were an outcome of a combination of both socio-economic and transport factors.

An instrument that affects the trade rates and thus the volumes transported is the currency. The manipulation of the currency (devaluation or revaluation) is strictly connected with the traded volumes. For example, Krugman and Taylor (1978) underline that devaluation is leading to rise of the prices of the traded goods that decrease the imported volumes, which in turn have impact on total volumes transported. From the above statement, it is evident that for a country, having a local currency being able to draw its own monetary policy can be an advantage. On the other hand, several studies have shown the advantages of abandoning the local currency and being part of an economic union on international trade (Barro and Tenreyro, 2007; Glick and Rose, 2002; Micco et al., 2003; Nitsch, 2002; Rose, 2000; Sadeh, 2013). Moreover, the national currency plays a role in the economy, especially during economic crises. Within the European Union, in addition to the fact that euro helped the Eurozone countries increase their traded volumes between them and internationally (as the abovementioned studies have indicated), it also provided a safety net against downforces affecting the global economy (Jones, 2009). Contrary, together with the disadvantage of the Eurozone countries to draw their own monetary policies, the three following principles make the Eurozone vulnerable during periods of crises: the absence of co-responsibility for public debt; the strict no-monetary financing rule; and bank-sovereign interdependence (Pisani-Ferry, 2012). Thus, it is not certain if the traded volumes were more or less affected in countries having adopted the Euro as a national currency.

## 1.1 Research Question

Monetary policies significantly affect the trade volumes, thus volumes transported. Therefore, there is a possibility that the volumes transported within a country are affected by the currency used. As a result, whether a country has adopted the Euro as a national currency may have an impact on transport volumes by road. As European Union has already established several policies to increase road freight transport, it would be interesting to identify whether those policies are targeting the correct countries and whether different policies need to be applied depending on whether and when a country entered Eurozone.

From the aforementioned statements a clear relation between the economic activity and freight transport is derived. It is unclear though, as there is no research on the matter, whether road freight transport was affected more in Eurozone countries. Hence, the following research question is formed:

*What are the differential effects of the recent economic recession on road freight transport in European Union, depending on whether a country was a member of the Eurozone?*

In order to answer the research question I use a dataset consisting of the 27 countries that currently comprise the European Union, excluding Malta and a time period from 2003 to 2013. The main variables are the road freight transport measured in tonnes per km (independent variable), the economic activity measured with the GDP, and whether a country has adopted euro as a national currency. A panel data analysis using fixed effects in conducted to examine the obtain dataset. In addition, a dynamic panel data analysis using Bardsen Error Correction Model with Newey West Standard Errors as well as the Arellano-Bond estimator is conducted. A further analysis of the dataset and the method used is provided under chapter 5.

## 1.2 Contribution

The contribution of my study is associated with the differences in the relation of the economic activity and road freight transport, depending on the time of the adoption of euro as national currency. The existing literature that examines the relation of economic activity and road freight transport solely investigates the elasticity between them and how to decouple road freight transport from GDP. Additionally, studies that examine the effects of the currency on trade, investigate the activity of a single country or bilateral trade between two countries, before and after joining a currency union. Instead, I am comparing how having a local or euro currency affected the transported volumes (international plus intra-national) during the years of economic recession. Furthermore, my data will be an expansion of already used datasets, including observations of European Union countries until 2013.

## 1.3 Outline

The remainder of my research is structured as follows: In chapter 2 I present an overview of the existing literature. In the first part of the literature review, I review the literature on the relation between economic activity and road freight transport. In the second part, I review the literature on the relation between currency and trade together with evidence of the influence of the adoption of euro on trade. In chapter 3 I present the other factors that influence the volumes transported by road. Chapter 4 includes the approach as well as the presentation of all variables included in the model. In chapter 5 I state the hypotheses and the methods that I follow in order to find the results. In chapter 6 I present the results. Chapter 7 and chapter 8 are the discussion and conclusion respectively.

# 2. Review of the existing literature

In this chapter I present an overview of the existing literature. First, literature on the relation between economic activity and road freight transport is reported. Furthermore, literature on the effects of currency unions on trade, followed by literature focusing solely on the effects of the European Monetary Union on trade is presented.

## 2.1 Relation between economic activity and road freight transport

Transport flows are needed to link raw materials to production and production to the final consumption via the distribution process. In this chain transport costs arise. Transport cots include direct costs such as fuel costs but also other cost factors (e.g. capital and labour costs). Additionally the amelioration of the financial situation of the households, essentially due to technological progress strongly affects the demand for products, hence it stimulates the development of the services sector (Eichengreen and Gupta, 2013). Since freight transport is part of the services sector, the economic activity and the development of the economic system have an effect on it.

On the other hand, freight transportation affects economic development. Improvements in transportation and facilities ameliorate overall productivity (Bougheas et al., 2000). Also, transportation facilitates technology spillovers across economies. Finally, transportation and its facilities have given companies the possibility to access lower cost inputs of production for their production activities, and to access broader markets at possibly more advantageous prices (Beyzatlar et al., 2014).

The above-mentioned bidirectional relation is examined by Beyzatlar et al. (2014) by running a Granger causality test in a panel data consisting of the time period 1970-2008 and 15 countries within the European Union. During the tested period, only well developed economies showed clear bidirectional causality, while the rest showed mixed results.

Other previous relevant analyses can be classified to two research streams, the ones researching the effects of road freight transport on the economic growth, and the ones researching the impact of the economic activity on road freight transport.

Road freight transport is found to follow closely the gross domestic product in a cross-sectional study undertaken by World Bank including 33 countries at diverse stages of development and using 1989 data (Bennathan et al., 1992). Through the regression analysis they find that differences in GDP explained 89% of the variation in road tonne-km. For the 17 developed countries of the sample the elasticity of ton-kilometers transported by road with respect to GDP was 1.02 (Bennathan et al., 1992). This study comes in line with the assumption that was made in the previous years that there was a simple one to one relation between GDP and road freight transport volumes (Meersman and Van de Voorde, 2013)

Wrzesinska (2011) conducts an analysis on the impact of the recent economic crisis on volumes transported by road. By taking into account the total volumes transported in tonnes per kilometer derived from Eurostat. Her core outcome is that there was a major decline of 10% between 2008 and 2009, leading to the conclusion that economic crisis cancelled the

growth in road freight transport that was observed six years prior to 2009. Additionally, she identified that the older members of the European Union suffered greater declines than the new members. Road freight transport in Denmark, France, Italy and Austria declined more than 40% while two new members (Poland and Bulgaria) recorded a growth during the time of crisis of around 10%.

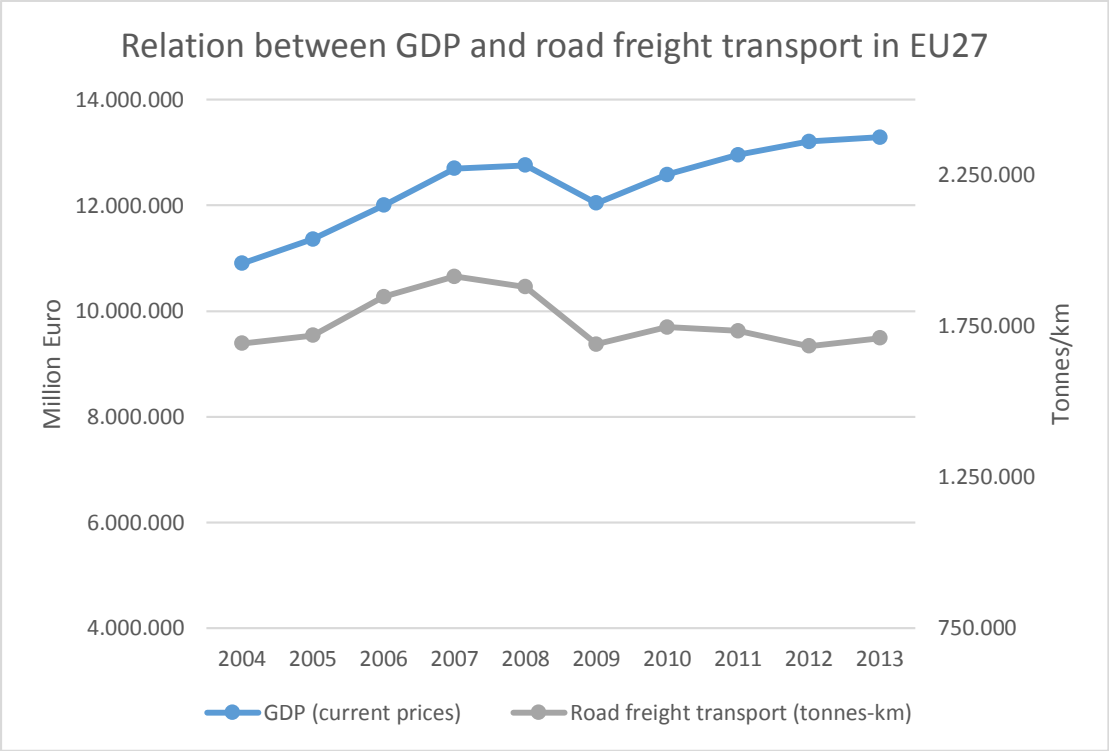
Meersman and Van de Voorde (1999) investigate the relation between economic activity and road freight transport in EU12 for the years 1984-1993 and in EU15 for the period 1991-2000. They conclude that GDP had a stronger impact on road freight transport in the 1990s compared to 1980s. Meersman and Van de Voorde (2005) conclude that the elasticity between GDP and tonnes transported by road per kilometer varied per country. The lowest elasticity is observed in Portugal (0.47), while the largest is observed in Finland (2.16). In a follow up study they examine the aforementioned relation in eleven EU countries for the years 1970, 1980, 1990, 2000, 2010. They underline that this relation is gradually changing and is different for each country (Meersman and Van de Voorde, 2013). The elasticity between GDP and tonnes per kilometer is lower in 1980 and 1990 compared to 1970 but increased the last two decades (2000, 2010) (Meersman and Van de Voorde, 2013). However, their results are not significant.

Research including multiple European countries is also conducted by Hilferink (2005), Tapio (2005) and Limão (2008). Hilferink (2005) conducts a cross-section and a time series analysis with data from 1980 until 1999 among EU-15 countries. A strong dependency of freight transport to GDP resulted from his time series analysis, although he argued that this fact may be subject to change since correlation between economic activity and freight transport is not based on an economic law. In the cross-section analysis between different countries it is evident that the correlation between freight transport and GDP in cross-section was not as strong as in time series. Finland is the country with the strongest relation between GDP and freight transport and Austria with the weakest relation.

Tapio (2005) researches the levels of decoupling among the EU countries in 1990's and analyzed further the case of Finland. He finds a weak relation between tonnes transported and economic activity in Finland, Sweden, Germany, Austria, Luxembourg, United Kingdom and Netherlands and expansive relation in Denmark, France, Belgium and Ireland. Limão (2008) analyzed the correlation between road freight transport and GDP in 118 regions within 15 EU countries. An inclination of the level of freight transport with GDP were observed in regions that belong to Luxembourg, Austria, Finland and Sweden, while in regions of Portugal, Spain, France and Italy freight transport trend declined from GDP.

In conclusion, it is evident from the literature that road freight transport has a strong relation with economic activity. This strong relation is partially depicted in Figure 1, where road freight transport and GDP follow the same trend until Europe was hit by the economic crisis between 2008 and 2009.

*Figure 1. Relation between GDP and Road freight transport in EU 27.*




*Source: Eurostat (online data codes: road_go_ta_tott, nama_10_gdp)*

A generalization though, should not be made as the level of the effects are diverse between different time periods and between countries. This happens because several developments or changes to other sectors influence the volumes transported by road over time and by country. These additional aspects that influence the level of road freight transport will be analyzed in the following chapter.

## 2.2 Relation between currency and trade of goods

By the time of the establishment of the first currency unions, their effects on trade of goods were ambiguous. Even though there were suggestions that exchange rate volatility has negative effects on trade, there was no empirical evidence on that matter. Since then, a vast empirical literature that investigates the effects of currency unions on trade has been developed.

The first research on that matter is conducted by Rose (1999). His dataset consists of 186 countries for the years 1970, 1975, 1980, 1985, 1990. He found that the trade between countries has been tripled after their involvement in the same currency union. His results are in line with the follow up study of Frankel and Rose (2002) who expanded the dataset using 200 countries and 50 years (1948-1997).They note that a currency union triples the trade volumes of their member states. The approach of Rose though attracted a lot of criticism as his dataset included small colonies and countries that are heavily dependent on larger countries and ended up adopting their currency.

As a result, several follow up studies have been carried out. In order to rationalize the results of Rose's research, Nitsch (2002) uses the same method and dataset with Rose, but provides some modifications and manipulations on the latter. Three main results are noted in his research. First, by manipulating the dataset, a common currency appears to double and not triple trade between countries, on average. Second, depending on country characteristics, it is possible that the effects of a common currency on trade are zero. Third, the enhancing effect is different across different currency unions. For example, trade volumes of several countries that adopted US dollar were unaffected and trade volumes of countries that adopted the Australian dollar have been 30 times higher. Nitsch (2002) notes that the currency effects on trade volumes are ambiguous, thus unreliable. By using the same dataset with Frankel and Rose (2002) but different approach, Glick and Rose (2002) conclude that countries that joined a currency union nearly doubled their trade and countries that exited a currency union halved their trade. Also, Rose and Van Wincoop (2001) conclude that national currency poses an important barrier to trade. Consequently, reducing such barriers will result in increased trade of goods. Additionally, Barro and Tenreyro (2007), by using the IV approach, indicate that the bilateral trade is rising when two countries are in the same currency union, but on the other hand, currency unions may reduce the degree of co-movement of output. Their OLS estimation though fail to prove the latter. Finally, Rose and Stanley (2005) conducted a meta-analysis on 34 studies on this topic. As they mention, meta-analysis is a set of quantitative techniques for evaluating and combining empirical results from different studies. They confirm that all the studies included have shown a positive impact of currency unions on trade. However, they underline that studies with a large dataset report lower effects, while studies of Rose (as an author and co-author) report greater effects.

