TALLINNA TEHNIKAÜLIKOOL
Majandusteaduskond
Rahandus ja majandusteooria instituut
Rahanduse ja panganduse õppetool

Madis Samel

THEORETICAL AND EMPIRICAL ASPECTS OF REGIONAL DEVELOPMENT

Bakalaureusetöö

Juhendaja: professor Karsten Staehr

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TABLE OF CONTENTS

ABSTRACT

The purpose of this paper is to study why different regions are on different levels of development and how is the speed of their progress influenced by the level of their initial development. To do so we first look into different economic theories that explain location decisions and trade patterns. After that we look into empirical surveys that cover these theories. Eventually we look into catch-up effect between different regions.

In order to so we measure convergence on both international and national scale. For international scale we use data on EU28 and for national scale we use data on Estonian counties over the last 20 years. After gathering the data we construct an ordinary least squares (OLS) model to estimate the convergence.

As we found out in our tests, our OLS model's estimations detected convergence on international scale with EU28 as an example. The results were similar to the ones often cited in economic literature. We also performed a test with only EU members that joined EU in 2004 or later and saw that poorer regions tend to progress relatively faster than more developed regions. These conclusions however do not apply to our tests on national scale. As we found out, on national scale there was no proof of convergence over the last 20 years with Estonia as an example. There was one exception, but this is not enough to draw further conclusions.

Keywords: regional development, β-convergence, σ-convergence, trade, location decisions, economic geography

INTRODUCTION

Today's world could be characterized with trends such as: globalization, increase of (international) investments, relocation of tasks and utilization of more advanced information and communication technologies. Fast technological progress has drastically decreased the communication and transportation costs and thus decreased the cost of doing business around the world. Incipience of those trends has led to a whole other level of developments such as vagueness of national and geographical identities and an added aspect of competition in face of a global dimension.

Parallel to all these trends we see, that some regions are more developed than others. This usually means that they have a higher standard of living, higher incomes, their labour has higher productivity and they produce and export more knowledge intensive goods.

Throughout economic history there have been economists who have tried to explain these differences. First of these theories are known as neo-capitalist theories. They assume that economic activities are steered by exogenous forces. They were developed as early as in 19th century and remained as the pillar of economic geography until the mid-twentieth century. At that time economists began to develop new ideas and approaches that would explain the economic geography. These theories would be known as new economic geography. Biggest difference amongst others was that it assumed endogenous factors as the main force in economic decisions.

What also interests economists is how regional development changes and what are the relations between growth and initial economic development. This effect is known as convergence or catch-up effect. There are two ways to look at it. σ-convergence that suggests the decrease in differences of incomes across economies and β-convergence that refers to a relation between economy's initial development and its growth tempo. In this paper we are going to focus on β-convergence in its unconditional form. Unconditional means that the growth of an economy slows, as it gets wealthier.

The goal of this paper is to test whether β-convergence is happening on both international and national scale. To do so we are measuring β-convergence, using data on European Union as an example of international scale and data on Estonian counties as an example of national scale. To do so we dissert on the following questions:

- is there proof of β-convergence on international scale with EU28 as an example in the last 20 years;
- is there proof of β-convergence on international scale with members that joined EU in 2004 or later as an example in the last 20 years;
- is there proof of β-convergence on national scale with 15 Estonian counties as an example in the last 20 years;
- has the β-convergence been on both international and national scale in the last 20 years consistent or erratic.

To solve these problems we construct ordinary least squares (OLS) models and test them in statistical package Gretl. As indicators we use purchasing power standard (PPS) while modelling international scale and gross domestic product (GDP) while modelling national scale. In our models we use data from the last 20 years, i.e. since 1995. The data is gathered from AMECO database and Statistikaamet's database.

This paper is divided into three chapters. In the first chapter we will be looking into the theories of economic location, trade and delocalization. We will cover the neo-capitalist theories with Ricardian and Heckscher-Ohlin models and new economic geography theories with Krugman's and Venables' models. In the second chapter we will look into the empirical literature regarding the theories in the first chapter. In the third chapter we will look into the principles of convergence and construct models to test whether we can prove the existence of β-convergence on international and national scale.

1. THEORIES OF ECONOMIC LOCATION, TRADE AND DELOCALIZATION

To understand the factors of regional development we have to look into theories of economic geography. Economic geography and location theories play a huge role when we try to understand the relations between different economic players, why the relations between participants change over the time, the choice of locations where the economic activity takes place in etc. Throughout the history there have been different theories that try to explain and give answers to all these questions.

As a result we have different approaches and interpretations of location theories and trade that we are going to look into in this chapter. More often than not they do not differ only in their assumptions but also in their conclusions. Since the theories have been developed over such a wide time-span, it is natural, that the models reflect the environment and times, they were developed in. These theories are usually divided into two groups: neo-classical theories and new economic geography. The purpose of this chapter is to familiarize us with these different concepts.

1.1. First nature theories

First nature theories, also known as neo-classical theories (NCT), were the first to analyze the location decisions and trade patterns of economic agents. First nature theories revolve around the understanding, that location decisions are steered by exogenous forces. Presence of natural resources being the biggest factor in these decisions (De Bruyne 2006, 76). Other characteristics of NCT models are that they presume perfect competition, constant returns to scale and homogeneous products. According to NCT models, different economic sectors choose a location that matches their comparative advantage, causing inter-industry specialization (Brühlhart 1998, 777). Neo-classical theories suggest, that poorer regions should have a higher marginal product and return to capital. It would mean that trade should lead to bigger capital accumulation in poorer regions and there should be a negative relation between initial GDP and growth rate (Martin 1998). This is theory is also known as β-convergence.

The two most famous neo-classical theories were written by Ricardo (1817) and Hecksecher-Ohlin (1933).

1.1.1. Ricardian model

Ricardian model, first published by David Ricardo in 1817, was based on the theory of comparative advantage. Krugman (2012, 26) has said the following about comparative advantage: “A country has a comparative advantage in producing a good if the opportunity cost of producing that good in terms of other goods is lower in that country than it is in other countries.” The approach of Ricardian model is that international trade and the gains from it are based on the differences in labour productivity in different countries.

Ricardian model is built on the assumptions that there are two countries (Home and Foreign) that trade two goods (cheese and wine). Both countries have one factor of production (labour), which productivity and supply is fixed but what is mobile across sectors. This model also assumes perfect competition and states that trade is based on technological differences that come from differences in labour productivity (Krugman 2012, 26).

Lets illustrate this model by looking at table 1. This table illustrates us a situation where two countries – Home and Foreign - are producing two goods - cheese and wine:

Country	Cheese	Wine
Home	$a_{LC} = 1$	$a_{LW} = 2$
Foreign	$a^*_{LC} = 8$	$a^*_{LW} = 4$

Table 1. Unit labour requirements in Home and Foreign for cheese and wine production

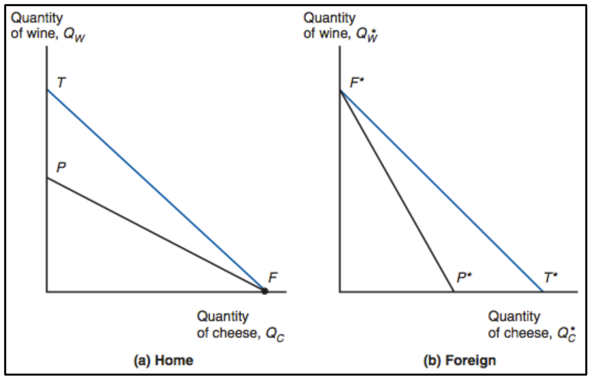
This table illustrates us the labour productivity each country has in each sector. In this table the productivity is expressed by unit labour requirement, i.e., how many man-hours are needed to produce a unit of cheese or wine. Since unit labour requirement is an inverse of productivity, the lower the number in the table, the higher the productivity (Krugman 2012, 26).

From table 1 we can see, that labour requirement in Home for a unit of cheese is a_{LC}=1 and for wine is a_{LW}=2. In Foreign the respective requirements for cheese and wine are a^*_{LC}=8 and a^*_{LW}=4. The symbol "*" is used to indicate the Foreign country. First thing we notice is that Home country has higher productivity in both sectors. This means Home has an absolute advantage. However, as we later see, absolute advantage plays no role in Ricardian model (Krugman 2012, 29).

To get better idea about the productivity in each country we have to compare it by sectors, i.e., look at the ratios of required labour to produce a unit of each product. With the help from the concept of opportunity cost we can evaluate these ratios. In our case we can see that a_{LC}/a_{LW} is smaller (1/2=0,5) than a^*_{LC}/a^*_{LW} (8/4=2) and that a_{LW}/a_{LC} is bigger (2/1=2) than a^*_{LW}/a^*_{LC} (4/8=0,5). This means Home country has lower opportunity cost and thus comparative advantage in cheese production and Foreign country in wine production (Krugman 2012, 29).

