CONVERGENCE IN TRANSPORTATION MEASURES ACROSS THE OECD COUNTRIES

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CONVERGENCE IN TRANSPORTATION MEASURES ACROSS THE OECD COUNTRIES

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ABSTRACT

CONVERGENCE IN TRANSPORTATION MEASURES ACROSS THE OECD COUNTRIES

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This thesis analyzes the convergence in transportation measures across the 23 OECD countries. The convergence hypothesis basically argues that poorer nations (GDP per capita) tend to grow faster than the richer nations and that they end up at similar income levels. Beyzatlar and Yetkiner (2017) argued that income convergence may also be reflected in individual sectors of which income is the front-end. To this end, they tested a transportation convergence equation for EU-15 countries This study aims to extend their study by testing the transportation convergence of 23 OECD countries from the period of 1970 to 2015 through Difference GMM Estimator and System GMM Estimator. Our results show that transportation convergence exists among the 23 OECD nations in both transportation measures: inland passenger transportation per capita and inland freight transportation per capita. We also find that a higher convergence is observed when control variables are considered. It was concluded that income convergence of the 23 OECD countries in the process of economic integration also has an impact on the convergence of their transportation sectors.

Keywords: Income Convergence, Transportation Convergence, OECD countries, Conditional Convergence, Panel data analysis, Difference GMM, System GMM.

ÖZET

OECD ÜLKELER ARASİNDA ULAŞIM ÖLÇUMLERİNDE YAKINSAMA

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Bu tez, 23 OECD ülkeler arasinda ulaşım ölçumlerinde yakınsamayı analiz etmektedir. Yakınsama hipotezi temel olarak yoksul ulusların (kişi başına GSYİH) daha zengin uluslardan daha hızlı büyüme eğiliminde olduklarını ve benzer gelir seviyelerinde olduklarını savunuyor. Beyzatlar ve Yetkiner (2017), gelirin yakınsamanın, gelirinin ön planda olduğu sektörlere de yansıyabileceğini savunurlar. Bu amaçla, AB-15 ülkeleri için bir ulaşım yakınsama denklemini test ettiler. Bu çalışma, 23 OECD ülkesinin 1970 ile 2015 süre zarfında Fark GMM Tahmincisi ve Sistem GMM Tahmincisi'ne kadar test etmeyi amaçlamaktadır. Sonuçlarımız, her iki ulaştırma ölçumlerinde: kişi başına iç yolcu taşımacılığı ve kişi başına iç nakliye taşımacılığı de 23 OECD ülkesinde ulaştırma yakınsamanın olduğunu göstermektedir. Ayrıca kontrol değişkenleri göz önüne alındığında daha yüksek bir yakınsama gözlemlendiğini tespit ettik. Ekonomik uyum sürecinde 23 OECD ülkesinin gelir yakınsamasının, ulaşım sektörlerinin yakınsamasına da etkisi olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Gelir Yakınsama, Ulaştırma Yakınsama, OECD ülkeleri, Koşullu Yakınsama, Panel veri analizi, Fark GMM, Sistem GMM.

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List of Abbreviations

OECD	The Organization for Economic Co-operation and Development
EU	European Union
HDI	Human Development Index
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
FDI	Foreign Direct Investment
VIF	Variance Inflation Factor
TV	Tolerance Value

CHAPTER 1: INTRODUCTION

There are number of developed economies today which were once considered to be underdeveloped. As the number of economies considered developed has started to increase, the question of those economies once considered poor converging to the ones which are richer has become one of the main and important topics in the growth literature, hence, more and more economists have started to pay attention to the income convergence issue (Barro, 1991; Aghion & Howitt, 1998; Sachs, 2003). Income convergence implies the possibility that relatively poorer economies may have faster growth rate than the richer ones in terms of per capita GDP, through which they can reach a similar steady state income.