Interestingly, two studies have shown that currency unions do not affect the traded volumes. Persson (2001) estimates the effect to be between 13% and 60% but his results are not statistically significant. Similarly, Pakko and Wall (2001) conclude that currency unions decrease the volumes of traded goods but their results were not statistically significant as well. They argue that even though their result may strain credulity, conclusions about the effects of currency unions on traded volumes should be drawn cautiously.

In all, it is clear from the majority of the previous literature that the involvement of a country in a currency union increases its trade of goods. There are several reasons of that outcome. First of all, a common currency diminishes the exchange rate volatility and as a result, significantly decreases the risk and uncertainty in trade transactions (Micco et al., 2003). In addition, transactions costs that exist when multiple currencies are involved in the trade of goods, are eliminated when a currency union is established (Micco et al., 2003). Moreover, being a part of a monetary union leads to a government commitment to long-term integration. This commitment encourages the private sector to be more involved in international trade (Rose, 1999). A currency union may also lead to financial integration, and thus higher trade in goods and services (Rose, 1999). Finally, a currency union provides a safety net to exchange rate risks in trade transactions with countries outside the union, by the adoption of a more liquid currency (Micco et al., 2003).

### 2.2.1 The influence of the adoption of Euro on trade of physical goods

In addition to the extensive literature on the effects of currency unions on trade, there is also a substantial amount of literature investigating solely the effects of Eurozone on trade of goods.

One of the first research focused on the European Monetary Union (EMU) was undertaken by De Nardis and Vicarelli (2003). They found that even though there is a positive effect on bilateral trade of goods between countries, this effect is low (9.7%). These results are in line with Chintrakarn (2008) who estimates the trade of goods between countries in the Eurozone to be 9% to 14% higher than trade between other country pairs. Bun and Klaassen (2002) conclude that the effects are 4% in the first year of the EMU and forecast a 6.9% and 9.6%, in 2000 and 2001 respectively, while in the long run their estimation rises up to 37.8%. However, in their follow-up study, Bun and Klaassen (2007) report only an effect of 3% on average for all EMU countries' bilateral trade prior to 2004. Finally the research of Baldwin et al. (2008) concludes to an effect of 2% on average, but they underline that the percentage may vary among sectors.

All the aforementioned literature examines the intra-EMU effects of the common currency on trade volumes. There are several studies though that claim that the introduction of euro has positive effects on trade with countries outside the Eurozone. Micco et al. (2003) report a 5% to 10% increase on bilateral trade volumes between EMU countries compared to other country pairs. They also report an 8% increase on average on trade between euro and non-euro countries. Flam and Nordström (2003) extended the research of Micco et al. (2003) by using unilateral instead of bilateral trade volumes as their dependent variable. By comparing the 1989-1997 with the 1998-2002 period, they estimate that the intra-EMU trade rises by 15% and the trade with outside countries by 8% in the latter period. Extending their literature to include the periods 1995-1998 and 2002-2006 in their follow-up study, Flam and Nordström (2007) report a 28% increase in the trade between Eurozone countries and 12%-14% increase in trade with countries outside Eurozone. Their results agree with their estimation in their first paper that the effect is increasing over time. Finally Sadeh (2013), by using more recent data compared to previous studies, argues that the unidirectional trade flows have risen 2 times within Eurozone by the introduction of Euro, while the most benefited were the Mediterranean countries. He also adds that trade volumes with non-member countries has risen by 35%.

In conclusion, the introduction of the Euro currency seems to have a significant positive impact on trade of goods among Eurozone countries. This effect fluctuates from 2% to 300% among studies. Positive effects are also noted on trade between member and non-member countries. Table 1 summarizes the results of the previous literature.

From Table 1, it is evident that the magnitude of the influence of currency unions on traded volumes is smaller in research solely on EMU compared the studies examining currency unions in general (with the research of Sadeh (2013) being the only exemption).

*Table 1. Summary of the results of the previous literature*

| | Studies reporting a positive effect of Euro on trade below 50% | Studies reporting a positive effect of Euro on trade above 50% |
|---|---|---|
| Studies examining the influence of currency unions in general on traded volumes | Persson (2001), Pakko and Wall (2001) | Rose (1999), Frankel and Rose (2002), Nitsch (2002), Barro and Tenreyro (2007), Rose and Van Wincoop (2001), Glick and Rose (2002) |
| Studies examining the influence of EMU on traded volumes | De Nardis and Vicarelli (2003), Bun and Klaassen (2002), Chintrakarn (2008), Bun and Klaassen (2007), Flam and Nordström (2003), Baldwin et al. (2008), Micco et al. (2003), Flam and Nordström (2007) | Sadeh (2013) |

Indeed, the European Monetary Union is a relatively distinctive case of a currency union. It is comprised by fairly similar countries, which have close trade linkages and well-established integration processes. In addition, cultural and neighborhood factors as well as several policy decisions enhance the trade relations of the country members (De Nardis and Vicarelli, 2003).

# 3. Other aspects that influence the level of road freight transport

In this chapter the main factors additional to currency and economic activity are presented. According to literature these are the e-commerce, industrial production and infrastructure. Also, the main demographic and geographic characteristics that are included in previous research are included.

## 3.1 E-commerce

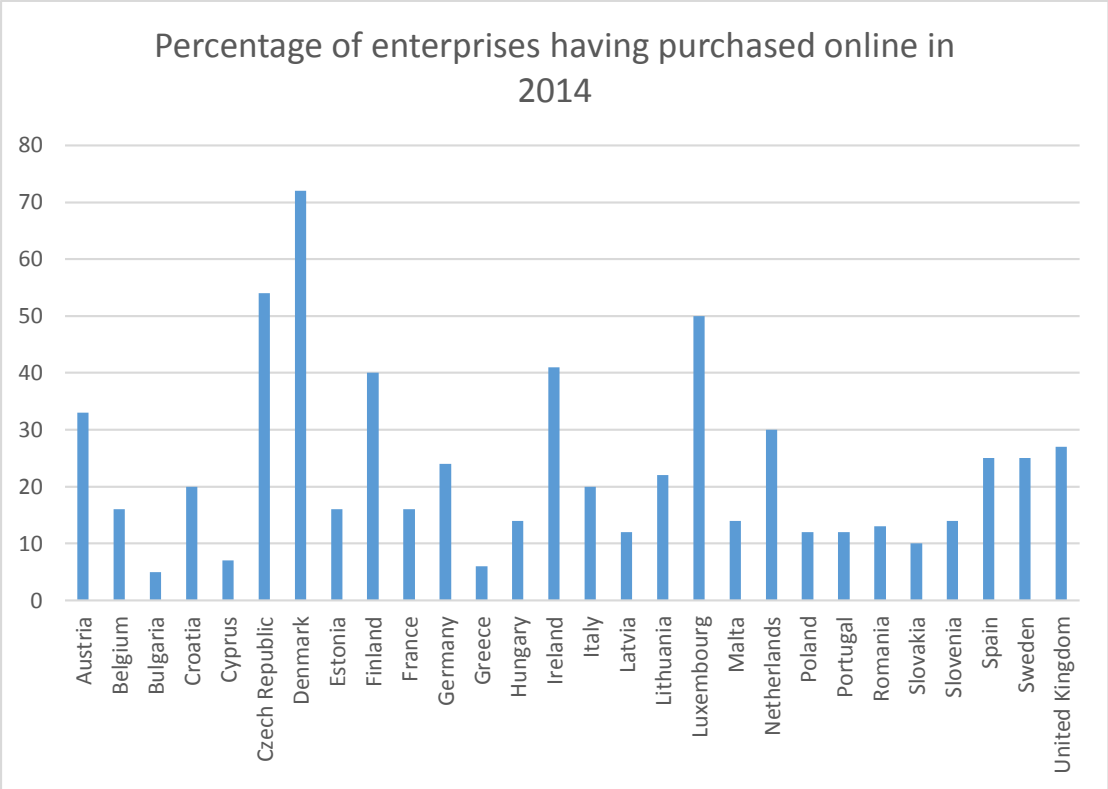
One of the aspects that has been developed over the last years and has changed road freight transport is the electronic commerce (simply referred as e-commerce). Electronic commerce refers generally to all forms of transactions relating to commercial activities, including both organizations and individuals that are based upon the processing and transmission of digitized data, including text, sound and visual images (OECD, 1997). With the development of e-commerce it is possible for companies and individuals to purchase products without the need of a physical presence.

E-commerce can be split into 5 categories depending on the parties involved in transactions (Visser and Nemoto, 2003):

- Business-to-business (B2B): Transactions between companies, conducted mainly through virtual marketplaces.
- Consumer-to-consumer (C2C): Transactions between consumers, such as transactions through online advertisements.
- Business-to-consumer (B2C): Transactions between businesses and consumers, via online stores.
- Consumers-to-government (C2G)
- Government-to-government (G2G)

According to OECD, among the above categories business-to-business transactions account for the larger part (about 80%) of all e-commerce activities (OECD, 1999). Thus, it has the greater effects on freight transport among the aforementioned categories. Figure 2 shows the percent of companies that have made online purchases in 2014 by country.

*Figure 2. Percentage of enterprises having purchased online.*




*Source: Eurostat (2015) http://ec.europa.eu/eurostat/tgm/graph.do?tab=graph&plugin=1&language=en&pcode=tin00112&toolbox=type*

The emergence of e-commerce resulted to an increased demand for logistics services (Meersman and Van de Voorde, 2005). As an outcome it led to an alteration of the demanded volume of goods. This alteration of the demand in terms of volume can stir the total volume transported by road either negatively or positively. On the one hand, e-commerce can generate an extra demand for goods as it can lead individuals and companies to purchases of products that would not have happened without its existence (such as distant products that would not have been bought in different circumstances) (Visser and Nemoto, 2003). On the other hand, e-commerce reduces the demand for certain goods. This happens as certain types of products can be can be transferred through the internet and a physical transportation is no longer needed (Visser and Nemoto, 2003). Such products are the e-books, newspapers, magazines, documents, music and software.

## 3.2 Industrial production

Through the years, an increase in demand for physical goods is observed. The increased demand results to a higher production in volumes. Augmented produced volumes lead, in turn, to an increased volume per kilometer transported ratio as more products require more transport flows. On the other hand, production is becoming more service-oriented throughout the years resulting to lighter and smaller products with emphasis on quality and design

(Banister and Berechman, 2001). This dematerialization (reduced use of physical materials) can have considerable effects on transportation as less volume needs to be moved leading to lower demand for travel (Banister and Berechman, 2001). Overall, the influence of production on road freight transport is an aggregate of the decline in material intensity and an increase in material consumption that is noticed in the last decades.

In addition, a relocation of a production plant from one country to another can significantly alter the produced volumes. An immense relocation of the industrial capacity from the developed countries to countries of East Asia and Eastern Europe, mainly due to lower labour costs, was observed through the last decades (Dicken, 2003). The relocation of industrial capacity has been growing rapidly in recent years, since China entered the World Trade Organization and Eastern European Countries (i.e. Poland, Romania, Bulgaria) were admitted into the European Union (McKinnon, 2007). Several companies operating in the European Union decided to move their manufacturing plants to the above mentioned countries.

A relocation of an industrial plant to another country or a substitution of its output by imports lead to significant alterations to the upstream and downstream supply networks (McKinnon, 2007). As a result, all road freight transport movements that were closely related to the industrial plant are moved to its new location. Several related vendors in the upper links (links between raw materials and the industrial plants) will be replaced by vendors in the new country. Thus, all transport flows between the plants and the raw materials will be moved from one country to the other causing the total volumes transported to decrease in the first country and increase in the country where the plant is moved.

A representative example of the effect of a reposition of an industrial plant is provided by McKinnon (2007). He demonstrates the case of Dyson (a household appliance manufacturer from the United Kingdom) that moved one of its production plants in Malaysia. After the relocation, all the materials and components are obtained from sources in Asia replacing sources within the UK. AS a result, all the upstream transport flows (flows of raw materials and components) were removed from the British roads and the products were transported inside the UK only in their finished forms.

The aforementioned facts are in accordance with the analysis of Meersman and Van de Voorde (1999). By using a pooled data for the first twelve countries of the European Union for the period 1984-1993, they found that, in both short-term and long-term, industrial production has a positive effect on freight transport. These effects are predominant in transport conducted by road in the majority of the countries. In addition, they forecast that a slower growth of the industrial production will prompt road freight transport volumes to rise slower. In the same direction, Hilferink (2005) argues that the economic structure (split in agriculture, industry and services) of a country plays a significant role on freight transport and its relation with the economic activity. Changes in the composition of the economy lead to a rise or decrease in transported volumes.

In conclusion, a relocation or an establishment of a new production plant together with the dematerialization and the increase of the demand for goods can result to a larger/smaller industrial sector. In turn, the size of the industrial sector alters the transport flows. Thus, it is

apparent that road freight transport is closely dependent on the industrial activity of a country.

## 3.3 Infrastructure

The quality and density of road infrastructure within a country can have considerable effects on freight transport. Hesse and Rodrigue (2004) underline that the extension of highways and the development of dense freeway networks on a regional as well as long-distance level, have played a significant role in the freight transport growth. In their research, Shepherd and Wilson (2006) find that improving quality of road infrastructure between Eastern Europe and Asia will enhance trade of physical goods by 50%. Coulibaly and Fontagné (2006) note that road quality in the West African countries has a significant impact on imports and exports of physical goods. Also, the quality of road network has a positive influence on intra-regional trade of goods among countries in Sub-Saharan Africa (Buys et al., 2006). Finally, Bougheas et al. (2000) conclude that the road infrastructure has a positive effect on trade between the core European countries (Belgium, Luxembourg, France, Germany, Italy, Netherlands, UK, Finland, Norway, Sweden).

Even though there is adequate infrastructure for international road transport, there are several missing links among European countries and between European and Asian countries. In addition, limited capacity of certain freeways as well inadequate quality act as a barrier as they increase the cost and time making such routes unwanted (Woodburn et al., 2008).