Now if these two countries enter free market and start to trade with each other, we see the following trends. Since Home country has comparative advantage in cheese production it is more focused on exporting cheese and Foreign has comparative advantage in wine production and it focuses on wine sector. The demand for Home's cheese rises while the demand for Home's wine falls. As a result the relative price of Home's cheese rises and relative price of Home's wine falls. In the mean time the exact opposite happens in Foreign, where the demand and price for cheese falls and wine rises. At the end, new international relative prices are achieved and both countries specialize on one product (Krugman 2012, 33).

As a result of international trade and complete specialization both countries and their consumers and workers have gained. Home workers earn higher wages due to cheese sector and Foreign workers earn more due to wine sector. Budget constraints have also shifted upwards and consumption is now on a higher indifference curve than before benefitting consumers in both countries (Krugman 2012, 33).



Graph 1. Indifference curves in Home (a) and Foreign (b) before and after trade
Source: (Krugman 2012, 34)

It is illustrated with the Graph 1. In these two graphs the x-axis shows us the quantity of cheese and y-axis the quantity of wine. The quantities are used for both production and consumption. In autarky Home and Foreign could consume what they produce. Meaning that their production frontier and indifference curve were the same, i.e. the curves PF in Home and F*P* in Foreign. As before, the symbol ”*” indicates again the Foreign country. With specialization and trade we can however see that the indifference curve is now higher. This means that consumers can consume anywhere on the lines TF and F*T*, even though these indifference curves lie outside countries production frontiers (Krugman 2012, 35).

This model shows that absolute advantage is not necessary to gain from trade and the difference that matters is comparative advantage. Since trade lifted the indifference curves for both countries you can also say that trade can be interpreted as an indirect method of production (Krugman 2012, 34).

1.1.2. Heckscher-Ohlin model

Heckscher-Ohlin (H-O) model was published in 1933 by Bertil Ohlin who credited Eli Heckscher as a co-author. Even though it represents NCT like Ricardian model and is largely based on it, it still has some adjustments, which make it different.

H-O model is built on the assumptions that, once again, there are two countries (Home and Foreign) that trade two goods (cloth and food). What is different from the Ricardian model, is that there are two factors of production (labour and capital) whose supply is constant and who both are mobile across sectors. It also assumes that both countries have same technologies and consumer preferences and that trade is based on the differences in their relative factor endowments (Krugman 2012, 81)

In Ricardian model each participant in international trade gained from it and that lead to a complete specialization. H-O model tries to explain why in the real world the specialization is not complete and how trade affects wealth distribution and why some economic agents are against free trade. Unlike Ricardian model, H-O model also tries to explain, why countries with similar technologies trade with each other.

While Ricardian model only had one factor of production, H-O model includes factors of production like land, capital and mineral resources and gathers them under the term capital.

Lets illustrate this theory with the tables 2 and 3:

Country	Capital (K)	Labour (L)	K/L
Home	50	150	1/3
Foreign	10	5	2

Table 2. Resources Home and Foreign have available

Table 2 shows us the availability of resources each country has in its use and also their ratio. We can see, that Home has more capital and labour, but if we look into the capital-land ratio, we see that Home is labour abundant and Foreign is capital abundant. In autarky conditions it would mean, that in Home the labour is relatively cheap while capital is relatively expensive. The opposite applies to Foreign, where in autarky conditions, the capital would be relatively cheap and labour relatively expensive (Krugman 2012, 91).

Table 3 illustrates us the factors usage for two goods that are produced in both countries:

Product	Capital (K)	Labour (L)	K/L
Cloth	a_{KC}=2	a_{LC}=2	1
Food	a_{KF}=3	a_{LF}=1	3

Table 3. Inputs in cloth and labour production

We can see, that the production of cloth is more labour intensive while the production of food is more capital intensive.

According to H-O theory if these countries are entering a free-market, each of them tries to gain from international trade. This means that Home, that is labour abundant, would specialize on the product, that is labour intensive, while Foreign, that is capital abundant, would focus on the product, that is capital intensive. As a result, Home will be producing and exporting more cloth while Foreign will produce and export more food (Krugman 2012, 85).

H-O model has given a platform to many economists, who have developed the H-O theory further with their own theorems. Most important being Stolper-Samuelson theorem. Stolper-Samuelson theorem suggests that if the price of a product rises, it makes the price of a factor, that is used intensely in that product also rise, while the price of the other factor falls. So if the price of a capital-intensive good raises then the price of capital will also rise and the price of labour will decline. Similarly the opposite scenario applies. This means, that international trade benefits owners of a country's abundant factor. If a country is labour abundant, then trade will raise the wages and if a country is capital abundant, then trade will raise the rents. This theorem illustrates how international trade affects incomes, why the complete specialization of countries, suggested by Ricardian model, has not manifested and why some agents are against international trade (Krugman 2012, 88).

1.2. Second nature theories

Second nature theories, also known as New Economic Geography (NEG) theories, center around the core-periphery theory. Unlike NCT theories, NEG theories suggest that location decisions are steered endogenously. NEG models show us why economic activity can be clustered into a region (agglomeration), which has no natural advantages. While NCT models explained why inter-industry trade between countries with different endowments is happening, then NEG models explain why intra-industry trade between similar countries can happen. Another difference between NCT and NEG models is, that while NCT assumes constant returns to scale, than NEG deals with increasing returns to scale. They also assume the importance of transportation costs (Redding 2010, 1).

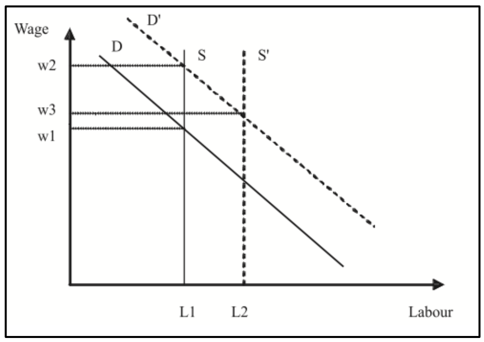
Two of the most known variations of NEG models are written by Krugman (1991) and Venables (1996).

1.2.1. Krugman model

Krugman model (1991), sometimes referred to as core-periphery model, is based on a theory that the linkage between firms and consumers is the most important factor for location of firms (De Bruyne 2006). It can be illustrated with a simple circle, where workers (also consumers) want to be near firms, because they create jobs. In the mean time firms want to locate near the consumers to increase demand.

Krugman model assumes that there are two countries that are identical in terms of technology and preferences. These countries are producing two goods (agricultural and manufacturing) and use one factor of production (labour). Labour is however divided into two categories - workers, who are mobile across regions and farmers, who cannot migrate. They also assume increasing returns to scale, imperfect competition, differentiated products and transport costs (De Bruyne 2006, 76).

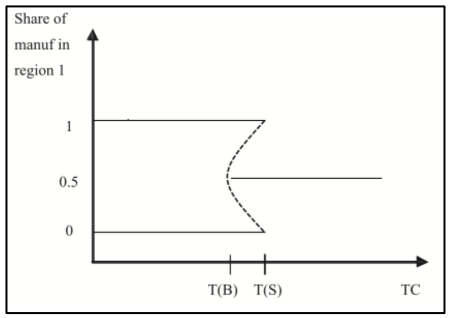
Lets illustrate this model with an example. Lets assume that a manufacturer relocates into a region X. As a result of that, the demand for labour increases and thus wages will rise, which causes demand linkage. This means that now worker from other regions move to region X. This increases the demand for manufacturers in region X, so manufacturers from other regions are now inclined to move into region X, that in turn causes supply linkage, and so the cycle begins again (Forslid 2011). If this process keeps repeating itself, it causes concentration of economic activity - agglomeration. Since only the workers are mobile and can migrate, this creates a situation where manufacturers are concentrated in one region, but agriculture is spread evenly. We use graph 2 to illustrate this theory a bit further:



Graph 2. Effects of agglomeration on wages and labour supply
Source: (De Bruyne 2006, 80)

In Graph 2 the x-axis shows us the amount of labour and y-axis the wage. In graph 2 we have a situation, where the labour-market equilibrium lies in the intersection of curve D that is the demand for labour and curve S that is the supply of labour. As a result we get the equilibrium wage at the point w1 and the amount of workers at the point L1. If new manufacturers move into the region, the demand for labour shifts upwards. This is illustrated with the demand-curve D'. As a result, the wages rise now from w1 to w2. Due to the increased demand for labour and higher wages new workers also move into the area. This however increases the supply of labour moving the curve rightwards. This is illustrated with the supply-curve S'. As we can see, the new equilibrium lays in the intersection of curves D' and S'. At the new equilibrium the employment is at point L2 and wages at point w3, i.e. both higher than before (De Bruyne 2006, 80).