*Figure 3. International E-Road Network*


*Source: UNECE (2007)*
*http://www.unece.org/fileadmin/DAM/trans/conventn/MapAGR2007.pdf*

In order to tackle problems such as missing links and poor quality, the United Nations Economic Commission for Europe (UNECE) has developed an international e-road network (Figure 3) that links all the European countries together. The e-road network was developed under the European Agreement on Main International Arteries that was signed in 1975 (UNECE, 2007). The particular agreement includes, besides the formation of a consistent road network, technical requirements to ensure the quality of the infrastructure (Woodburn et al., 2008).

## 3.4 Demographic and geographic characteristics

From the research presented in the previous chapter several demographic and geographic characteristics are considered to affect the transported volumes by road. First, the population of a country is commonly used in order to control the effects of currency and economic activity on freight transport.

Moreover, whether a country is landlocked or not may have significant impact on the volumes transported within the borders of a country. Having a coastline may initiate large amounts of goods to be transported to the country by sea that are intended to be moved to several markets. Hence, the total amount of goods will be transported through non-landlocked countries, increasing the tonnes per kilometer transported by road. Finally, the number of borders with other countries should be considered since it can possibly encourage international trade and thus, affect the international road freight transport.

## 3.5 Summary

According to the aforementioned literature there are a number of factors influencing the level of road freight transport. The main factors are the economic activity and consequently economic crises and the national currency. Additional factors, which are presented in this chapter, are the level of e-commerce activities of the enterprises, the infrastructure as well as the industrial production. Finally, demographic and geographic characteristics such as population, number of borders and whether a country is landlocked are also considered to influence road freight transport.

In conclusion, the variables that are suggested from previous literature to influence the level of road freight transport are presented in Table 2.

*Table 2. Overview of variables*

| | |
|---|---|
| Road freight transport | Dependent variable |
| Economic activity (GDP) | Independent variable |
| Economic crisis | Independent variable |
| Currency | Independent variable |
| E-commerce | Control variable |
| Infrastructure | Control variable |
| Industrial production | Control variable |
| Population | Control variable |
| Landlocked country | Control variable |
| Number of borders | Control variable |

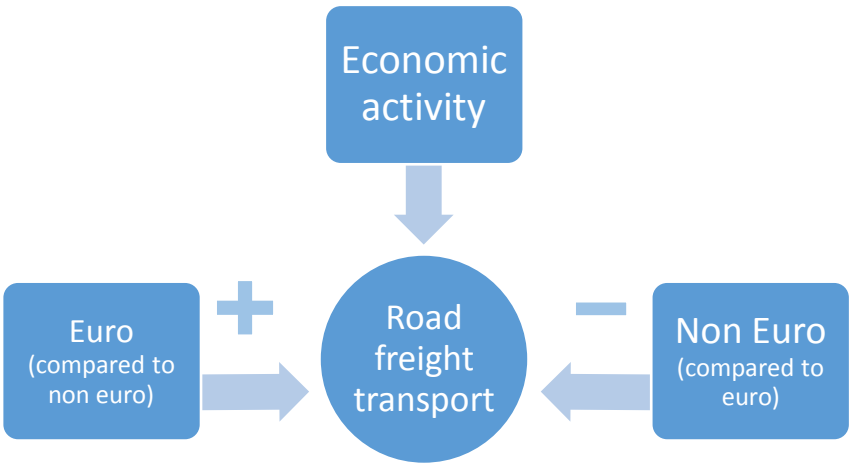
# 4. Approach and data

In this chapter, I present the approach, the dataset as well as the main variable (road freight transport) and the independent and control variables that are used (aspects that influence road freight transport).

## 4.1 Approach

In my research I examine the differential effects of having the euro as national currency or not on road freight transport during the last economic recession. Previous literature has proven that road freight transport is strongly dependent on the economic activity of a country and whether a country is a member of the European Monetary Union, as depicted in Figure 4.

*Figure 4. Determinants of the level of road freight transport*




In order to examine the aforementioned statement, I follow a panel data approach as well as a dynamic panel data approach. A panel data and the dynamic panel data are the most suitable approaches since there is a possibility to include observations for several entities (in my case the EU countries) for a certain period of time. In addition, in a dynamic panel data lags of the dependent and independent variables can be included and long run effects of the explanatory variables can be calculated. In chapter 5 further analysis of the methods that are used is provided.

## 4.1 Sample

The dataset consists of all the countries that have entered the European Union until 2013, excluding Malta, as seen in Table 3. Malta is not included in my research because road freight transport data are not available. Also, its economy is not adequately diverse and a small number of major transactions may alter its trade data significantly (Sadeh, 2013). The time period considered is from 2003 to 2013. The majority of the data are collected from Eurostat. The availability of data is limiting the research to the aforementioned time period. 2013 is taken as upper limit since data on road freight transport is available until that year. While the

availability of data related to e-commerce (control variable) restricts the time period to be from 2003.

*Table 3. Member states of the European Union*

| Country | Accession | Currency | Adoption of Euro |
|---|---|---|---|
| Austria | 1995 | Euro | 1999 |
| Belgium | Founder | Euro | 1999 |
| Bulgaria | 2007 | Lev | N/A |
| Croatia | 2013 | Kuna | N/A |
| Cyprus | 2004 | Euro | 2008 |
| Czech Republic | 2004 | Koruna | N/A |
| Denmark | 1973 | Krone | N/A |
| Estonia | 2004 | Euro | 2011 |
| Finland | 1995 | Euro | 1999 |
| France | Founder | Euro | 1999 |
| Germany | Founder | Euro | 1999 |
| Greece | 1981 | Euro | 2001 |
| Hungary | 2004 | Forint | N/A |
| Ireland | 1973 | Euro | 1999 |
| Italy | Founder | Euro | 1999 |
| Latvia | 2004 | Euro | 2014 |
| Lithuania | 2004 | Euro | 2015 |
| Luxembourg | Founder | Euro | 1999 |
| Netherlands | Founder | Euro | 1999 |
| Poland | 2004 | Zloty | N/A |
| Portugal | 1986 | Euro | 1999 |
| Romania | 2007 | Leu | N/A |
| Slovakia | 2004 | Euro | 2009 |
| Slovenia | 2004 | Euro | 2007 |
| Spain | 1986 | Euro | 1999 |
| Sweden | 1995 | Krona | N/A |
| United Kingdom | 1973 | Pound Sterling | N/A |

## 4.2 Road Freight transport

There are several ways to measure the road freight transport. Previous literature on the relation between economic activity and freight transport that have been reported in the previous chapter use three different measurements. Limão (2008) uses kilometers driven as well as the number of trips that were carried out. Whereas, Beyzatlar et al. (2014), Hilferink (2005), McKinnon (2007), Meersman and Van de Voorde (2013), Meersman and Van de

Voorde (2005), Tapio (2005) and Wrzesinska (2011) use the total tonnes per kilometer transported.

In my research I use the tonnes per kilometer in order to determine the volumes transported by road. I use this measure as it is used by the majority of the previous research as well as due to its broad availability. The data are taken from the Eurostat database (online data code: road_go_ta_tott) (Table 14). The total values reported are a summary of national transport and international transport. The latter is a summary of goods load and unloaded in the reporting country, cross-trade and cabotage. The data are collected by Eurostat through questionnaires distributed by the member countries, onboard journals and in case of large companies, through their databases. Double counting is avoided since each country reports figures related only to the resident carriers. Regarding the accuracy, the sample error of large countries lies within a 5% standard percentage error. However, there is an acknowledged issue of underreporting.

## 4.3 E-commerce

In order to determine the level of e-commerce activity per country I use the percentage of the enterprises having purchased online. Since business-to-business transactions account for the 80% of all e-commerce activities, only data concerning enterprises' activity is taken into account. The data are derived from the Eurostat database (online data code: tin00112) (Table 15). Only enterprises with more than 10 employees are included. Also, solely enterprises that have made at least 1% of their purchases online are taken into consideration. The data are collected by Eurostat through National statistical Institutes or Ministries on a yearly basis. They are derived from self-administered mail surveys or online web questionnaires. After the collection the data are verified by applying automated validation procedures. Hence, the results of the surveys published are considered reliable. However, since these results are based on a sample of the total population of the enterprises, errors associated with random sampling may occur.

## 4.4 Industrial production

Following the analysis of Meersman and Van de Voorde (1999), I use the industrial production index (IPI) for in order to measure the industrial production of a country. The data are collected from the Eurostat database (online code: sts_inpr_a) (Table 16). The production index indicates changes in the volume of output. It measures the volume added over a given period. The reported data are represented in percentage change compared to the reference year. The information is collected from the national authorities of each country through statistical questionnaires, however, the content of them vary among countries. In order to tackle the problem of incoherence of the final output Eurostat and the national authorities collaborate to validate the data.

## 4.5 Infrastructure

There are several ways to measure the infrastructure quality of a country. Woodburn et al. (2008) discuss the importance of the e-road network on road freight transport. However,

previous studies on the effects of the infrastructure on road freight transport use the percentage of paved roads (Buys et al., 2006; Coulibaly and Fontagné, 2006; Shepherd and Wilson, 2006), the length of motorways and the investment in inland infrastructure (Bougheas et al., 2000).

Because of the unavailability of a yearly data on the percentage of paved roads, the no/small differences of that percentage among European Union countries, I use the investment in inland infrastructure as a measure for infrastructure. The data are collected from the OECD database (online code: ITF_INV-MTN_DATA) (Table 17). The reported data are an outcome of the ITF Investment in Transport Infrastructure questionnaire, which is developed the International Transport Forum (ITF). The questionnaire is filled by the national authorities of each country (ministries, statistical offices or other institutions designated as an official data source).

## 4.6 Economic activity and economic recession

From the first part of chapter 2 it becomes evident that the economic activity affects the volumes transported by road within a country. In order to measure the economic activity, previous literature that was presented in the previous chapter use the Gross Domestic Product (GDP) (Beyzatlar et al., 2014; Hilferink, 2005; Limão, 2008; Meersman and Van de Voorde, 2005; Tapio, 2005; Wrzesinska, 2011). Following the previous research on the field, I also use GDP as a measure of economic activity. The data are collected from Eurostat database (online code: nama_aux_gph) (Table 18).

A slowdown in economic activity, when observed for at least two consecutive quarters is characterized as a recession. Such a period was noticed between 2008 and 2009 in all European Union. As it is proven by previous research, economic activity, measured with GDP, affects road freight transport. Following the same line of reasoning, recession periods have negative effects on transported volumes. The latest recession of 2008-2009, that met the IMF criteria for being a global recession, potentially had negative impact to a greater extent. In order to capture the effects of the last recession on road freight transport of that certain period, I introduce a time dummy. The time dummy is split in periods. The recent global recession is captured by the period 2008-2009 since a slowdown in economic activity was observed in all countries of the European Union between those years.

## 4.7 Currency

From the literature review in second part of chapter 2, it is concluded that entering a monetary union has positive effects on trade, thus in transported volumes. Positive effects are also derived from research solely on countries entering the European Monetary Union (EMU) but to a lesser extent as member states have always had close trade links and well-established integration processes. But even if the effects of EMU on the volumes of transported goods appear to be lower compared to other monetary unions, they are still significant. In order to capture the differential effects of the Euro or a local currency as a national currency I introduce a currency dummy. The value of the dummy depends on the time a country adopted Euro as national currency, as seen in Table 19. By this division, two

groups are formed. The euro group is consisted by 12 countries and the non-euro group by 11 countries. There are also 4 countries moved from the non-euro group to the euro group during the considered time period. Table 4 summarizes the groups.

*Table 4. Country groups by currency*

| Euro Group | Non-Euro Group | Countries moved from Non-Euro to Euro group |
|---|---|---|
| Austria | Bulgaria | Cyprus |
| Belgium | Croatia | Estonia |
| Finland | Czech Republic | Slovakia |
| France | Denmark | Slovenia |
| Germany | Hungary | |
| Greece | Latvia | |
| Ireland | Lithuania | |
| Italy | Poland | |
| Luxembourg | Romania | |
| Netherlands | Sweden | |
| Portugal | United Kingdom | |
| Spain | | |

## 4.8 Demographic and geographic characteristics

In the literature on the relation between economic activity and freight transport and currency unions, three demographic and geographic characteristics are included as control variables. However, in this research only one of them is included. The control variable that is used is the population of a country and the variables on whether a country is landlocked or not and the number of borders are dropped.

# 5. Methodology

In this chapter I present the hypotheses and the methods used in order to test the hypotheses. First, the hypotheses are stated, followed by the methods as well as the presentation of the regression models.

## 5.1 Hypotheses development

An economic recession is the period when a slowdown in economic activity is observed. At that period macroeconomic indicators such the Gross Domestic Product fall. In addition, recessions generally take place when there is an extensive drop in spending. Previous research on the relation of the economic activity and road freight transport estimate that there is a positive relation between them (Hilferink, 2005; Limão, 2008; McKinnon, 2007; Meersman and Van de Voorde, 2005; Meersman and Van de Voorde, 2013; Tapio, 2005) . Therefore, a decline in economic activity will lead to a decline in the volumes transported by road as well (see for example Wrzesinska (2011)). As a result, the following hypothesis is formed:

*Hypothesis 1: There is a positive relation between economic activity and road freight transport.*

In addition, being a part of a monetary union seems to have strong positive effects on the volumes of traded goods (Barro and Tenreyro, 2007; Frankel and Rose, 2002; Glick and Rose, 2002; Rose, 1999; Rose and Van Wincoop, 2001). The reasons behind this positive relation are that a currency union decreases the risk, costs and uncertainty in trade transactions (Micco et al., 2003) and leads to a political and financial integration (Rose, 1999). The observed positive effects also apply to the European Monetary Union, but they seem to be lower than the ones observed in other currency unions (Baldwin et al., 2008; Bun and Klaassen, 2002; Bun and Klaassen, 2007; Chintrakarn, 2008; De Nardis and Vicarelli, 2003; Flam and Nordström, 2003; Flam and Nordström, 2007; Micco et al., 2003). This happens because its country members are similar and they already have close trade links (De Nardis and Vicarelli, 2003). As the majority of traded volumes are being transported by road (Meersman and Van de Voorde, 2013), being a member of the European monetary Union has consequently a positive impact on road freight transport. Thus, the following hypotheses are formed:

*Hypothesis 2: Having the euro as a national currency has a positive effect on transported volumes by road compared to having another (local) currency.*

From previous literature it is evident, as already stated, that a decline in economic activity results to a decline in road freight transport. Hence, it is expected that the volumes transported by road decreased during the economic recession of 2008-2009. However, the impact of the recession maybe different among countries. This assumption is derived from previous research that underline that countries that have entered the European Monetary Union trade more than the ones that have not adopted euro. Consequently, it is expected that the impact of economic recession on volumes transported by road is greater in countries outside the Eurozone. Therefore, the below hypothesis arises:

*Hypothesis 3: The road freight transport of member countries of the European Monetary Union is less affected by an economic recession compared to non-member countries.*

## 5.2 Panel Data and Dynamic Panel Data Model

In order to test the above-mentioned hypotheses, I use panel data and dynamic panel data estimation techniques. The advantage of the panel data and dynamic panel data models is that data for several countries over a number of time periods can be combined and regression analysis with both spatial and temporal dimensions can be conducted. Also, in the case of a dynamic panel data model, it is possible to incorporate temporal dependencies (lags) of the dependent variable as well as to determine whether the independent variables have long term effects on road freight transport.

However, the majority of the literature examining the relation between currency and trade use a cross-sectional approach. Yet, a number of potential issues arise. In cross-sectional analysis all estimated effects are occurring in the same period of time and are therefore static (De Boef and Keele, 2005). Using cross-sectional data it is not possible to evaluate whether causal effects are static or not. In addition, it is not possible to access whether they have some component that is distributed over future time periods (De Boef and Keele, 2005). Most importantly, using a cross-sectional approach one can only examine the bilateral trade of two countries. In addition, the majority of the literature use a number of time invariant factors (geographical, cultural or historical factors that are independent of time). It is plausible though that several time invariant variables are difficult to estimate and are omitted from the regression, facing a risk of using an improper regression. In that case, a panel data method is more appropriate since it is possible to control for all the potential time-invariant factors In addition by the use of a dynamic panel data model, whether the causal effects are static or lagged can be evaluated. Furthermore, other econometric issues arise, for example, when using a cross-sectional approach the econometric estimates may be obscure (Glick and Rose, 2002).

### 5.2.1 Testing the variables for stationarity

I test all the variables included for non-stationarity because non-stationary variables could cause several model miss-specifications. Since the panel is unbalanced I use the Fisher Test for panel unit root using an augmented Dickey-Fuller test to test whether a variable contain a unit root and thus is non-stationary. Four variables (road freight transport, GDP, e-commerce and population) are found to be non-stationary. Because of non-stationary autoregressive data a dynamic panel model is more appropriate (De Boef and Keele, 2005). In the case of the panel data model, in order to correct this issue I include the first differences of these variables.

### 5.2.2 Panel Data Model

#### 5.2.2.1 Fixed effects or Random effects?

In order to verify whether fixed effects method is more suitable than random effects, I run a test of overidentifying restrictions. A test of fixed vs. random effects can be seen as a test of overidentifying restrictions since:

- The fixed effects (FE) estimator uses the orthogonality conditions that the regressors are uncorrelated with the idiosyncratic error $e_{it}$, i.e., $E(X_{it}*e_{it})=0$.

- The random effects (RE) estimator uses the additional orthogonality conditions that the regressors are uncorrelated with the group-specific error $u_i$ , i.e., $E(X_{it}*u_i)=0$.

These additional orthogonality conditions are overidentifying restrictions. I apply the test by xtoverid command, in which a random effects equation is re-estimated by being augmented with additional variables consisting of the original regressors transformed into deviations-from-mean form (Schaffer and Stillman, 2011).

*Table 5. Test of overidentifying restrictions to determine fixed effects/random effects suitability*

```
Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re
Sargan-Hansen statistic  51.575  Chi-sq(7)    P-value = 0.0000
```

Hence, from Table 5 it can be concluded that in this case, a fixed effects method is more appropriate. The equation for the fixed effects model is:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it}$$

Where:

- $\alpha_i$ (i=1….n) is the unknown intercept for each entity (n entity-specific intercepts).
- $Y_{it}$ is the dependent variable where i is the entity and t is the time.
- $X_{it}$ represents one independent variable,
- $\beta_1$ is the coefficient for the independent variable,
- $u_{it}$ is the error term

Since a fixed effects model is more appropriate, the variables that are constant through time (i.e number of borders, whether a country is landlocked) are dropped. Also, an Issue arising when dealing with panel data is time related correlation between cross-sections. So, in order to control for time fixed effects I include a dummy for each period of the panel.

Thus, inserting the variables, the equation becomes:

$$\Delta lnrft_{it}=\beta_1\Delta lngdp_{it}+\beta_2 lninfra_{it}+\beta_3 lninprod_{it}+\beta_4\Delta lnecom_{it}+\beta_5\Delta lnpop_{it}+\beta_6 eur_{it}+\beta_7 crisis_{it}+\beta_8 eur*crisis_{it}\beta_9 year_{it}+\alpha_i+u_{it}$$

Where:

- Δ is the difference in the respective variable
- $\beta_i$ is the respective coefficient
- rft is the road freight transport
- gdp is economic activity (measured with GDP)
- infra is the infrastructure variable
- inprod is the variable for industrial production
- ecom is the e-commerce variable

- pop is the population variable
- eur is the dummy variable for whether a country has the euro as a national currency
- crisis is the dummy variable for identifying the recession period of 2008-2009
- eur*crisis is the interaction between the two dummy variables
- year is the dummy variable for each time period in the panel

### 5.2.3 Dynamic Panel Data Models

#### 5.2.3.1 Bardsen Error Correction Model with Newey West Standard Errors

The first dynamic panel data model I use is the Bardsen Error Correction Model with Newey West Standard Errors. The Bardsen ECM is used since both short- and long run effects of the independent variables on road freight transport can be identified. Moreover, it reduces the collinearity among regressors and minimizes the risk of a spurious regressions due to autoregressive data (De Boef and Keele, 2005). The equation of the Bardsen Error Correction Model is:

$$\Delta y_t = a_0 + \sum_{i=1}^{m-1} a_i \Delta y_{t-i} + \sum_{j=1}^{p} \sum_{i=0}^{n-1} \beta_{ij} \Delta x_{jt-i} + a_m y_{t-m} + \sum_{j=1}^{p} \beta_{jn} x_{jt-i} + e_t$$

Where:

- m is the number of lags of the dependent variable
- n is the number of lags of the independent variable
- p is the number of exogenous variables
- i is the time period
- j is the entity

The long run effects are given by the following equation:

$$\theta_j = \frac{-\beta_{jn}}{a_m}$$

Where:

- $\theta_j$ is the long run coefficient
- $\alpha_m$ is the adjustment coefficient

Inserting the variables, the equation becomes:

$\Delta rft = \alpha_0 + (\alpha_1 - 1) lnrft + \beta_1 \Delta lngdp + \beta_2 \Delta lninfra + \beta_3 \Delta lninprod + \beta_4 \Delta lnecom + \beta_5 \Delta lnpop + \beta_6 lngdp_{\tau-1} + \beta_7 lninfra_{\tau-1} + \beta_8 lninprod_{\tau-1} + \beta_9 lnecom_{\tau-1} + \beta_{10} lnpop_{\tau-1} + \beta_{11} eur + \beta_{12} crisis + \beta_{13} eur*crisis + \beta 14 year + \varepsilon_\tau$

Where:

- Δ is the difference in the respective variable
- t-1 shows the lag of the variable
- $a_0$ is the intercept
- $\beta_i$ is the respective coefficient

#### 5.2.3.2 Arellano-Bond estimator

In addition to the Bardsen Error Correction Model with Newey West Standard Errors I also use the Arellano-Bond estimator to verify the results. This estimator is better suited when there is a small T and a relatively large N (in this case T=11 and N=27).

Also, linear dynamic panel-data models, in addition to a number of lags of the explanatory variables, contain lags of the dependent variable and also unobserved panel-level effects. These unobserved panel-level effects are correlated with the lagged dependent variable and thus the latter is not exogenous as assumed. As a result, the standard estimators are inconsistent. Arellano and Bond (1991) derived a consistent generalized method of moments (GMM) estimator for the parameters of this model.

As linear GMM estimator, the Arellano-Bond estimator have one-step and two-step variants. The two-step variant is asymptotically more efficient, however the standard errors tend to be biased downwards (Arellano and Bond, 1991). To correct this bias a finite-sample correction to the standard error according to Windmeijer (2005) is included (Roodman, 2006).

#### 5.2.3.3 Determination of the appropriate number of lags

When dealing with dynamic panel data models, an appropriate number of lags for the dependent as well as the independent variables has to be included in the regression. Pesaran and Shin (1998) suggest that when dealing with annual data a maximum number of two lags has to be considered. In order to identify the appropriate number of lags I use the Akaike's Information Criterion (Table 6).

*Table 6. Akaike's Information Criterion for optimal lags*

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| oneone | 162 | 111.3006 | 186.6253 | 20 | -333.2505 | -271.4986 |
| twoone | 144 | 100.5248 | 182.4234 | 20 | -324.8467 | -265.4505 |
| onetwo | 133 | 114.0441 | 179.2366 | 24 | -310.4732 | -241.1048 |
| twotwo | 132 | 112.8073 | 183.1329 | 25 | -316.2659 | -244.1959 |

The outcome of the Table 6 suggests that the optimal lags (where AIC is smaller) that should be taken into account are one for the dependent variable and one for the independent variables.

### 5.2.4 Test for serial correlation and heteroscedasticity

Before obtaining the results, the model has to be tested for heteroscedasticity and autocorrelation. I test the model for serial correlation using Wooldridge's Test (Table 7).

*Table 7. Wooldridge's test for serial correlation*

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      26) =     39.112
           Prob > F =      0.0000
```

The outcome suggests that there is serial correlation in the panel data. This means that there is a pattern across the error terms. Thus, they are not independently distributed across the observations and are not strictly random. In order to correct the serial correlation, the continuous variables have been transformed in their logarithmic forms. In the case of the Bardsen Error Correction Model, the Newey and West standard error corrects for the observed serial correlation.

According to Wooldridge's test, there is no serial correlation after the transformation of the continuous variables (Table 8).

*Table 8. Wooldridge's test for serial correlation after the transformation of the variables*

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      25) =      0.099
           Prob > F =      0.7561
```

I also test the model for heteroscedasticity using the White test. From the output shown in

Table 9 it can be derived there is heteroscedasticity in the model. As a result, the error terms do not have constant variance across observations.

*Table 9. White test for heteroscedasticity*

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(29)     =    149.93
         Prob > chi2  =    0.0000
```

Concerning the panel data approach, in order to correct the problem of heteroscedasticity I use the fixed effects model with adjusted standard errors that produces robust results. This is achieved by adding the Huber/White/sandwich estimate of variance (Huber, 1967; White, 1980). By specifying the model with the Huber/White/sandwich estimate of variance (this is achieved by adding the vce(robust) option, it is possible to remove the model-based variance estimates in favor of the more model-agnostic robust variances (Wooldridge, 2010). Robust

variances give precise assessments of the variability of the parameter estimates even if the model is miss-specified.

In the case of the Bardsen Error Correction Model, the Newey and West standard error is also correcting for the problem of heteroscedasticity in addition to serial correlation. Regarding the Arellano-bond estimator, the standard covariance matrix of the two-step estimation is already robust. This is solving the problem of heteroscedasticity.

# 6. Results

In this chapter I present the outcome of the fixed effects regression, the regression with Newey-West standard errors as well as the outcome of the Arellano-Bond Estimator. The results are shown in Table 10, Table 11 and Table 12 respectively.

## 6.1 Fixed Effects Model

*Table 10. Results of the fixed effects model*

```
Fixed-effects (within) regression               Number of obs      =       162
Group variable: country                         Number of groups   =        27

R-sq:  within  = 0.4110                         Obs per group: min =         2
       between = 0.1059                                        avg =       6.0
       overall = 0.3158                                        max =         8

                                                F(14,26)           =      9.65
corr(u_i, Xb)  = -0.1498                        Prob > F           =    0.0000
```

| Dependent Variable | | Δrft | | | | |
|---|---|---|---|---|---|---|
| | **Variable** | **Coefficient** | **Robust Std. Errors** | **T** | **P>\|T\|** | **95% Conf. Interval** |
| **Explanatory Variables** | | | | | | |
| | Δlngdp | **1.525917** | 0.405157 | 3.77 | **0.000*** | 0.723802 2.328032 |
| | lninprod | 0.109719 | 0.173099 | 0.63 | 0.527 | -0.232976 0.452414 |
| | Δlnecom | 0.005230 | 0.0284508 | 0.18 | 0.854 | -0.051095 0.061556 |
| | lninfra | -0.01134 | 0.040025 | -0.28 | 0.777 | -09058 0.0678999 |
| | Δlnpop | **5.137009** | 2.929929 | 1.75 | **0.082**** | -0.663557 10.93758 |
| **Dummy Variables** | | | | | | |
| | eur | -0.056613 | 0.0591731 | -0.96 | 0.341 | -0.173761 0.060535 |
| | crisis | **-0.1000276** | 0.0520722 | -1.92 | **0.057**** | -0.203118 0.003063 |
| | eurcrisis | -0.0047415 | 0.0445034 | -0.11 | 0.915 | -0.092847 0.083364 |

***Significant at 1% level**
****Significant at 10% level**

From Table 10, a positive relation between GDP and road freight transport can be noted since the coefficient of GDP is positive. The coefficient is also significant at 1% level with a p-value of 0.001. Thus, a 1% increase in GDP leads to a 1.52% increase in tonnes per kilometer transported by road, keeping everything else constant.

Industrial production has also a positive effect on road freight transport. A 1% increase lead to a 0.1% increase in volumes transported by road. However, the effect is not significant (p-value 0.527).

Regarding e-commerce, its coefficient of e-commerce is positive, meaning that there is a positive relation between e-commerce and road freight transport. A 1% increase in the percentage of companies that are involved in online purchases result to 0.005% increase in

tonnes per kilometer transported by road. Yet the coefficient is insignificant even at 10% level (with a p-value of 0.854).

Interestingly, the coefficient of infrastructure is negative. This outcome suggests that investments affect road freight transport negatively. A 1% increase in infrastructure investments result to a 0.011% decrease in road freight transport, but the coefficient is insignificant.

As expected, the coefficient of population is positive and significant at 10% level. The outcome suggests that a 1% increase in the population leads to a 5.13% increase in road freight transport.

A notable effect derives from the euro variable, as the sign of its coefficient is negative. Road freight transport in countries that have the euro as a national currency is lower by 5.6% compared to road freight transport in countries that have another currency. However, the effect of euro is not significant (p-value 0.341).

The crisis of 2008-2009 appears to have negative results on the level of road freight transport, as anticipated and its coefficient is significant at 10% level. During the period of crisis the level of transported goods by road was decreased by 10% compared to the rest of the period that is taken into account.

The eurcrisis variable is the interaction between euro currency and the economic crisis of 2008-2009. From Table 11 it can be concluded that countries that have euro saw a greater decline by 0.5% in road freight transport compared to countries that do not have the euro as their national currency. Yet, since the p-value of the coefficient of the eurcrisis variable is 0.915, the outcome is not significant.

In conclusion, from all the variables that were taken into account in the regression, only two of them have significant effects, namely population and GDP. Concerning, the signs of the coefficients, GDP, industrial production, e-commerce and population have a positive tendency towards road freight transport. On the other hand, infrastructure investments, euro currency, crisis and the interaction between euro currency and the crisis have a negative tendency towards the tonnes per kilometer transported by road.

## 6.2 Bardsen Error Correction Model with Newey West Standard Errors

*Table 11. Results of the Bardsen Error Correction Model with Newey West Standard Errors*