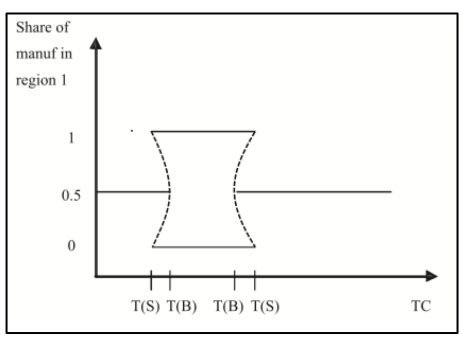
Krugman model also describes the effects of transportation costs on agglomeration. He came up with the following explanation that is illustrated with graph 3. On the x-axis we have transportation costs and on the y-axis we have the share of manufacturers in region 1. If transportation costs (TC) are high, then manufacturing activity is equally divided between two locations. However if transportation costs fall (T(B)), then this symmetry breaks and total agglomeration is the only stable equilibrium. The space between T(B) and T(S), illustrated with the dotted line, shows us the situation where agglomeration might be stable but not yet possible (De Bruyne 2006, 85).



Graph 3. Effects of transport costs on agglomeration
Source: (De Bruyne 2006, 85)

Krugman also tweaked the previous model and added an extra dispersion force in the form of transportation costs of agricultural goods, to show that symmetry can also be a stable equilibrium.

This is illustrated with graph 4:



Graph 4. Effects on agricultural transport costs on agglomeration
Source: (De Bruyne 2006, 86)

This graph follows the same logic as the previous one, i.e. on the x-axis we have transportation costs and on the y-axis we have the share of manufacturers in region 1. As we can see from the graph, in this instance, agglomeration increases as transportation costs decrease but will decline again as transportation costs decrease even further. De Bruyne (2006, 85) has said the following: ”If economic activity were to be fully agglomerated, one now has to take into account the fact that agricultural goods will become more expensive. This may indeed render the agglomerative outcome unsustainable because people might prefer to locate again in the periphery where agricultural goods are cheaper.”

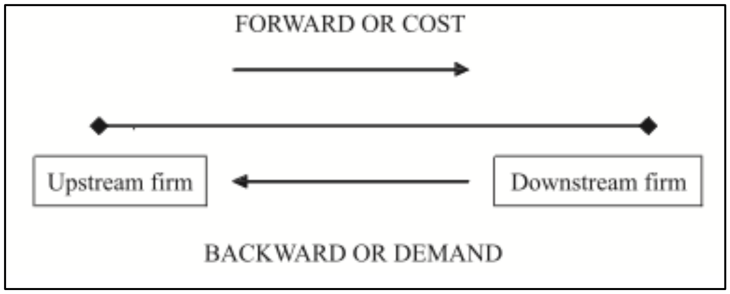
The result of decreasing transportation costs could be that industries with increasing returns to scale would concentrate in core while industries with constant return, like agriculture and low technology industries, would stay in periphery (Martin 1998).

Since this model assumes free movement of labour it has been suggested, that it suits better to analyze interregional economies, like US, rather than international economies, like Europe (Forslid 2011).

1.2.2. Venables model

Krugman model gets sometimes criticized due to its full labour mobility, which is not a realistic assumption. Venables model (1996) suggests that not only labour mobility, i.e. firm-consumer linkage, but also firm-firm linkage can cause agglomeration. This model is sometimes also referred to as vertical model because it suggests, that agglomeration comes from firms relying on other firms to get intermediate inputs (De Bruyne 2006, 86).

For example if region X has a large manufacturing sector, it has a bigger selection of intermediate goods that will push the costs for the final product lower. This is referred to as forward linkage, cost linkage or supply linkage. In the same time a big final goods sector in manufacturing also causes a big demand for intermediates. This is called backward linkage or demand linkage (De Bruyne 2006, 87).



Graph 5. Illustration of forward and backward linkage
Source: (De Bruyne 2006, 87)

Graph 5 illustrates the relations of upstream and downstream firms. Upstream firms are the ones that are providing downstream firms with intermediate inputs. If upstream firms follow downstream firms, it is called demand linkage. If downstream firms locate near upstream firms to get more variety or cut costs, it is called supply cost linkage.

The transportation costs affect this model similarly to the Krugman model. If transportation costs are high then the economic activity is dispersed. If the transportation costs begin to decrease, then full agglomeration is the stable equilibrium.

Since this model has fixed labour movement, it is often considered better suited in international context (Forslid 2011).

1.3. Conclusion

Like we saw in this chapter, there are many theories and approaches regarding economic relations that also reflect on regional development. These theories can loosely be divided into two categories: neo-classical theories and new economic geography. First of them rely in their approach on natural differences of regions and comparative advantage. These can manifest in abundance of natural resources or labour. On the other hand new economic geography suggests, that these relations are steered endogenously, i.e. firm-consumer or firm-firm linkage. Another difference between these two approaches is that first assume constant return to scale while the other increasing return to scale. Since there are many different approaches with different assumptions and conclusions, we are going to look, in chapter 2, at the empirical literature regarding these theories, to see whether and how well they can be applied in the real world.

2. EMPIRICAL SURVEYS ON TRADE THEORIES

In chapter 1, we saw that there are many theories that explain location decisions and trade. These theories varied with their assumptions and approaches. While theories are important for us to understand the concepts, it is also important to put these theories to test, to see whether they can be, and in witch conditions, applied in the real world. The purpose of this chapter is to familiarize us with the empirical literature regarding these theories.

2.1. Empirical surveys on Ricardian model

Ricardian and H-O model are often regarded as the “workhorse“ models of international trade and specialization (Theis 2010, Morrow 2010). The empirical tests on these models tend to however give different conclusions.

The earliest tests of Ricardian model come from post –World War II. McDougall (1951) did the first study on Ricardian model, when he compared the British and US productivity and trade patterns. His results supported the claims of Ricardian model. Even though US was more effective in all sectors, the British still exported some goods to US. Another study with similar results was made a couple of years later by Balassa (1963). He also used the productivity and trade data of US and the British and found that US was more productive in all of the 26 sectors. However in 12 of these sectors Britain had a bigger part of exports than USA.

However with the growth of international trade and the resulting specialization, it is more difficult to support the Ricardian model with the evidence from 21st century (Krugman 2012).

As Krugman (2012, 45) points out the Ricardian model is a very useful tool to help us understand the reasons and consequences of world trade. There are however also some issues that can lead to wrong conclusions. First, the Ricardian model predicts complete specialization as a result of trade that does not manifest in real world. Second, the Ricardian model does not reflect on the effects of trade on wages within countries, rather predicts that countries as a whole will benefit. In real world however, trade has great effect on income distribution. Third, it does not consider endowment of resources, a country has, as a source for trade. And last, it does not consider economies of scale as a possible factor for trade. As a result Ricardian model can often lead to wrong conclusions or misleading predictions, which does not mean, it is not a valuable mechanism to study trade.

2.2. Empirical surveys on Heckscher-Ohlin model

Theis (2010, 135) has concluded the following regarding H-O model: ”However, both anecdotal evidence and empirical tests tend to reject it. Negative empirical results have been obtained as early as in the fifties of the last century (Leontief, 1953), they have been reaffirmed more recently by Maskus (1985), Bowen, Leamer, and Sveikauskas (1987), and Trefler (1995).”

Leontief (1953) was the first to test H-O model with real data. His test focused on US, which at the time was, the most capital abundant country in the world. He used the input-output data from the year 1947 and aggregated all industries into 50 sectors. He also divided all factors of productions into two categories – labour and capital. According to the H-O model US should have imported labour-intensive goods while exporting capital-intensive goods. Contrary to H-O model, US imports were actually 30% more capital-intensive than exports.

Since then this model has been studied many times, often with similar results. First again by Leontief himself (1956), who again used trade data of US. This time he aggregated all industries into 192 sectors and concluded that US imports were more capita-intensive than exports by 6%. Baldwin (1971) tested H-O model using again US trade data and concluded, that US imports were 27% more capital-intensive than exports. Tatemoto and Ichimura (1959) tested H-O model using the Japanese trade data. Japan was at that time a labour-abundant country and should have thus imported more capital-intensive goods and exported more labour-intensive goods. Again the results were contrary to the H-O theory – Japan actually exported more capital-intensive goods and imported more labour-intensive goods.