```
Regression with Newey-West standard errors          Number of obs   =       162
maximum lag: 1                                      F( 20,   141)   =      6.83
                                                    Prob > F        =    0.0000
```

| **Dependent Variable** | **Δrft** | | | | | |
|---|---|---|---|---|---|---|
| | **Variable** | **Coefficient** | **Corrected Std. Errors** | **T** | **P>\|T\|** | **95% Conf. Interval** |
| **Short-Run** | | | | | | |
| | Δlngdp | **1.632692** | 0.4618209 | 3.54 | **0.001** | 0.719703 2.545680 |
| | Δlninprod | -0.283766 | 0.3055549 | -0.93 | 0.355 | -0.887827 0.320294 |
| | Δlnecom | 0.015128 | 0.0353504 | 0.43 | 0.669 | -0.054756 0.085014 |
| | Δlninfra | 0.052485 | 0.0749987 | 0.70 | 0.485 | -0.095782 0.200752 |
| | Δlnpop | 2.220696 | 1.615269 | 1.37 | 0.171 | -0.972579 5.413971 |
| **Dummy Variables** | | | | | | |
| | eur | 0.0101735 | 0.0305397 | 0.33 | 0.740 | -0.050201 0.070548 |
| | crisis | -0.0728511 | 0.071567 | -1.02 | 0.310 | -0.214334 0.068632 |
| | eurcrisis | 0.0073315 | 0.0424059 | 0.17 | 0.863 | -0.076502 0.091165 |
| **Lagged Variables** | | | | | | |
| | $Lnrft_{t-1}$ | -0.0021533 | 0.0231646 | -0.09 | 0.926 | -0.047948 0.043641 |
| | $lngdp_{t-1}$ | -0.0546439 | 0.0311049 | -1.76 | 0.081 | -0.116136 0.006848 |
| | $lninprod_{t-1}$ | 0.0850527 | 0.1259261 | 0.68 | 0.501 | -0.163894 0.333999 |
| | $lnecom_{t-1}$ | 0.0164458 | 0.0288033 | 0.57 | 0.501 | -0.040496 0.073388 |
| | $lninfra_{t-1}$ | -0.0113685 | 0.0093012 | -1.22 | 0.569 | -0.029756 0.007019 |
| | $lnpop_{t-1}$ | -0.0007528 | 0.0198272 | -0.04 | 0.224 | -0.039949 0.038444 |
| | **Variable** | **Coefficient** | **Corrected Std. Errors** | **z** | **P>\|z\|** | **95% Conf. Interval** |
| **Long Run** | | | | | | |
| | $lngdp_{t-1}$ | -25.37654 | 276.0745 | -0.09 | 0.927 | -566.4727 515.7196 |
| | $lninprod_{t-1}$ | 39.49832 | 416.1046 | 0.09 | 0.924 | -776.0517 855.0484 |
| | $lnecom_{t-1}$ | 7.637423 | 84.33659 | 0.09 | 0.928 | -157.6593 172.9341 |
| | $lninfra_{t-1}$ | -5.279524 | 57.76524 | -0.09 | 0.927 | -118.4973 107.9383 |
| | $lnpop_{t-1}$ | -0.349606 | 12.83363 | -0.03 | 0.978 | -25.50306 24.80384 |

From Table 11, a positive relation between GDP and road freight transport is derived. The coefficient of gdp is significant at 1% level with a p-value of 0.001. Thus, a 1% increase in GDP leads to a 1.63% increase in tonnes per kilometer transported by road, compared to 1.52% increase in the fixed effects model.

All other variables show insignificant effects, with Industrial production and crisis having a negative tendency. Whereas, e-commerce, infrastructure investments, population, euro currency and the interaction between euro and the crisis have a positive tendency.

Concerning the long run effects, none of the independent variable have significant effects on road freight transport.

In conclusion, from all the variables that were taken into account in the regression, only one of them have significant effects, namely GDP. Concerning, the signs of the coefficients, GDP, e-commerce, infrastructure investments, euro currency, population and the interaction between euro currency and the crisis have a positive tendency towards road freight transport. On the other hand, industrial production and crisis have a negative tendency towards the tonnes per kilometer transported by road. On the long run, industrial production and e-commerce show only a positive tendency, whereas the economic activity, infrastructure investments and population show only a negative tendency.

## 6.3 Arellano-Bond estimator

*Table 12. Results of the Arellano-Bond estimator*

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       132
Time variable : year                            Number of groups   =        27
Number of instruments = 49                      Obs per group: min =         1
F(20, 27)     =    182.68                                      avg =      4.89
Prob > F      =     0.000                                      max =         7
```

| **Dependent Variable** | **Δrft** | | | | | |
|---|---|---|---|---|---|---|
| | **Variable** | **Coefficient** | **Corrected Std. Errors** | **T** | **P>\|T\|** | **95% Conf. Interval** |
| **Short-Run** | | | | | | |
| | Δlngdp | **1.692818** | 0.7307913 | 2.32 | **0.028** | 0.193358 3.192278 |
| | Δlninprod | 0.060478 | 0.7637348 | 0.08 | 0.937 | -1.506577 1.627532 |
| | Δlnecom | 0.013956 | 0.0387429 | 0.36 | 0.721 | -0.065538 0.093449 |
| | Δlninfra | 0.031372 | 0.0966006 | 0.32 | 0.748 | -0.166835 0.229580 |
| | Δlnpop | -4.903819 | 22.91478 | -0.21 | 0.832 | -51.92107 42.11343 |
| **Dummy Variables** | | | | | | |
| | eur | 0.044257 | 0.0840043 | 0.53 | 0.603 | -0.128105 0.216619 |
| | crisis | 0.018611 | 0.0714672 | 0.26 | 0.797 | -0.128027 0.165249 |
| | eurcrisis | 0.020462 | 0.0642879 | 0.32 | 0.753 | -0.111445 0.152370 |
| **Lagged Variables** | | | | | | |
| | $Lnrft_{t-1}$ | -0.723081 | 1.033068 | -0.70 | 0.490 | -2.842761 1.396598 |
| | $lngdp_{t-1}$ | 2.961787 | 1.933602 | 1.53 | 0.137 | -1.005636 6.929210 |
| | $lninprod_{t-1}$ | -1.027521 | 1.208783 | -0.85 | 0.403 | -3.507738 1.452697 |
| | $lnecom_{t-1}$ | 0.021769 | 0.045363 | 0.48 | 0.635 | -0.071307 0.114846 |
| | $lninfra_{t-1}$ | -0.038455 | 0.142103 | -0.27 | 0.789 | -0.330026 0.253116 |
| | $lnpop_{t-1}$ | -1.504812 | 5.523836 | -0.27 | 0.787 | -12.83879 9.829163 |
| | **Variable** | **Coefficient** | **Corrected Std. Errors** | **z** | **P>\|z\|** | **95% Conf. Interval** |
| **Long Run** | | | | | | |
| | $lngdp_{t-1}$ | 4.096063 | 4.570849 | 0.90 | 0.370 | -4.862636 13.05476 |
| | $lninprod_{t-1}$ | -1.421030 | 1.699821 | -0.84 | 0.403 | -4.752618 1.910557 |
| | $lnecom_{t-1}$ | 0.030106 | 0.0640519 | 0.47 | 0.638 | -0.095432 0.155646 |
| | $lninfra_{t-1}$ | -0.053182 | 0.2630908 | -0.20 | 0.840 | -0.568830 0.462466 |
| | $lnpop_{t-1}$ | -2.081110 | 4.857491 | -0.43 | 0.668 | -11.60162 7.439396 |

The results of the Arellano-Bond estimator are mainly in line with the results of the Bardsen Error Correction Model with Newey West Standard Errors. Again, only the economic activity that is measured with GDP show significant impact on road freight transport. The outcome of the Arellano-Bond estimator suggests that a 1% increase in GDP leads to a 1.69% in road freight transport. Concerning the rest of the variables, all but population show a positive tendency.

Finally, on the long run, economic activity and e-commerce have a positive tendency, whereas industrial production, infrastructure investments and population have a negative tendency on road freight transport. None of the coefficients of the variables are significant.

# 7. Discussion

In this chapter, the hypotheses, the link with the previous literature as well as the limitations of the research are discussed. First, I discuss the hypotheses, followed by a comparison of the results with the previous literature. Finally, the limitations are presented.

## 7.1 Verification of hypotheses

### 7.1.1 Hypothesis 1

The results provided in the previous chapter suggest that there is a significant impact of economic activity on road freight transport. The outcome of this research concerning the relation between GDP and tonnes per kilometer transported by road show that a 1% increase in GDP lead to a 1.5%-1.6% increase in tonnes per kilometer transported by road, ceteris paribus. As a result, the first hypothesis that there is positive relation between economic activity and road freight transport is verified.

Concerning the previous literature, the research of Bennathan et al. (1992), Meersman and Van de Voorde (1999), Meersman and Van de Voorde (2005), Hilferink (2005), Tapio (2005) and Limão (2008) conclude that economic activity (measured with GDP) affects the volumes transported positively. On the other hand, Meersman and Van de Voorde (2013) report that that economic activity does not affect the volumes transported by road.

Bennathan et al. (1992) reports that there is one on one relationship, meaning that a certain increase in GDP leads to an equivalent increase in freight volumes transported by road. Similar results are found by Tapio (2005) and Hilferink (2005). Whereas, Meersman and Van de Voorde (1999) report that GDP has stronger effects over time. They state that GDP did not have a significant effect on transported tonnes per kilometer by road in 1984-93 period in EU12, while in period 1991-2000 a 1% increase in GDP led to 30% increase in road freight transport. In their follow up study, Meersman and Van de Voorde (2013) underline that the relation of road freight transport with the economic activity is gradually changing. However, they find insignificant effects. Finally, in the research of Limão (2008) a significant correlation of 0.26 is stated between road freight transport and economic activity.

In conclusion, regarding the relation between economic activity and road freight transport, the outcome of this research is in line with the majority of the previous literature. However the magnitude of the effects differ. Specifically, in this research the magnitude of the effect of GDP on tonnes per kilometer transported by road is slightly greater than the magnitude reported in the majority of the previous literature, which report a one on one relationship.

Two facts can be derived from the outcome of this research in relation with the previous literature. First, it is challenging to find a stable trend between economic activity and road freight transport. Hence, forecasting the trend of these two aspects, especially in long-term, would lead to unreliable results. Second, policy measures undertaken by the European Union, such as POSSUM and SPRITE, which target the minimization of the dependence of freight transport on economic activity seem to fail to provide any results.

### 7.1.2 Hypothesis 2

The results presented in chapter 5 show insignificant effects of the euro currency on road freight transport. Only a negative tendency is noted in the fixed effects model, whereas a positive tendency is derived from the dynamic panel data models. Hence, the second hypothesis that having the euro as a national currency has a positive effect on transported volumes by road compared to having another (local) currency is rejected.

Two studies that are researching the effect of currency unions on trade provide similar results. Persson (2001) estimates the effect to be between 13% and 60% but his results are not statistically significant. Similarly, Pakko and Wall (2001) find statistically insignificant results.

On the contrary, previous literature studying only the EMU show significant positive effects of euro on trade of physical goods. However, even though the results of the previous studies show significant effects, they are relatively low. They fluctuate from 2% (Baldwin et al., 2008) to 9.7% (De Nardis and Vicarelli, 2003).

The reason behind the positive relation of euro currency on trade that is depicted in the previous literature is that Eurozone decreases the risks, costs and uncertainty in trade transactions, hence trade is facilitated (Micco et al., 2003). In addition, being a part of a currency union leads to a political and financial integration (Rose, 1999). However, country members of the European Union have already achieved, at a certain level, political and financial integration. Furthermore, free trade among the country members of the European Union was one of its fundamental pillars. Consequently, the results of this research are not expected to be in line with the previous studies. Difference in the results is expected since I only include countries of the European Union. In contrast, previous literature include several additional to the Eurozone countries.

### 7.1.3 Hypothesis 3

The regression of both Bardsen Error Correction Model with Newey West Standard Errors and Arellano-Bond estimator as well as the regression of the fixed effects model indicate an insignificant effect of the eurcrisis dummy variable on road freight transport. The result suggests that there are no differential effects of the recent economic recession on road freight transport in European Union, depending on whether a country is a member of the Eurozone. Therefore the hypothesis that the road freight transport of member countries of the European Monetary Union is less affected by an economic recession compared to non-member countries is rejected. This result gives a new insight on the topic, as there is no previous research investigating whether road freight transport was affected more in Eurozone countries during a period of crisis.

It was expected that countries of the Eurozone would be less affected by the economic recession. However, there are reasons behind the result. First, the sample includes European Union countries that have already reached a certain degree of integration. Furthermore, European Union policies are instituted on all countries of European Union regardless of the national currency. There are however several measures targeting financial stability in the Eurozone, but they have only been used by volatile economies (i.e. Greece, Portugal, Ireland). Finally, certain countries of the European Union that do not have the Euro as a national

currency (i.e. Poland and Bulgaria) have seized the opportunities appeared during the crisis and have developed their freight transport sector and attracted a number of enterprises. This actually led to a significant increase in tonnes per kilometer transported by road within their borders during the period of the recent recession.

*Table 13. Overview of hypotheses*

| | **Predicted direction** | **Involved variables** | **Effect/Significance** | **Accepted** |
|---|---|---|---|---|
| *Hypothesis 1* | *There is a positive relation between economic activity and road freight transport* | Dependent variable: rft Independent variable: gdp | Main effect/Yes | Yes |
| *Hypothesis 2* | *Having the euro as a national currency has a positive effect on transported volumes by road compared to having another (local) currency* | Dependent variable: rft Independent variable: eur | Main effect/No | No |
| *Hypothesis 3* | *The road freight transport of member countries of the European Monetary Union is less affected by an economic recession compared to non-member countries`* | Dependent variable: rft Independent variable: crisis Moderating variable: eur | Interaction effect/No | No |

# 8. Conclusion

The aim of this research is mainly to identify if there were different effects of the recent economic recession on road freight transport, depending on whether a country has a euro or not as a national currency. Additionally, the influence of economic activity on road freight transport as well as the effect of having the euro as a national currency on road freight transport are tested. In order to test the hypotheses formed, a panel data and a dynamic panel data approach is used. Specifically, concerning the panel data approach, a Fixed Effects Model is used. Concerning the dynamic panel data approach, a Bardsen Error Correction Model with Newey West Standard Errors and Arellano-Bond estimator are used.

Previous literature studying the relation between economic activity and freight transport find significant positive effect of the latter on the former. The finding of this research provides further support to previous studies. The result though is slightly different than the results of previous literature, suggesting that 1% increase in GDP leads to slightly more than 1% increase in road freight transport measured in tonnes per kilometer.

Concerning the relation between being a member of the European Monetary Union and trade, previous studies find significant positive effects. These effects though are low, varying from four to ten percent. The results of this research fail to support the fact that country members of the European Monetary Union trade by road more than the countries that have a another national currency. However, a positive tendency is noted.

The new insight that my research added to the literature on road freight transport is study of the differential effects of the recent economic recession on road freight transport in European Union, depending on whether a country was a member of the Eurozone. The outcome of the Bardsen Error Correction Model with Newey West Standard Errors, Arellano-Bond estimator and Fixed Effects model show no differential effects. However, the results should be interpreted cautiously taking into account the following limitations.

## 8.1 Limitations

One limitation of this study is that the number of the countries that compose the treatment group, which consists of the member countries of the Eurozone, is small. In addition, the control group that consists of the non-euro countries is also small. When a dataset is comprised by few Eurozone member countries or few non-euro countries, low external validity is noticed (Baldwin et al., 2008; Barro and Tenreyro, 2007).

Furthermore the dataset consists only of country members of European Union. Countries of European Union have reached a certain level of political and financial integration. Also policies concerning trade between them and with countries outside the European Union are applied to all member states and are not distinct depending on the national currency.

Finally, due to absence of common definitions among countries on obtaining the data for transport infrastructure investment and maintenance spending, comparisons between countries should be made cautiously. However, data for each country is consistent over time. In addition, a small minority of countries do not report data on urban spending.

## 8.2 Future research

This research can be expanded in two ways. First, since the control group (non-euro countries) is relatively small and there is no possibility to expand the treatment group (euro countries) future research should include a larger number of non-euro countries or only countries outside the European Union. In addition, the research should be conducted on other currency unions as well in order to identify whether the recent recession had different effects depending on the monetary union.

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# Appendix

*Table 14. Summary of annual road freight transport [road_go_ta_tott]*

*Unit: Million TKM (tonne-kilometre)*
*Carriage: Total*

| GEO/TIME | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 50.542 | 47.878 | 43.847 | 43.017 | 42.085 | 38.356 | 36.174 | 35.002 | 33.107 | 32.105 | 32.796 |
| Bulgaria | : | : | : | 13.765 | 14.624 | 15.322 | 17.742 | 19.433 | 21.214 | 24.372 | 27.097 |
| Czech Republic | 46.535 | 46.011 | 43.447 | 50.376 | 48.141 | 50.877 | 44.955 | 51.832 | 54.830 | 51.228 | 54.893 |
| Denmark | 23.009 | 23.114 | 23.299 | 21.254 | 20.960 | 19.480 | 16.876 | 15.018 | 16.120 | 16.679 | 16.072 |
| Germany | 290.745 | 303.752 | 310.103 | 330.016 | 343.447 | 341.532 | 307.547 | 313.104 | 323.833 | 307.009 | 305.744 |
| Estonia | 3.974 | 5.099 | 5.824 | 5.548 | 6.417 | 7.354 | 5.340 | 5.614 | 5.912 | 5.791 | 5.986 |
| Ireland | 15.650 | 17.144 | 17.910 | 17.454 | 19.020 | 17.402 | 11.687 | 10.939 | 10.108 | 9.976 | 9.215 |
| Greece | 19.340 | 36.773 | 23.761 | 34.002 | 27.791 | 28.850 | 28.585 | 29.815 | 20.597 | 20.839 | 18.970 |
| Spain | 192.596 | 220.822 | 233.230 | 241.788 | 258.875 | 242.983 | 211.895 | 210.068 | 206.843 | 199.209 | 192.597 |
| France | 203.608 | 212.201 | 205.284 | 211.445 | 219.212 | 206.304 | 173.621 | 182.193 | 185.685 | 172.445 | 171.472 |
| Croatia | : | : | : | : | : | 11.042 | 9.426 | 8.780 | 8.926 | 8.649 | 9.133 |
| Italy | 174.088 | 196.980 | 211.804 | 187.065 | 179.411 | 180.461 | 167.627 | 175.775 | 142.843 | 124.015 | 127.241 |
| Cyprus | 1.401 | 1.119 | 1.393 | 1.165 | 1.202 | 1.308 | 963 | 1.087 | 941 | 896 | 634 |
| Latvia | 6.808 | 7.381 | 8.394 | 10.753 | 13.204 | 12.344 | 8.115 | 10.590 | 12.131 | 12.178 | 12.816 |
| Lithuania | 11.462 | 12.279 | 15.908 | 18.134 | 20.278 | 20.419 | 17.757 | 19.398 | 21.512 | 23.449 | 26.338 |
| Luxembourg | 9.645 | 9.575 | 8.803 | 8.807 | 9.562 | 8.965 | 8.400 | 8.694 | 8.835 | 7.950 | 8.606 |
| Hungary | 18.208 | 20.608 | 25.152 | 30.479 | 35.805 | 35.759 | 35.373 | 33.721 | 34.529 | 33.736 | 35.818 |
| Netherlands | 79.765 | 89.695 | 84.163 | 83.193 | 77.921 | 78.159 | 72.675 | 75.783 | 73.713 | 67.804 | 70.184 |
| Austria | 39.557 | 39.186 | 37.044 | 39.187 | 37.402 | 34.313 | 29.075 | 28.659 | 28.542 | 26.089 | 24.213 |
| Poland | : | 102.807 | 111.826 | 128.315 | 150.879 | 164.930 | 180.742 | 202.308 | 207.651 | 222.332 | 247.594 |
| Portugal | 27.425 | 40.819 | 42.607 | 44.835 | 46.203 | 39.091 | 35.808 | 35.368 | 36.453 | 32.935 | 36.555 |
| Romania | : | : | : | 57.288 | 59.524 | 56.386 | 34.269 | 25.889 | 26.349 | 29.662 | 34.026 |
| Slovenia | 7.040 | 9.007 | 11.032 | 12.112 | 13.734 | 16.261 | 14.762 | 15.931 | 16.439 | 15.888 | 15.905 |
| Slovakia | 16.748 | 18.527 | 22.566 | 22.212 | 27.159 | 29.276 | 27.705 | 27.575 | 29.179 | 29.693 | 30.147 |
| Finland | 30.926 | 32.290 | 31.857 | 29.715 | 29.819 | 31.036 | 27.805 | 29.532 | 26.863 | 25.460 | 24.429 |
| Sweden | 36.638 | 36.949 | 38.575 | 39.918 | 40.540 | 42.370 | 35.047 | 36.268 | 36.932 | 33.481 | 33.529 |
| United Kingdom | 167.143 | 162.654 | 161.285 | 165.479 | 170.991 | 160.296 | 139.536 | 146.685 | 153.517 | 158.461 | 147.188 |

*Source: Eurostat*
*http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_go_ta_tott&lang=en*
*Extracted on: 01.06.15*

*Table 15. Enterprises having purchased online (at least 1%) [tin00112]*

*Percentage of enterprises with at least 10 persons employed*

| GEO/TIME | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 22 | 9 | 18 | 16 | 43 | 34 | 44 | 51 | : | : | : |
| Bulgaria | : | 4 | : | 3 | 3 | 3 | 5 | 4 | 6 | 4 | 3 |
| Czech Republic | 22 | 19 | 21 | 17 | 22 | 26 | 26 | 33 | 39 | 40 | 46 |
| Denmark | 22 | 28 | 32 | 34 | 36 | 38 | : | 48 | : | : | : |
| Germany | 11 | 47 | 41 | 48 | 52 | : | 42 | 40 | : | : | : |
| Estonia | : | 32 | 13 | 17 | 13 | 18 | 17 | 17 | : | : | : |
| Ireland | 24 | 33 | 41 | 53 | 55 | 55 | 44 | 44 | 49 | 51 | 45 |
| Greece | 7 | 14 | 14 | 11 | 8 | 10 | : | : | 6 | : | 13 |
| Spain | 3 | 3 | 4 | 15 | 16 | 19 | 17 | 21 | 20 | 19 | 19 |
| France | : | : | : | : | : | 18 | 20 | 19 | 20 | 14 | 14 |
| Croatia | : | : | : | : | 19 | 22 | 22 | 23 | : | : | : |
| Italy | 4 | 6 | 4 | 10 | 10 | 12 | 14 | 17 | 11 | 14 | 15 |
| Cyprus | : | 14 | 15 | 10 | 12 | 14 | 15 | 14 | 12 | 11 | 8 |
| Latvia | : | : | 1 | 3 | 5 | 9 | 8 | 9 | 14 | 14 | 13 |
| Lithuania | : | 13 | 7 | 17 | 18 | 25 | 20 | 26 | 27 | 19 | 19 |
| Luxembourg | 17 | 34 | 22 | 30 | 34 | 23 | 22 | 34 | 32 | 35 | 43 |
| Hungary | : | 14 | 5 | 11 | 7 | 7 | 14 | 17 | 18 | 17 | 15 |
| Netherlands | 20 | 22 | 20 | 32 | 36 | 40 | 37 | 32 | 28 | : | 28 |
| Austria | 21 | 22 | 22 | 37 | 42 | 34 | 30 | 39 | 41 | : | : |
| Poland | : | 9 | 9 | 16 | 13 | 11 | : | 12 | 12 | 15 | 16 |
| Portugal | 9 | 8 | 12 | 14 | 12 | 20 | 18 | 22 | 14 | 17 | 12 |
| Romania | : | : | : | : | 8 | 4 | 4 | 7 | 9 | 7 | 18 |
| Slovenia | : | 17 | 15 | 18 | 21 | 15 | 19 | 16 | 18 | 17 | 14 |
| Slovakia | : | 3 | 7 | : | 8 | 9 | 12 | 14 | 15 | 14 | 20 |
| Finland | 16 | 19 | 19 | 23 | 19 | : | 25 | 28 | 33 | 37 | 32 |
| Sweden | 23 | 38 | 41 | 44 | 48 | 50 | 47 | 53 | 38 | : | : |
| United Kingdom | 25 | 53 | 51 | 51 | 49 | 47 | 28 | 44 | : | : | : |

*Source: Eurostat*
*http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tin00112*
*Extracted on: 01.06.15*