Bowen, Leamer and Sveikauskas (1987) did a study that focused on 27 countries and 12 factors of production. According to their theory, countries should export factors that have bigger income share and import factors that have smaller income share. The result however showed that with about 2/3 of factors, the flow of factors was right less than 70% of the time.

There are however also cases where H-O model was proved to work. For example Stolper and Roskamp (1961) tested H-O model on the trade data of East Germany. They concluded that 75% of their trade was with Soviet Union compared to which they were relatively capital-abundant. According to their results, East Germany exported capital-intensive goods, which confirmed H-O model.

H-O models tend to give more accurate results, if it studies the trade between developed and developing regions, i.e. regions that are skill-abundant but labour-scarce with regions skill-scarce but labour-abundant (Krugman 2012, 98). For example Romalis (2004) did a study, where he compared the import patterns of US with Bangladesh and Germany. Bangladesh being the developing country with low-skill labour and Germany the developed country with high-skill labour. What he concluded was that Bangladesh had a relatively bigger part of US imports in low-skill-intensive goods like clothing. Germany however had a relatively bigger part of US imports in high-skill-intensive goods.

2.3. Empirical surveys New Trade Theory

As we read in the first chapter, NCTs assumed that trade takes place between countries that are different and exist in the inter-industry form. However many economists in the second part of 20th century noticed that neither of these assumptions are always true in practice.

Grubel and Lloyd (1975) did a study where they examined intra-industry trade and Linder (1961) did an empirical study where he analyzed the trade between similar countries. Both these studies refuted the notions of NCT models. These were the empirical evidences and influences that lead to a new approach towards international trade, which we know as New Trade Theory or New Economic Geography (Redding 2008).

Krugman (1979, 1980) explained that the reasons behind international trade lays behind increasing returns to scale and consumers love of variety. This causes a situation where production concentrates in a single location (agglomeration) and consumers consume all different varieties of products resulting in intra-industry trade. His conclusions imply that economies often specialize due to increasing returns to scale and not due to endowments of natural resources, like NCTs suggested. Davies (1997) also shared similar conclusion about intra-industry trade between similar regions.

Davis and Weinstein (1999, 2003) had studies, where they used Japanese regional data and found evidence that there was home market effect within many manufacturing industries. Home market effect describes a situation where economic integration causes deindustrialization in smaller economies. This happens when producers of differentiated products with increasing returns to scale move closer to the bigger economies to cut on transportation costs. As a result smaller economies get more specialized and focus more on homogeneous products like agricultural goods (Goh 2010). Evidence of home market effect on international scale has been found by Hanson and Xiang (2004).

There are also a variety of studies that focus on wages and market access. Since according to NEG theories firms prefer to be close to larger markets due to lower transportation costs and increasing returns to scale they are also willing to pay higher wages. This creates a situation where high wages correlate with market access. Mayer (2008) found evidence of correlation between market access and per capita income with both cross section data and time series. Hanson (2004) focused in his study on US and found also that there was a correlation between income and market access. Breinlich's (2006) study also supported these conclusions, when he researched the data on regions of EU.

3. REGIONAL DEVELOPMENT AND CONVERGENCE

In the previous chapters we saw that there are many economic theories that try to explain location decisions and reasons and effects of trade. There is also a lot of empirical literature that focuses on these theories that either approves or disapproves them. These previous chapters gave us important foundations to understand why different regions are on a different level of development.

What interests us however, is how regions with different levels of development progress differently. To study this we look into the effect known as convergence or catch-up effect. Convergence gives us good tools to analyze regional development.

Scientific literature presents us usually with two ways of measuring convergence. σ-convergence, which is referred to as "traditional approach" and β-convergence, which is referred to as "new-classical approach" (Marques 1998, 2). σ-convergence refers to dispersion of incomes between economies while β-convergence refers to a situation, where regions with lower income per capita grow faster than regions with higher income per capita (Soukiazis 2000, 2).

There are two ways to measure β-convergence. First is known as conditional or absolute β-convergence and other as unconditional β-convergence. Unconditional β-convergence assumes that the lower the initial income per capita, the higher the average growth rate. However in some conditions it does not explain why some regions have had any growth over a long period. Cconditional β-convergence on the other hand assumes that it is the structural characteristics (technological progress, qualification of human capital etc.) that affect convergence and that regions have different long run levels towards the convergence takes place (Soukiazis 2000).

In scientific literature most of the studies refer to an average annual β-convergence over a longer period at the rate of 2% per year (Marques 1998, 5). The studies that focus solely on β-convergence on national scale have however more divided results and there is no consensus on whether β-convergence is taking place also within countries (Soukiazis 2010, 9).

The purpose of this chapter is to measure β-convergence in unconditional form on both international and national scale.

3.1. Method

To calculate β-convergence we follow the equation used by Soukiazis (2000). To do so we are using an ordinary least squares (OLS) model and the following equation:

$$\mathbf{(1/T)\log(Y_{it}/Y_{i0}) = \alpha + \beta \log Y_{i0} + u_{it}} \quad (1)$$

where

- Y - income per capita
- i - the individual region
- 0 - the base year
- t - the final year
- T - the length of total time period in which the growth is measured
- α - constant term that shows autonomous growth
- β - the coefficient of convergence
- u_{it} - stochastic error

The catch-up effect, or β-convergence, is indicated if the coefficient of β has a negative sign.

3.2. Data

Since we are measuring β-convergence on both international and national scale, we also have to use international and national data.

To measure β-convergence on international scale, we are using purchasing power standard (PPS) as an indicator. We are using PPS rather than GDP, because it allows us to take account of price differences in different countries. We are using data from 1995 to 2015 where annual average of EU15=100. To see whether the coefficient is consistent throughout the whole period, we split it into smaller, five-year periods and measure the annual coefficient for these periods separately. We use logarithms of all the values. The data we use to measure β-convergence in EU28 originates from AMECO database and is presented in appendix 1.

Since according to the theory poorer countries should grow faster in terms of their per capita income (Marques 1998, 2) we are measuring β-convergence separately for countries that joined EU in 2004 or later (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania and Croatia). Once again we measure the coefficient for the whole period as well for smaller five-year periods. This gives us a great opportunity to compare the results with the whole EU28. Once again we use logarithms of the values we used. The data we use to measure β-convergence for newer EU members originates from AMECO database and is presented in appendix 2.

To measure β-convergence on national scale, we are using Estonia and its counties as an example. We are using data from 1995 to 2014 and since we assume that there are no substantial price differences within Estonia, we are using GDP per capita as a percentage of Estonian average as an indicator. Once again we are using five-year periods (and one four year period) to see, whether the growth has been consistent. Like with two previous tests we use logarithms. The data we use to measure β-convergence on national scale originates from Statistikaamet's database and is presented in appendix 3.

3.3. Results

3.3.1. Results for EU28

First we measure β-convergence on international scale and use PPS data of EU28 from 1995 to 2015 as an indicator. To do so we construct OLS models and test them to see whether our models detect β-convergence. We perform our tests in five steps. First we measure the catch-up effect between the whole period, from 1995 to 2015. To see whether the convergence has been consistent throughout the period, we perform four separate tests with five-year periods: from 1995 to 2000, from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015.

After constructing all five models with statistical package Gretl, we got the following results, presented in table 4:

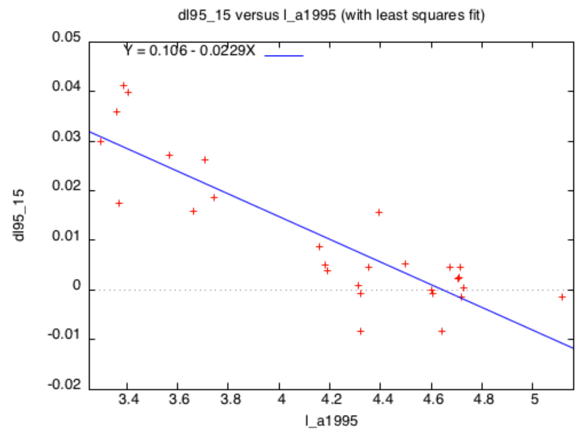
Period	β-coefficient	Std. error	R^2
1995 to 2015	-0,0229 ***	0,0026	0,7515
1995 to 2000	0,0015	0,0068	0,0018
2000 to 2005	-0,0404 ***	0,0047	0,7386
2005 to 2010	-0,0365 ***	0,0065	0,5487
2010 to 2015	-0,0304 ***	0,0086	0,3265

* indicates statistical significance at 10% level; ** indicates statistical significance at 5% level; *** indicates statistical significance at 1% level

Table 4. Results for an OLS model, measuring annual β-convergence in 1995-2015, 1995-2000, 2000-2005, 2005-2010 and 2010-2015 in EU28
Source: Author's calculations with statistical package Gretl

As we can see from table 4, the model that includes the whole period from 1995 to 2015 suggests annual β-convergence at the rate of 2,3%. We also see, that the standard error is low (0,0026), which results in the model's statistical significance at 1% level. This model's coefficient of determination is equal to R^2=0,75, which suggests that the goodness of the fit of the model is quite high and no important factors have been left out.