*Table 16. Production in industry, annual data (2010 = 100) [sts_inpr_a]*

*Volume index of production, data adjusted by working days*

| GEO/TIME | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 76,62 | 82,19 | 85,18 | 90,51 | 96,62 | 100,14 | 89,99 | 100,00 | 104,10 | 101,92 | 102,88 |
| Bulgaria | 84,98 | 95,62 | 102,39 | 108,82 | 119,31 | 119,81 | 97,79 | 99,87 | 105,73 | 105,52 | 105,45 |
| Czech Republic | 79,02 | 86,72 | 90,42 | 98,30 | 108,76 | 106,23 | 92,27 | 99,80 | 105,67 | 104,83 | 104,96 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 114,23 | 112,94 | 116,42 | 120,18 | 117,05 | 115,01 | 98,04 | 99,98 | 101,84 | 101,97 | 102,40 |
| Germany | 89,70 | 92,46 | 95,68 | 101,09 | 107,22 | 107,19 | 89,68 | 99,48 | 106,64 | 106,29 | 106,48 |
| Estonia | 78,56 | 86,13 | 95,64 | 105,29 | 112,06 | 106,73 | 81,20 | 99,78 | 119,41 | 121,19 | 126,26 |
| Ireland | 87,17 | 88,25 | 91,75 | 94,55 | 99,51 | 97,35 | 93,01 | 100,01 | 99,58 | 98,12 | 95,93 |
| Greece | 120,53 | 121,35 | 119,42 | 120,40 | 123,15 | 117,95 | 106,51 | 100,00 | 94,16 | 92,18 | 89,23 |
| Spain | 117,46 | 119,33 | 120,51 | 125,18 | 127,49 | 117,80 | 99,23 | 100,00 | 98,30 | 91,51 | 89,94 |
| France | 109,62 | 111,08 | 111,59 | 112,94 | 114,35 | 110,73 | 95,03 | 99,81 | 102,14 | 99,38 | 98,78 |
| Croatia | 93,91 | 96,27 | 101,06 | 105,40 | 110,73 | 111,53 | 101,56 | 100,00 | 98,81 | 93,53 | 91,72 |
| Italy | 114,30 | 114,09 | 113,29 | 117,35 | 119,39 | 115,28 | 93,68 | 100,01 | 101,23 | 94,80 | 91,78 |
| Cyprus | 99,94 | 101,42 | 102,20 | 102,72 | 107,54 | 112,29 | 101,70 | 100,00 | 92,27 | 83,45 | 73,01 |
| Latvia | 88,47 | 94,10 | 101,19 | 107,76 | 109,37 | 105,86 | 86,83 | 99,33 | 108,12 | 114,78 | 114,37 |
| Lithuania | 81,51 | 90,53 | 97,58 | 102,42 | 104,41 | 109,36 | 94,27 | 100,00 | 106,60 | 110,59 | 114,21 |
| Luxembourg | 105,10 | 110,09 | 113,06 | 115,80 | 115,43 | 109,57 | 91,99 | 100,00 | 101,97 | 96,29 | 92,32 |
| Hungary | 80,93 | 86,51 | 92,76 | 102,56 | 110,83 | 109,90 | 90,63 | 99,99 | 105,64 | 104,12 | 105,68 |
| Netherlands | 89,45 | 93,53 | 93,90 | 95,83 | 99,77 | 100,43 | 92,81 | 100,02 | 99,28 | 98,75 | 99,29 |
| Austria | 82,63 | 87,68 | 91,45 | 98,49 | 104,26 | 105,62 | 93,71 | 99,98 | 106,83 | 106,53 | 107,40 |
| Poland | 63,08 | 71,28 | 74,32 | 83,33 | 91,23 | 93,65 | 89,99 | 100,01 | 106,73 | 108,07 | 110,58 |
| Portugal | 117,57 | 112,63 | 108,69 | 112,09 | 112,20 | 107,64 | 98,39 | 100,00 | 98,99 | 92,91 | 93,36 |
| Romania | 82,47 | 83,74 | 82,34 | 90,49 | 99,59 | 101,53 | 96,39 | 101,13 | 109,11 | 111,88 | 120,24 |
| Slovenia | 89,58 | 92,95 | 97,25 | 103,43 | 110,88 | 112,79 | 92,72 | 99,16 | 101,22 | 100,71 | 99,32 |
| Slovakia | 68,79 | 71,24 | 70,69 | 81,81 | 95,54 | 109,45 | 92,44 | 100,01 | 105,32 | 113,70 | 119,59 |
| Finland | 95,11 | 99,73 | 98,83 | 109,08 | 114,34 | 115,10 | 94,59 | 99,66 | 101,34 | 99,81 | 96,60 |
| Sweden | 99,71 | 104,16 | 106,53 | 110,37 | 114,76 | 111,35 | 91,48 | 99,45 | 102,00 | 100,78 | 96,11 |
| United Kingdom | 108,06 | 108,60 | 108,39 | 109,10 | 109,25 | 105,96 | 97,03 | 100,00 | 99,36 | 96,34 | 96,12 |

*Source: Eurostat*
*http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sts_inpr_a&lang=en*
*Extracted on: 04.06.15*

*Table 17. Transport infrastructure investment and maintenance spending [ITF_INV-MTN_DATA]*
*Unit: Euro*
*Total inland transport infrastructure investment*

| GEO/TIME | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|
| Austria | 1797617000 | 2066021000 | 2023620091 | 2297648471 | 2378915756 | 2560373278 | 2731499722 | 2337284492 | 2454208202 |
| Belgium | 2230770000 | 2561521118 | 2633988043 | 2681823406 | 2468665808 | 2842912838 | 2842912838 | | |
| Bulgaria | | | 403127412 | 402392883 | 583904285 | 240310870 | 150833419 | 411084978 | 434093466 |
| Croatia | 1154013846 | 1008163592 | 846016647 | 997651781 | 1160324902 | 1228976038 | 1011035422 | 601308804 | 549670655 |
| Czech Republic | 1055169838 | 1453618150 | 1910179693 | 1974434975 | 2118941327 | 3279286106 | 2783726379 | 2342788002 | 1764088202 |
| Denmark | 924542775 | 1069369212 | 1168576720 | 1368931909 | 1260972271 | 1308610515 | 1070478902 | 1332966310 | |
| Estonia | 64000000 | 76000000 | 122000000 | 151000000 | 156270000 | 164700000 | 156496000 | 172141000 | 252025000 |
| Finland | 810193000 | 931630000 | 876877000 | 886038000 | 1018380000 | 1302100000 | 1284862000 | 1180000000 | 1288000000 |
| France | 14213383390 | 15060902000 | 15580171298 | 16475310062 | 17161728448 | 17883574855 | 17877252551 | 17045407240 | 17221160000 |
| Germany | 18843000000 | 17904000000 | 14401000000 | 15501000000 | 15501000000 | 16131000000 | 16752000000 | 16617000000 | 16570000000 |
| Greece | 3335000000 | 3293000000 | 1870000000 | 2084000000 | 2199000000 | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hungary | 529649408 | 1582235897 | 1875923769 | 679090707 | 1026480290 | 1274347097 | 1884740123 | 1116720296 | |
| Ireland | 1416000000 | 1374000000 | 1337000000 | 1667000000 | 1669000000 | | | | |
| Italy | 14311750000 | 16431460000 | 19396403000 | 23305208000 | 21394569000 | 20194000000 | 11355000000 | 8204000000 | |
| Latvia | 98329952 | 96211666 | 201091640 | 214018960 | 278531638 | 325885869 | 198384583 | 217299280 | 277502478 |
| Lithuania | 227647928 | 207072316 | 233723355 | 294543559 | 391276645 | 526529194 | 515813253 | 530294254 | 461943930 |
| Luxembourg | 277267398 | 243367337 | 254458594 | 280445906 | 296095271 | 287966101 | 321164231 | 340129200 | 371883539 |
| Netherlands | 4104700000 | 3871300000 | 3020799999 | 2668500000 | 2788600000 | 3284000000 | 3501800000 | 3647900000 | 3686200000 |
| Norway | 1274423488 | 1360152249 | 1655988678 | 1731931682 | 2028350852 | 2271304963 | 2753880978 | 3100981950 | 3252068918 |
| Poland | 1204654969 | 1471237961 | 2117822521 | 2964655150 | 4102862278 | 5433501324 | 6015805527 | 7225073222 | 9273406785 |
| Portugal | 2247078471 | 2424761494 | 2546591702 | 2260259749 | 1792000000 | 1765290000 | 1316248207 | 1914523597 | |
| Romania | 969880962 | 1343618860 | 1580270099 | 2264734245 | 3475849249 | 4697767881 | 3818486285 | 3442144248 | 3963577174 |
| Slovak Republic | 301424746 | 331877572 | 521036331 | 637704551 | 807666198 | 782128471 | 838400000 | 618400000 | 726000000 |
| Slovenia | 491356190 | 555265700 | 492440543 | 586061887 | 719910506 | 823032291 | 506297231 | 351884836 | 234116211 |
| Spain | 11111972000 | 11612922000 | 14344137000 | 14746900000 | 16422000000 | 17503000000 | 18368000000 | 16073000000 | 13492000000 |
| Sweden | 2051467526 | 2385826858 | 2421839650 | 2468123271 | 2676511605 | 2923704135 | 2892241339 | 3086617806 | 3271279541 |
| United Kingdom | 12687861272 | 10399292766 | 11389295116 | 14281942203 | 13935408447 | 13605425091 | 12925131889 | 12859640942 | 11798594308 |

*Source: OECD*
*http://stats.oecd.org/Index.aspx?DataSetCode=ITF_INV-MTN_DATA*
*Extracted on: 04.06.15*

*Table 18. Gross domestic product per capita [nama_aux_gph]*

*Unit: Current prices, million euro*

| GEO/TIME | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 27.800 | 28.600 | 29.000 | 29.500 | 30.200 | 30.200 | 29.200 | 29.600 | 29.800 | 29.600 | 29.500 |
| Bulgaria | 2.600 | 2.800 | 3.000 | 3.200 | 3.400 | 3.700 | 3.500 | 3.500 | 3.700 | 3.700 | 3.800 |
| Czech Republic | 9.200 | 9.600 | 10.200 | 10.900 | 11.500 | 11.700 | 11.100 | 11.400 | 11.600 | 11.500 | 11.300 |
| Denmark | 36.700 | 37.500 | 38.300 | 39.400 | 39.900 | 39.300 | 36.900 | 37.300 | 37.500 | 37.200 | 37.200 |
| Germany | 26.500 | 26.800 | 27.000 | 28.000 | 29.000 | 29.300 | 27.900 | 29.100 | 30.000 | 30.200 | 30.200 |
| Estonia | 7.100 | 7.600 | 8.300 | 9.200 | 9.900 | 9.500 | 8.100 | 8.400 | 9.100 | 9.500 | 9.800 |
| Ireland | 36.900 | 37.800 | 39.200 | 40.300 | 41.000 | 39.300 | 36.400 | 35.900 | 36.500 | 36.400 | 36.200 |
| Greece | 16.400 | 17.100 | 17.400 | 18.300 | 18.900 | 18.800 | 18.200 | 17.400 | 16.200 | 15.100 | : |
| Spain | 20.200 | 20.600 | 21.000 | 21.500 | 21.800 | 21.700 | 20.700 | 20.600 | 20.600 | 20.200 | 20.100 |
| France | 26.500 | 27.000 | 27.300 | 27.800 | 28.200 | 28.100 | 27.000 | 27.400 | 27.800 | 27.600 | 27.600 |
| Croatia | 7.700 | 8.000 | 8.400 | 8.800 | 9.200 | 9.400 | 8.800 | 8.600 | 8.600 | 8.400 | 8.400 |
| Italy | 24.300 | 24.500 | 24.500 | 24.900 | 25.100 | 24.700 | 23.200 | 23.500 | 23.500 | 22.800 | 22.400 |
| Cyprus | 17.500 | 18.000 | 18.400 | 18.900 | 19.400 | 19.600 | 18.700 | 18.500 | 18.100 | 17.400 | 16.400 |
| Latvia | 4.700 | 5.200 | 5.800 | 6.500 | 7.200 | 7.000 | 5.900 | 5.900 | 6.400 | 6.800 | 7.100 |
| Lithuania | 5.300 | 5.800 | 6.300 | 6.900 | 7.700 | 8.000 | 6.900 | 7.100 | 7.700 | 8.100 | 8.500 |
| Luxembourg | 60.900 | 62.700 | 65.000 | 67.200 | 70.400 | 68.700 | 63.700 | 64.500 | 64.200 | 62.600 | 62.400 |
| Hungary | 8.000 | 8.400 | 8.800 | 9.200 | 9.200 | 9.300 | 8.700 | 8.800 | 8.900 | 8.800 | 9.000 |
| Netherlands | 30.300 | 30.900 | 31.500 | 32.500 | 33.700 | 34.200 | 32.700 | 33.100 | 33.200 | 32.700 | 32.300 |
| Austria | 28.800 | 29.300 | 29.800 | 30.800 | 31.800 | 32.100 | 30.800 | 31.300 | 32.100 | 32.200 | 32.200 |
| Poland | 5.900 | 6.200 | 6.400 | 6.800 | 7.300 | 7.600 | 7.800 | 8.000 | 8.300 | 8.500 | 8.700 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 14.400 | 14.600 | 14.600 | 14.800 | 15.100 | 15.100 | 14.600 | 14.900 | 14.700 | 14.300 | 14.300 |
| Romania | 3.300 | 3.600 | 3.700 | 4.100 | 4.400 | 4.800 | 4.500 | 4.500 | 4.600 | 4.700 | 4.800 |
| Slovenia | 13.300 | 13.800 | 14.400 | 15.100 | 16.100 | 16.600 | 15.200 | 15.300 | 15.400 | 15.000 | 14.800 |
| Slovakia | 6.400 | 6.700 | 7.100 | 7.700 | 8.500 | 9.000 | 8.600 | 8.900 | 9.200 | 9.400 | 9.500 |
| Finland | 28.200 | 29.300 | 30.000 | 31.200 | 32.700 | 32.700 | 29.700 | 30.600 | 31.300 | 30.900 | 30.300 |
| Sweden | 31.000 | 32.200 | 33.000 | 34.300 | 35.100 | 34.700 | 32.600 | 34.500 | 35.200 | 35.300 | 35.600 |
| United Kingdom | 29.400 | 30.200 | 31.000 | 31.700 | 32.500 | 32.100 | 30.200 | 30.500 | 30.600 | 30.200 | 30.600 |

*Source: Eurostat*
*http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_gph&lang=en*
*Extracted on: 04.06.15*

*Table 19. Currency dummy per country*

| Country | Currency | Adoption of Euro | Currency dummy | |
|---|---|---|---|---|
| Austria | Euro | 1999 | 1 | |
| Belgium | Euro | 1999 | 1 | |
| Bulgaria | Lev | N/A | 0 | |
| Croatia | Kuna | N/A | 0 | |
| Cyprus | Euro | 2008 | Before 2008 | From 2008 |
| | | | 0 | 1 |
| Czech Republic | Koruna | N/A | 0 | |
| Denmark | Krone | N/A | 0 | |
| Estonia | Euro | 2011 | Before 2011 | From 2011 |
| | | | 0 | 1 |
| Finland | Euro | 1999 | 1 | |
| France | Euro | 1999 | 1 | |
| Germany | Euro | 1999 | 1 | |
| Greece | Euro | 2001 | 1 | |
| Hungary | Forint | N/A | 0 | |
| Ireland | Euro | 1999 | 1 | |
| Italy | Euro | 1999 | 1 | |
| Latvia | Euro | 2014 | 0 | |
| Lithuania | Euro | 2015 | 0 | |
| Luxembourg | Euro | 1999 | 1 | |
| Netherlands | Euro | 1999 | 1 | |
| Poland | Zloty | N/A | 0 | |
| Portugal | Euro | 1999 | 1 | |
| Romania | Leu | N/A | 0 | |
| Slovakia | Euro | 2009 | Before 2009 | From 2009 |

| | | | 0 | 1 |
|---|---|---|---|---|
| Slovenia | Euro | 2007 | Before 2007 | From 2007 |
| | | | 0 | 1 |
| Spain | Euro | 1999 | 1 | |
| Sweden | Krona | N/A | 0 | |
| United Kingdom | Pound Sterling | N/A | 0 | |