If we construct a scatter plot, where on the x-axis we have the values of base year and on the y-axis the change between base year and final year, we get the following graph:



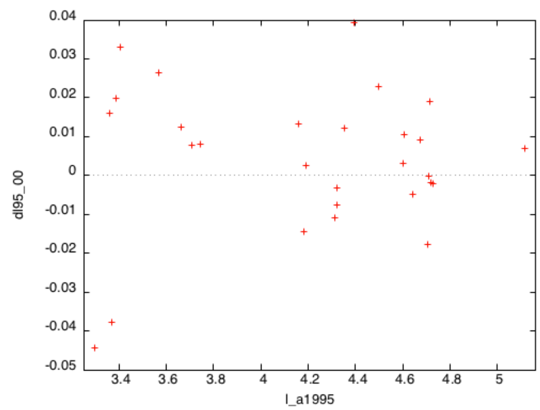
Graph 6. Correlation between initial income per capita and growth of income from 1995 to 2015 in EU28, measured in PPS per capita with EU15=100

Source: Author's calculations with statistical package Gretl

As we can see, graph 6 illustrates us what the OLS estimated. We see, that there is a trend that suggests correlation between initial income per capita and growth of income. We also see, that this trend is negative, which means that poorer regions are growing faster. We notice that countries that had initially the lowest income per capita measured in PPS have had the fastest growth of income per capita between 1995 and 2015. The crosses on the top-left corner of the graph represent the countries that joined EU after 2004. At the same time crosses on the bottom-right corner are mostly countries that were members of EU before 2004.

If we look at the shorter periods, we see that the period between 1995-2000 is statistically not significant and thus the model does not detect β-convergence between those years. We also see, that the coefficient of determination is extremely low (R^2=0,0018), which indicates that some important factors are for sure missing.

To illustrate this model better we constructed a following scatter plot:



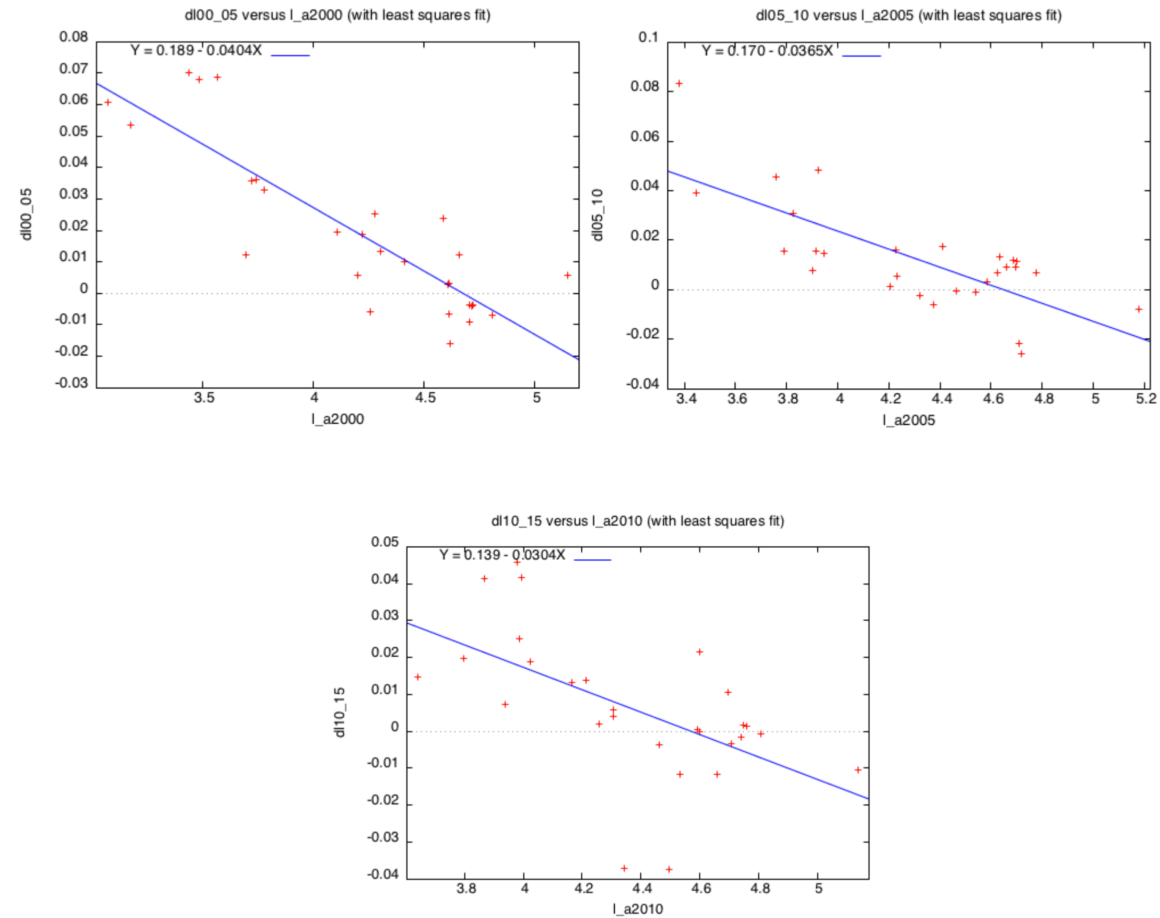
Graph 7. Correlation between initial income per capita and growth of income from 1995 to 2000 in EU28, measured in PPS per capita with EU15=100

Source: Author's calculations with statistical package Gretl

Looking at this graph 7 we can see, that there is no apparent relationship between initial per capita income in PPS and growth of PPS between 1995 and 2000 and thus there is no clear trend.

All the other models that represent the periods from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015 are however detecting β-convergence. We see, that their coefficients are negative and they have quite low standard errors, which result in statistical significance at 1% level. The table shows us that with each five-year period the rate of β-convergence is slowing down. In 2000-2005 it was about 4% per year, in 2005-2010 it was about 3,65% per year and in 2010-2015 it was about 3% per year. What is interesting is that with each period also the coefficient of determination has decreased. From 0,74 in 2000-2005, to 0,55 in 2005-2010 and eventually to 0,33 in 2010-2015. This indicates us that as years have gone by there have come other factors that influence the goodness of fit of the models.

After constructing scatter plots to illustrate the trends between the initial incomes per capita and growth for each period, we get the following graphs:



Graphs 7, 8 and 9. Correlation between initial income per capita and growth of income from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015 in EU28, measured in PPS per capita with EU15=100

Source: Author's calculations with statistical package Gretl

The graphs 7, 8 and 9 illustrate us what we saw from OLS estimations. Between 2000 and 2005 was the correlation between initial income per capita and growth of income the highest. After that period the correlation got weaker which is represented with a gentler slope. We also see that after the period from 2000 to 2005, the results became more spread out with more outliers, which also explains the lower coefficient of determination in the following periods.

3.3.2. Results for newer EU members

According to the theory β-convergence should be bigger for the countries whose initial income per capita was relatively smaller. To see, whether this assumption is true, we make a separate OLS model with countries that joined EU in year 2004 or later. This means that we only included countries like: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania and Croatia. Like in the previous section, we first perform a test for the whole period from 1995 to 2015. After that we perform four separate tests to see, whether the convergence is consistent or not.

After constructing the OLS models we got the results, presented to us in table 5:

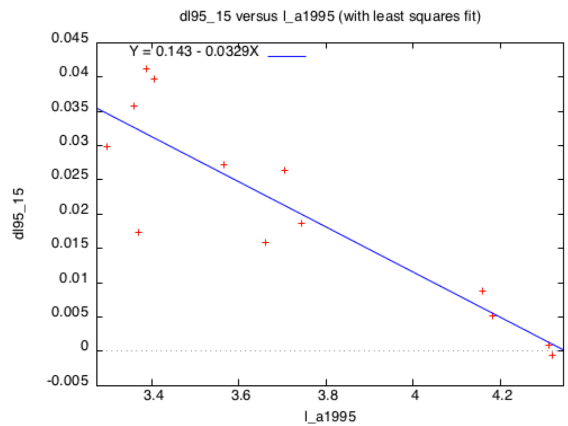
Period	β-coefficient	Std. error	R^2
1995 to 2015	-0,0329 ***	0,0051	0,7926
1995 to 2000	-0,0043	0,0183	0,0049
2000 to 2005	-0,0486 ***	0,0115	0,6216
2005 to 2010	-0,0567 ***	0,0153	0,5561
2010 to 2015	-0,0586 **	0,0212	0,4108

* indicates statistical significance at 10% level; ** indicates statistical significance at 5% level; *** indicates statistical significance at 1% level

Table 5. Results for an OLS model, measuring annual β-convergence in 1995-2015, 1995-2000, 2000-2005, 2005-2010 and 2010-2015 in countries that joined EU in 2004 or later
Source: Author's calculations with statistical package Gretl

If we look at table 5 we see that the model that included the whole period from 1995 to 2015 detects β-convergence at an annual rate of 3,3%. The standard error in that model is low, which reflects in the statistical significance at 1% level. The coefficient of determination is equal to R^2=0,79, which suggests a high goodness of fit of the model and that major factors have not been left out. We instantly see, that there is a significant difference in this OLS estimation compared to the model that included the whole EU28. For the whole EU the rate of annual convergence was around 2,3%. If we include only countries that joined EU in 2004 or later, the rate of β-convergence is 3,3% per year. This supports the theory, that poorer regions should see a faster growth.

If we present the results in the form of scatter plot, we get the following graph:

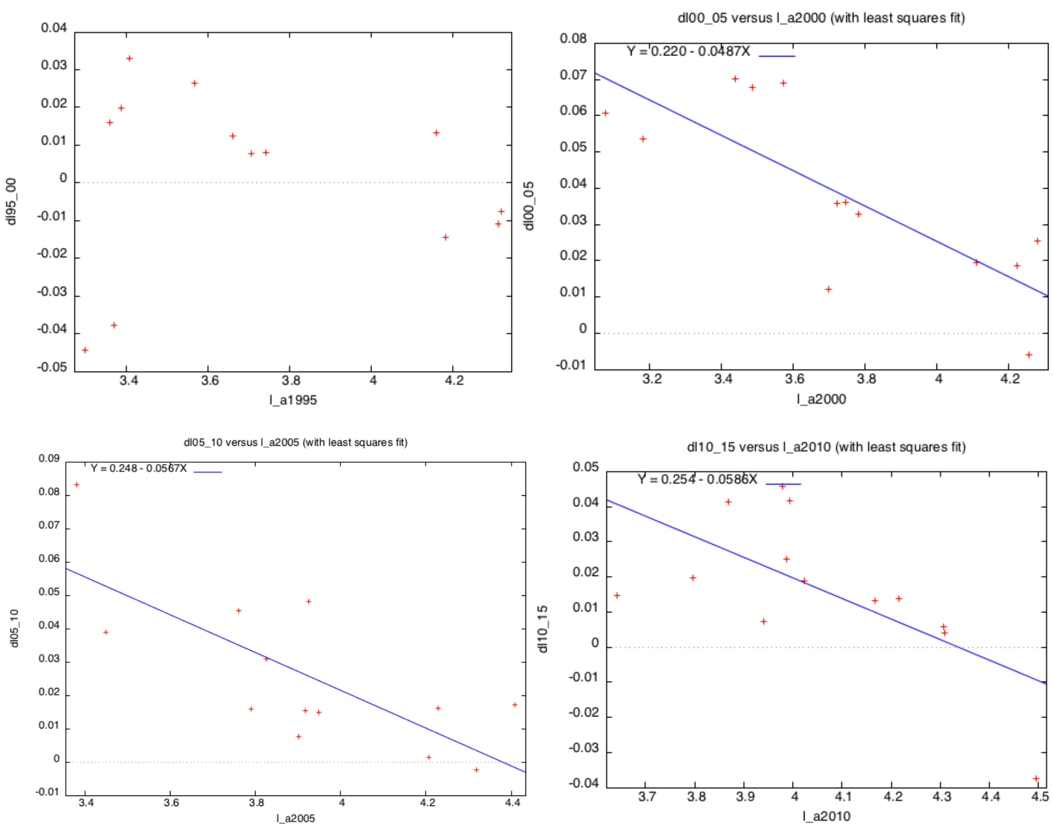


Graph 10. Correlation between initial income per capita and growth of income from 1995 to 2015 in countries that joined EU in 2004 or later, measured in PPS per capita with EU15=100
Source: Author's calculations with statistical package Gretl

We see from graph 10 that there is a correlation between initial incomes per capita and growth of income measured in PPS over the last 20 years for countries that joined EU in 2004 and later. We also notice, that all the countries we included in this model, with the exception of one, have shown a positive growth of income per capita. This is also the country that had initially the biggest income per capita.

As we look at the shorter periods we see that similarly to the last section, the model that includes the period between 1995 and 2000 is not statistically significant and shows a low coefficient of determination R^2=0,0049. The other models that covered the periods from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015 all detected β-convergence. We notice that for newer EU members the rate of convergence has been bigger in all three statistically significant periods. What is however interesting, is that compared to the test with EU28, the rate of convergence has constantly grown over the last 15 years. From 0,048 between 2000-2005, to 0,057 between 2005-2010 and eventually to 0,059 between 2010-2015. Similarly to the test with EU28, the coefficient of determination has decreased (however not as fast), which suggests that in resent years there have also been other factors that influence the goodness of the fit of the model.

To illustrate the findings of OLS models better we present he following scatter plots:



Graphs 11, 12, 13 and 14. Correlation between initial income per capita and growth of income from 1995 to 2000, from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015 in countries that joined EU in 2004 or later, measured in PPS per capita with EU15=100

Source: Author's calculations with statistical package Gretl

We see that from 1995 to 2000 there is no correlation between initial income per capita and growth of income. The other three five-year periods all show a trend between these two variables. Even though there is a correlation between these variables, we also see that it is not always the poorest countries that have shown the biggest growth of income. For example between 2000-2005 and 2010-2015 it was the countries with incomes somewhere in the middle that showed the fastest growth of income. This would support the suggestions of conditional β-convergence in these periods. According to Soukiazis (2010) convergence can be conditional on factors such as technology levels and human capital. These factors might create an obstacle for the poorest regions and hinder their development, while slightly more developed regions might not have these obstacles and have higher rates of convergence.

3.3.3. Results for Estonian counties

As we learned from the previous chapter, β-convergence is on the international scale often proved. What is however interesting is that within countries, on national scale, the results often do not show the same trend. To test these assertions, we construct an OLS model, where we include GDP data from 15 Estonian counties from 1995 to 2014. This means we include the data of Harju county, Hiiu county, Ida-Viru county, Jõgeva county, Järva county, Lääne county, Lääne-Viru county, Põlva county, Pärnu county, Rapla county, Saare county, Tartu county, Valga county, Viljandi county and Võru county. Once again we measure β-convergence first for the whole period between 1995-2014 and then separately for five-year (and one four-year) periods.

After constructing the OLS models we get the results, presented in table 6:

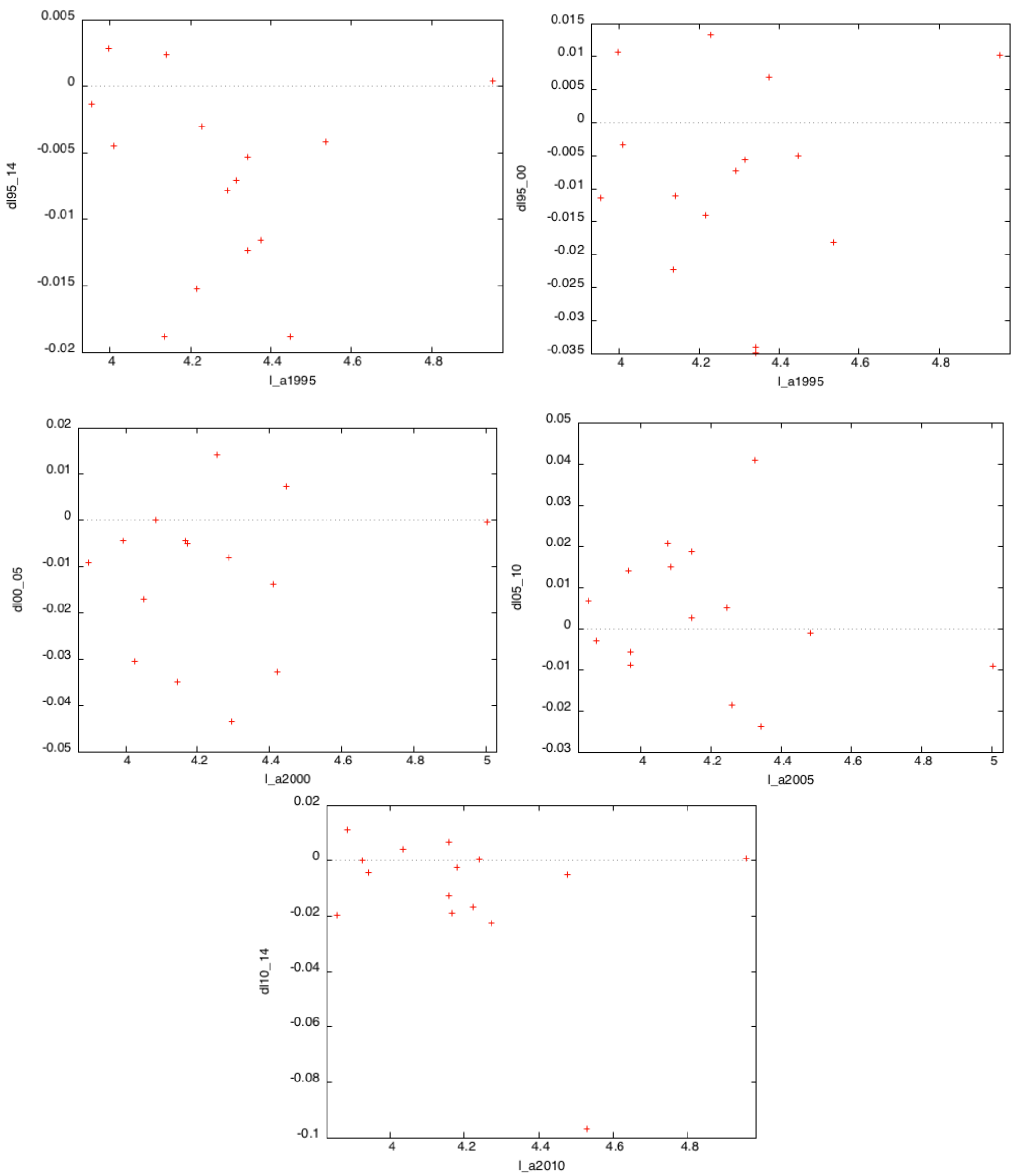
Period	β-coefficient	Std. error	R^2
1995 to 2015	-0,0018	0,0079	0,0040
1995 to 2000	0,0055	0,0166	0,0082
2000 to 2005	0,0091	0,0170	0,0213
2005 to 2010	-0,0106	0,0156	0,0341
2010 to 2014	-0,0258	0,0238	0,4108

* indicates statistical significance at 10% level; ** indicates statistical significance at 5% level; *** indicates statistical significance at 1% level

Table 6. Results for an OLS model, measuring annual β-convergence in 1995-2014, 1995-2000, 2000-2005, 2005-2010 and 2010-2014 in Estonian counties
Source: Author's calculations with statistical package Gretl

As we can see from table 6 none of the models were statistically significant which means that there is no proof of β-convergence on national scale with Estonia as an example. Another thing is that the coefficients are not consistent. In some periods the coefficients are negative while in the other periods they are positive. We also notice that the coefficients of determinations are really low, which would indicate that some important factors are missing. What is however interesting is that the coefficient between 2010 and 2014 shows a similar rate of convergence that is often expressed in literature. The period from 2010 to 2014 also shows a relatively high coefficient of determination (R^2=0,41).

To illustrate the findings of our OLS models better, we construct the following scatter plots:



Graphs 15, 16, 17, 18 and 19. Correlation between initial GDP per capita and growth of GDP per capita from 1995 to 2014, from 1995 to 2000, from 2000 to 2005, from 2005 to 2010 and from 2010 to 2014 in Estonian counties, measured as a % of Estonian average GDP per capita

Source: Author's calculations with statistical package Gretl

If we look at the graphs, we see that there seems to be no correlation between initial GDPs per capita and their change during the periods, measured as a percentage of Estonian average GDP in none of the scatter plots, which supports the estimations of OLS models. However if we look at graph 19, we see, that there might be a slight trend that is interrupted with one outlier that is Harju county.

To see whether there is a correlation between initial GDP and change of GDP, we make a last model. Instead of comparing the GDP as a percentage of Estonian average, we compare it to Harju county.

After constructing an OLS model, we got the following results:

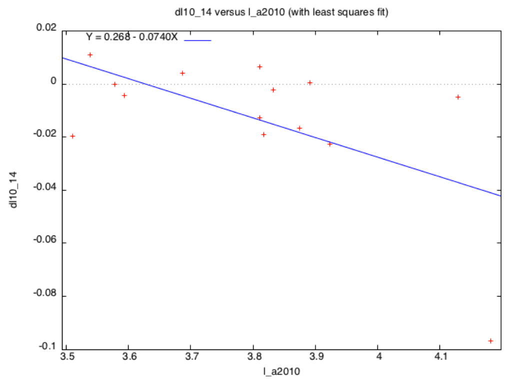
Period	β-coefficient	Std. error	R^2
2010 to 2014	-0,0740 **	0,0307	0,3262

* indicates statistical significance at 10% level; ** indicates statistical significance at 5% level; *** indicates statistical significance at 1% level

Table 7. Results for an OLS model, measuring annual β-convergence between 2000-2014 in other Estonian counties
Source: Author's calculations with statistical package Gretl

As we see, between 2010 and 2014, OLS model estimation detects β-convergence in other Estonian counties compared to Harju county. The annual rate of convergence within Estonia compared to Harju county was 7,4%, which is surprisingly high.

Constructing a the scatter plot of this last model, we get the following graph:



Graph 20. Correlation between initial GDP per capita and their change from 2010 to 2014 in other Estonian counties, measured as a percentage of Harju county's GDP
Source: Author's calculations with statistical package Gretl

Graph 20 supports the conclusions we made from the last model. As we see there is now a trend and even though there are some outliers, there is also a detectable correlation between other Estonian counties' initial GDP and their change compared to Harju county's GDP between 2010 and 2014.

3.4. Conclusion

From chapter 3 we saw, that the literature suggested that convergence is taking place usually on international scale and rarely on national scale. The purpose of this chapter was to test these assumptions. To do so we used data from EU28 over the last 20 years (from 1995 to 2015) to measure β-convergence on international scale and data of Estonian counties from 1995 to 2014 to measure β-convergence on national scale.

To perform these tests we gathered data from AMECO database and Statistikaamet's database. We built our model as an OLS model and also used scatter plots to illustrate the relations between growth and initial state.

Our first test used the data from all the members of EU28 from 1995 to 2015. As an indicator we used PPS per capita and set EU15=100. When we looked at the changes from 1995 to 2015 we saw, that the results were statistically significant and gave us the coefficient of -0,0229, which means that between 1995 and 2015 the annual rate β-convergence was around 2,29%. If we performed separate test for five-year periods we saw that the results were a little erratic. Between 1995 and 2000 the result were not statistically significant. All other five-year periods showed statistical significance with the period between 2000 and 2005 showing the highest β-convergence with around 4% per year.

We also performed a separate test that included only the member countries that joined EU in 2004 or later to see, whether they show a different rate of β-convergence. Once again we first performed a test that covered the whole period from 1995 to 2015 and later separate test for five-year periods to see, whether the coefficients are consistent. When we tested the whole 20-year period we saw, that the test was statistically significant and gave us a coefficient of -0,0329. This means that compared to the whole EU28 the annual rate of β-convergence was a whole percentage-point higher if we included only the newer members. The results of five-year periods were similar to the tests with EU28 in the sense that the period between 1995 and 2000 was not statistically significant. Other than that, the coefficients were for newer members in each period higher than in the tests with the whole EU28.

Last we performed a test on national scale using Estonian counties and their data from 1995 to 2014. As an indicator we are using GDP per capita as a percentage of Estonian average GDP per capita. First we measured the β-convergence between 1995 and 2014. The results were not statistically relevant. We repeated this test with five-year periods but the results were once again not statistically relevant. However we saw, that between 2010 and 2014 the result were indicating a slight correlation with one outlier that was Harju county. As a result we constructed a final OLS model. This time our indicator was GDP per capita and its change over the period in other counties compared to Harju county's GDP per capita. We saw that the OLS model estimation detected β-convergence between 2010 and 2014. The coefficient of annual convergence between 2010 and 2014 was according to this test about 7,4%. This means that even though we did not detect β-convergence on national level in most of the cases, we found a time period in which other counties showed β-convergence compared to Harju county.