*Table 20. Stata output of the Fixed Effects Model*

```
Fixed-effects (within) regression               Number of obs      =       162
Group variable: country                         Number of groups   =        27

R-sq:  within  = 0.4110                         Obs per group: min =         2
       between = 0.1059                                        avg =       6.0
       overall = 0.3158                                        max =         8

                                                F(14,26)           =      9.65
corr(u_i, Xb)  = -0.1498                        Prob > F           =    0.0000
```

| dlnrft | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| dlngdp | 1.525917 | .405157 | 3.77 | 0.000 | .7238022 | 2.328032 |
| lninprod | .1097191 | .173099 | 0.63 | 0.527 | -.2329761 | .4524143 |
| dlnecom | .0052304 | .0284508 | 0.18 | 0.854 | -.0510954 | .0615562 |
| lninfra | -.01134 | .040025 | -0.28 | 0.777 | -.09058 | .0678999 |
| dlnpop | 5.137009 | 2.929929 | 1.75 | 0.082 | -.6635577 | 10.93758 |
| eur | -.056613 | .0591731 | -0.96 | 0.341 | -.1737618 | .0605357 |
| crisis | -.1000276 | .0520722 | -1.92 | 0.057 | -.2031183 | .0030631 |
| eurcrisis | -.0047415 | .0445034 | -0.11 | 0.915 | -.0928477 | .0833648 |
| _Iyear_2004 | 0 | (omitted) | | | | |
| _Iyear_2005 | -.0980212 | .0643043 | -1.52 | 0.139 | -.2302005 | .0341581 |
| _Iyear_2006 | -.1155988 | .0438885 | -2.63 | 0.014 | -.2058129 | -.0253848 |
| _Iyear_2007 | -.1224837 | .0616131 | -1.99 | 0.057 | -.2491312 | .0041638 |
| _Iyear_2008 | 0 | (omitted) | | | | |
| _Iyear_2009 | -.0256469 | .0425408 | -0.60 | 0.552 | -.1130908 | .061797 |
| _Iyear_2010 | -.0514026 | .0504475 | -1.02 | 0.318 | -.1550988 | .0522937 |
| _Iyear_2011 | -.1050031 | .051164 | -2.05 | 0.050 | -.2101721 | .0001659 |
| _Iyear_2012 | 0 | (omitted) | | | | |
| _Iyear_2013 | 0 | (omitted) | | | | |
| _cons | -.1741463 | 1.17289 | -0.15 | 0.883 | -2.585056 | 2.236763 |
| sigma_u | .07265792 | | | | | |
| sigma_e | .11273754 | | | | | |
| rho | .29346798 | (fraction of variance due to u_i) | | | | |

*Table 21. Stata output of the Bardsen Error Correction Model with Newey West Standard Errors*

```
. newey d.lnrft l.lnrft d.lngdp d.lninprod d.lnecom d.lninfra d.lnpop l.lngdp l
> .lninprod l.lnecom l.lninfra l.lnpop eur crisis eurcrisis _Iyear*, lag(1) for
> ce
note: _Iyear_2009 omitted because of collinearity
note: _Iyear_2011 omitted because of collinearity
note: _Iyear_2012 omitted because of collinearity
note: _Iyear_2013 omitted because of collinearity

Regression with Newey-West standard errors          Number of obs   =       162
maximum lag: 1                                      F( 20,   141)   =      6.83
                                                    Prob > F        =    0.0000
```

| D.lnrft | Coef. | Newey-West Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnrft L1. | -.0021533 | .0231646 | -0.09 | 0.926 | -.0479481 | .0436415 |
| lngdp D1. | 1.632692 | .4618209 | 3.54 | 0.001 | .7197035 | 2.54568 |
| lninprod D1. | -.2837666 | .3055549 | -0.93 | 0.355 | -.8878278 | .3202946 |
| lnecom D1. | .0151289 | .0353504 | 0.43 | 0.669 | -.0547564 | .0850141 |
| lninfra D1. | .052485 | .0749987 | 0.70 | 0.485 | -.0957823 | .2007524 |
| lnpop D1. | 2.220696 | 1.615269 | 1.37 | 0.171 | -.9725798 | 5.413971 |
| lngdp L1. | -.0546439 | .0311049 | -1.76 | 0.081 | -.1161362 | .0068484 |
| lninprod L1. | .0850527 | .1259261 | 0.68 | 0.501 | -.1638945 | .3339999 |
| lnecom L1. | .0164458 | .0288033 | 0.57 | 0.569 | -.0404963 | .073388 |
| lninfra L1. | -.0113685 | .0093012 | -1.22 | 0.224 | -.0297564 | .0070193 |
| lnpop L1. | -.0007528 | .0198272 | -0.04 | 0.970 | -.0399498 | .0384442 |

| | | | | | | |
|---|---|---|---|---|---|---|
| eur | .0101735 | .0305397 | 0.33 | 0.740 | -.0502013 | .0705484 |
| crisis | -.0728511 | .071567 | -1.02 | 0.310 | -.2143342 | .068632 |
| eurcrisis | .0073315 | .0424059 | 0.17 | 0.863 | -.0765021 | .0911651 |
| _Iyear_2004 | .1059949 | .0485923 | 2.18 | 0.031 | .0099312 | .2020585 |
| _Iyear_2005 | .0211311 | .0435027 | 0.49 | 0.628 | -.0648707 | .1071329 |
| _Iyear_2006 | .0179509 | .0360474 | 0.50 | 0.619 | -.0533124 | .0892142 |
| _Iyear_2007 | .0051908 | .0293185 | 0.18 | 0.860 | -.0527698 | .0631514 |
| _Iyear_2008 | .0646966 | .0575276 | 1.12 | 0.263 | -.0490315 | .1784246 |
| _Iyear_2009 | 0 | (omitted) | | | | |
| _Iyear_2010 | .0588028 | .0290339 | 2.03 | 0.045 | .0014048 | .1162009 |
| _Iyear_2011 | 0 | (omitted) | | | | |
| _Iyear_2012 | 0 | (omitted) | | | | |
| _Iyear_2013 | 0 | (omitted) | | | | |
| _cons | .3290484 | .6049218 | 0.54 | 0.587 | -.8668406 | 1.524937 |

```
. nlcom _b[L.lngdp]/-_b[L.lnrft]

       _nl_1:  _b[L.lngdp]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -25.37654 | 276.0745 | -0.09 | 0.927 | -566.4727 | 515.7196 |

```
. nlcom _b[L.lninprod]/-_b[L.lnrft]

       _nl_1:  _b[L.lninprod]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | 39.49832 | 416.1046 | 0.09 | 0.924 | -776.0517 | 855.0484 |

```
. nlcom _b[L.lnecom]/-_b[L.lnrft]

       _nl_1:  _b[L.lnecom]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | 7.637423 | 84.33659 | 0.09 | 0.928 | -157.6593 | 172.9341 |

```
. nlcom _b[L.lninfra]/-_b[L.lnrft]

       _nl_1:  _b[L.lninfra]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -5.279524 | 57.76524 | -0.09 | 0.927 | -118.4973 | 107.9383 |

```
. nlcom _b[L.lnpop]/-_b[L.lnrft]

       _nl_1:  _b[L.lnpop]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -.3496061 | 12.83363 | -0.03 | 0.978 | -25.50306 | 24.80384 |

*Table 22.Stata output of the Arellano-Bond estimator*

```
. xtabond2 d.lnrft d.lngdp d.lninprod d.lnecom d.lninfra d.lnpop eur crisis eur
> crisis L.(lnrft  lngdp lninprod  lnecom lninfra  lnpop) _Iyear*, gmm(L.lnrft)
>  iv(L(0/1).(lngdp  lninprod  lnecom  lninfra  lnpop  eur  crisis  eurcrisis
> _Iy*)) nolevel twostep robust small
Favoring space over speed. To switch, type or click on mata: mata set matafavor
>  speed, perm.
_Iyear_2009 dropped due to collinearity
_Iyear_2011 dropped due to collinearity
_Iyear_2012 dropped due to collinearity
_Iyear_2013 dropped due to collinearity
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-ste
> p estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       132
Time variable : year                            Number of groups   =        27
Number of instruments = 49                      Obs per group: min =         1
F(20, 27)     =    182.68                                      avg =      4.89
Prob > F      =     0.000                                      max =         7
------------------------------------------------------------------------------
             |               Corrected
     D.lnrft |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lngdp |
         D1. |   1.692818   .7307913     2.32   0.028     .1933582    3.192278
             |
    lninprod |
         D1. |   .0604776   .7637348     0.08   0.937    -1.506577    1.627532
             |
      lnecom |
         D1. |   .0139556   .0387429     0.36   0.721    -.0655382    .0934495
             |
     lninfra |
         D1. |   .0313723   .0966006     0.32   0.748    -.1668357    .2295802
             |
       lnpop |
         D1. |  -4.903819   22.91478    -0.21   0.832    -51.92107    42.11343
             |
         eur |    .044257   .0840043     0.53   0.603    -.1281055    .2166195
      crisis |   .0186108   .0714672     0.26   0.797    -.1280278    .1652493
   eurcrisis |   .0204622   .0642879     0.32   0.753    -.1114457    .1523701
             |
       lnrft |
         L1. |  -.7230814   1.033068    -0.70   0.490    -2.842761    1.396598
             |
       lngdp |
         L1. |   2.961787   1.933602     1.53   0.137    -1.005636     6.92921
             |
    lninprod |
         L1. |  -1.027521   1.208783    -0.85   0.403    -3.507738    1.452697
             |
      lnecom |
         L1. |   .0217695    .045363     0.48   0.635    -.0713076    .1148466
             |
     lninfra |
         L1. |  -.0384552    .142103    -0.27   0.789    -.3300265     .253116
             |
       lnpop |
         L1. |  -1.504812   5.523836    -0.27   0.787    -12.83879    9.829163
```

| | | | | | | |
|---|---|---|---|---|---|---|
| _Iyear_2004 | .2142439 | .1134159 | 1.89 | 0.070 | -.0184663 | .4469541 |
| _Iyear_2005 | .1679183 | .1089942 | 1.54 | 0.135 | -.0557194 | .391556 |
| _Iyear_2006 | .0985273 | .1036728 | 0.95 | 0.350 | -.1141917 | .3112464 |
| _Iyear_2007 | .0778207 | .1273016 | 0.61 | 0.546 | -.1833806 | .339022 |
| _Iyear_2008 | .0254486 | .1178655 | 0.22 | 0.831 | -.2163915 | .2672887 |
| _Iyear_2010 | .0090503 | .0657357 | 0.14 | 0.892 | -.1258282 | .1439289 |

```
Instruments for first differences equation
  Standard
    D.(lngdp L.lngdp lninprod L.lninprod lnecom L.lnecom lninfra L.lninfra
    lnpop L.lnpop eur L.eur crisis L.crisis eurcrisis L.eurcrisis _Iyear_2004
    L._Iyear_2004 _Iyear_2005 L._Iyear_2005 _Iyear_2006 L._Iyear_2006
    _Iyear_2007 L._Iyear_2007 _Iyear_2008 L._Iyear_2008 _Iyear_2009
    L._Iyear_2009 _Iyear_2010 L._Iyear_2010 _Iyear_2011 L._Iyear_2011
    _Iyear_2012 L._Iyear_2012 _Iyear_2013 L._Iyear_2013)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/10).L.lnrft
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.50  Pr > z =  0.615
Arellano-Bond test for AR(2) in first differences: z =   0.51  Pr > z =  0.613
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(29)   =  49.63  Prob > chi2 =  0.010
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(29)   =   7.40  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(L.lnrft, lag(1 .))
    Hansen test excluding group:     chi2(1)    =   0.30  Prob > chi2 =  0.585
    Difference (null H = exogenous): chi2(28)   =   7.11  Prob > chi2 =  1.000
  iv(lngdp L.lngdp lninprod L.lninprod lnecom L.lnecom lninfra L.lninfra lnpop
> L.lnpop eur L.eur crisis L.crisis eurcrisis L.eurcrisis _Iyear_2004 L._Iyear_
> 2004 _Iyear_2005 L._Iyear_2005 _Iyear_2006 L._Iyear_2006 _Iyear_2007 L._Iyear
> _2007 _Iyear_2008 L._Iyear_2008 _Iyear_2009 L._Iyear_2009 _Iyear_2010 L._Iyea
> r_2010 _Iyear_2011 L._Iyear_2011 _Iyear_2012 L._Iyear_2012 _Iyear_2013 L._Iye
> ar_2013)
    Hansen test excluding group:     chi2(8)    =   6.37  Prob > chi2 =  0.606
    Difference (null H = exogenous): chi2(21)   =   1.03  Prob > chi2 =  1.000

. nlcom _b[L.lngdp]/-_b[L.lnrft]

       _nl_1:  _b[L.lngdp]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | 4.096063 | 4.570849 | 0.90 | 0.370 | -4.862636 | 13.05476 |

```
. nlcom _b[L.lninprod]/-_b[L.lnrft]

       _nl_1:  _b[L.lninprod]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -1.42103 | 1.699821 | -0.84 | 0.403 | -4.752618 | 1.910557 |

```
. nlcom _b[L.lnecom]/-_b[L.lnrft]

       _nl_1:  _b[L.lnecom]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | .0301066 | .0640519 | 0.47 | 0.638 | -.0954328 | .155646 |

```
. nlcom _b[L.lninfra]/-_b[L.lnrft]

       _nl_1:  _b[L.lninfra]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -.0531824 | .2630908 | -0.20 | 0.840 | -.5688309 | .462466 |

```
. nlcom _b[L.lnpop]/-_b[L.lnrft]

       _nl_1:  _b[L.lnpop]/-_b[L.lnrft]
```

| D.lnrft | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _nl_1 | -2.08111 | 4.857491 | -0.43 | 0.668 | -11.60162 | 7.439396 |