CONCLUSION

There have been many economic theories that have tried to explain the location decisions, economic relations between regions and the reasons and effects of trade, which would also explain why different regions develop differently. These theories are generally divided into two categories. First are known as neo-classical theories and they were developed as early as in 19th century. Two most known of these theories are known as Ricardian model and Heckscher-Ohlin model. These theories explained trade and location decisions through comparative advantage and believed that economic decisions are steered through exogenous forces such as differences in technological development or natural resources. In the middle of 20th century however new ideas about economic geography would be developed, which would lead to the second category - new economic geography. Unlike neo-classical theories, new economic geography assumed that economic decisions are steered by endogenous forces. For example through firm-consumer or firm-firm linkages. Unlike the neo-classical theories, they also assumed increasing returns to scale contrary to constant returns to scale.

After looking into the empirical literature we saw that the these theories do not always reflect the reality. From the empirical literature we saw that these theories often tend to reflect the times they were developed in. This means that as international trade became more and more complex, the older, i.e. neo-classical theories, did not in their original form give correct conclusions. However we also noticed, that these theories are still important to understand the basics of trade and if they are adjusted, they can still be used to analyze trade patterns and location decisions.

After reading up on the different theories that explain trade and location decisions we looked into the regional development and how it changes. In this paper we studied the catch-up effect, also known as convergence. There are two ways to measure convergence. First is known as σ-convergence and second as β-convergence. As we learned σ-convergence suggests a decrease in differences of incomes across economies while β-convergence suggests to a relation between economy's initial development and its growth tempo. In this paper we focused on β-convergence in its unconditional form. Unconditional approach assumes that there is a relation between a regions initial development and its growth tempo and as the region becomes more developed, the slower its grows. Economic literature however suggests, that while there is proof β-convergence on international scale, the results for national scale are often divided.

To test β-convergence, we decided to do it on both international and national scale. For international scale we used data on EU28 from 1995 to 2015. To measure β-convergence on national scale we used data on Estonian counties from 1995 to 2014. The data was gathered from AMECO database and Statistikaamet's database. The estimations were calculated with OLS models and scatter plots were used to illustrate the correlations.

Our first test was about β-convergence on international scale with EU28 as an example. We used data from 1995 to 2015 and as an indicator used PPS per capita with EU15=100. We performed our test in five steps. First we measured the rate of β-convergence through the whole period from 1995 to 2015. Later we performed four separate tests with five-year periods to see, whether the rate is consistent. After constructing an OLS model its estimation detected an annual rate of convergence at the rate of 2,29% per year. After performing separate tests for five-year periods, we saw that OLS model's estimation did not detect β-convergence between 1995 and 2000. All the other periods from 2000 to 2005, from 2005 to 2010 and from 2010 to 2015 were statistically significant and detected β-convergence. We noticed that the rate of β-convergence was slowing down, going from 4% per year in 2000-2005 to 3% per year in 2010-2015.

Our second test was in principle similar to the first, but included only the countries that joined EU in 2004 or later. We used the same period and indicator as for the first test. Testing the whole period gave us an annual rate of convergence at 3,29%. Testing the five-year periods showed once again that OLS model's estimation did not detect β-convergence between 1995 and 2000. However all the other periods were statistically significant and each of these periods showed higher rate of β-convergence compared to the model with EU28. We also noticed that compared to the EU28 the rate of β-convergence was rising over the last 15 years. Going from 4,86% per year in 2000-2005 to 5,86% in 2010-2015.

Our third test was about β-convergence on national scale with Estonian counties as an example. We used data from 1995 to 2014 and as an indicator we used GDP per capita as a percentage compared to the Estonian average. The test was performed similarly to the two previous tests, i.e. in five steps. The OLS model's estimation did not detect β-convergence through the whole periods nor in shorter five-year periods as the results were statistically not relevant. However looking at the OLS model estimations and scatter plot we noticed that in the last period, from 2010 to 2014, there were suggestions of a β-convergence. To test this period again we removed one outlier that was Harju county and as an indicator used GDP per capita as a percentage of Harju county's GDP per capita. After performing these alterations the OLS model's estimation did indeed detect β-convergence in this period with the rate of 7,4% per year.

As we saw the assumptions of β-convergence we previously learned, were largely proven correct in our tests. The annual rate of convergence in EU28 was close to 2%, and the poorer regions developed at a faster rate as we saw from the test that included only newer EU members. Also there was not much proof of β-convergence on national scale, i.e. within countries with Estonia as an example. The one instance we detected β-convergence is not enough to draw further conclusions that convergence is taking place within Estonia. We also noticed that convergence was not consistent throughout the testing periods, but there were periods in which the rate of β-convergence was higher, lower or not at all detectable.

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APPENDICE

Appendix 1. Gross national income at current prices per head of population in EU28 from years 1995-2015, in PPS with EU15=100

Country	1995	2000	2005	2010	2015
Austria	112,94	111,77	109,45	114,68	113,80
Belgium	111,86	110,78	105,82	110,82	108,93
Bulgaria	29,05	24,05	31,44	38,20	41,12
Croatia	38,86	41,35	49,48	51,43	53,37
Cyprus	75,19	72,38	82,17	89,58	74,24
Czech Republic	65,54	60,94	67,17	67,66	72,55
Denmark	110,75	110,62	108,65	115,42	116,33
Estonia	30,16	35,57	50,20	54,25	66,85
Finland	89,64	100,45	101,88	105,41	99,44
France	99,58	101,12	97,86	99,48	99,35
Germany	110,39	101,06	102,74	109,72	115,62
Greece	75,46	74,31	79,38	77,04	63,97
Hungary	42,21	43,94	51,82	55,83	61,37
Ireland	81,01	98,60	111,10	99,61	110,91
Italy	103,83	101,38	93,61	93,17	87,87
Latvia	28,75	31,14	44,21	47,85	58,87
Lithuania	29,56	32,63	45,83	53,49	67,27
Luxembourg	166,70	172,56	177,45	170,60	161,88
Malta	74,54	70,62	68,56	74,29	75,76
Netherlands	111,65	122,81	118,52	122,52	122,07
Poland	35,40	40,37	42,92	53,90	61,05

Continuation of appendix 1. Gross national income at current prices per head of population in EU28 from years 1995-2015, in PPS with EU15=100

Portugal	65,99	66,87	68,76	70,66	71,31
Romania	27,07	21,70	29,41	44,57	49,19
Slovakia	40,70	42,30	50,70	64,52	68,92
Slovenia	64,04	68,40	75,12	74,22	76,37
Spain	77,78	82,62	86,88	86,65	85,11
Sweden	107,20	112,21	110,09	116,64	117,40
UK	100,22	105,56	112,21	98,65	98,83

Source: AMECO database

Appendix 2. Gross national income at current prices per head of population in countries that joined EU in 2004 or later, from years 1995-2015, in PPS with EU15=100

Country	1995	2000	2005	2010	2015
Bulgaria	29,05	24,05	31,44	38,20	41,12
Croatia	38,86	41,35	49,48	51,43	53,37
Cyprus	75,19	72,38	82,17	89,58	74,24
Czech Republic	65,54	60,94	67,17	67,66	72,55
Estonia	30,16	35,57	50,20	54,25	66,85
Hungary	42,21	43,94	51,82	55,83	61,37
Latvia	28,75	31,14	44,21	47,85	58,87
Lithuania	29,56	32,63	45,83	53,49	67,27
Malta	74,54	70,62	68,56	74,29	75,76
Poland	35,40	40,37	42,92	53,90	61,05
Romania	27,07	21,70	29,41	44,57	49,19
Slovakia	40,70	42,30	50,70	64,52	68,92
Slovenia	64,04	68,40	75,12	74,22	76,37

Source: AMECO database

Appendix 3. GDP in Estonian counties from 1995 to 2014, as % from Estonian average

County	1995	2000	2005	2010	2014
Harju county	141,6	149	148,8	142,2	142,7
Hiiu county	85,4	83,3	70,7	64,4	59,7
Ida-Viru county	76,8	64,5	63,1	69,3	69,4
Jõgeva county	52,2	49,3	47,1	48,7	50,9
Järva county	68,6	73,3	59	65,4	64,8
Lääne county	76,8	64,8	63,2	64	60,8
Lääne-Viru county	74,8	72,7	69,8	71,6	65,4
Põlva county	62,6	56	48,1	47,4	43,8
Pärnu county	79,5	82,3	76,8	68,2	63,8
Rapla county	67,7	63,1	53	50,7	50,7
Saare county	73	70,4	75,6	92,7	62,9
Tartu county	93,4	85,3	88,5	88	86,3
Valga county	55,1	54,2	53	51,5	50,6
Viljandi county	62,8	59,4	59,4	64	65,7
Võru county	54,4	57,4	52,7	56,5	57,4

Source: Statistikaamet's database