Income is the front-end for all economic activities by back-end sectors. The back-end sectors can be but not limited to transportation, mining, health, agriculture, among others. If the front-end income does show convergence behavior, back-end sectors must also show a similar behavior, as a result of cause or effect. This intuition has led to research in convergence in back-end sectors. As an example, Beyzatlar & Yetkiner (2017) have taken the back-end sector transportation and studied its convergence among EU-15 countries. The study based its research on the conditions that back-end sectors will imitate the income convergence if the back-end sector:

- is subject of law of diminishing returns per capita income
- has a sufficiently high share in the income (of economy).

Considering the conditions presented above, transportation sector is one of the sectors which is subject to law of diminishing returns and has a sufficiently large share in the economy. Back-end sectors tend to impact the economy greatly due to their importance in the economy. Transportation is one of the back-end sectors which cannot be omitted from having convergence behavior as it is one of the sectors through which all the public (passengers) and freight moves within the nation.

1.1. Objectives of the Study

The main objective of this study is to undertake the convergence in transportation measures for OECD nations to find out whether transportation does depict a convergence behavior or not. In neoclassical growth models, the country's per capita growth rate is inversely related to its initial per capita income level. Specifically, if countries are similar in terms of structural parameters for privileges and technology preferences, poor countries tend to grow faster than rich countries. The study selected OECD countries because of the economic integration which these nations are in, the integration among these nations is not limited to simply trade but includes a great deal of markets in which they contribute to each other, raw material, various factor of production, and goods and services in a great range. Previously, there have been several empirical studies on testing convergence hypothesis carried out on OECD countries, for instance Baumol (1986), Barro (1991), Mankiw et al. (1992), and Sala-i-Martin (1996). All these studies have shown evidence of economic integration among these nations, yet no study has been conducted on OECD nations which measures the transportation convergence across the OECD nations. Current study is the first to measure the transportation convergence of OECD countries. Objectives of the study are as follows:

- Whether there is existence of transportation convergence among the 23-OECD nations in two transportation measures:
    - inland per capita passenger transportation
    - inland per capita freight transportation
- How different controlled variables impact the significance of convergence

This thesis expects that data analyses will offer an affirmative answer to the first question and that several control variables accelerating convergence in the two transportation measures will be determined.

1.2. Contribution

This study contributes to both income convergence and transportation (convergence) literatures. First, this study is one of the first for measuring transportation convergence among 23 OECD nations. The study also demonstrates the importance of the back-end sectors which both directly and indirectly contribute to the economies of nations across

the world which have not been given much importance previously. This study also hints to the future studies which want to carry out research on either transportation convergence or on different back-end sectors.

1.3. Synopsis of Study

The organization of the thesis is as follows. The second chapter presents the literature on the topics related to the study. It covers range of topics such as income convergence, economic growth, the role of production functions, OECD integration, and transportation. The third chapter covers the theoretical background of growth models and methodology. It goes over the general concept of income convergence and growth models which have been introduced in the past. The chapter also presents the methodology, data, and findings of the study. The last chapter concludes the thesis and presents policy implications of the findings and make recommendations for future studies.

CHAPTER 2: LITERATURE REVIEW

This chapter of the study covers the literature conducted on the topics related to topic of current study. Topics which will be covered in this chapter are: various definitions of convergence, history of income convergence, fundamental issues in economic growth, OECD integration, and transportation convergence. Along with these topics, various subtopics are also covered. The main reason for presenting prior literature related to the topics is to establish links between current study and prior studies.

2.1. Convergence

Solow's (1956) neoclassical growth model has created a huge theoretical background and empirical literature in income convergence. Earlier studies on convergence are Baumol (1986), Abramovitz (1986), De Long (1988), and Mankiw et al. (1992). According to Barro & Sala-i-Martin (2003), there are two types of convergence which are known as: β-Convergence and σ-Convergence. When the convergence speed across nations which are poor is faster than rich nations β-Convergence is applied. The concept of β-Convergence is directly related to the Solow's (1956) neo-classical growth theory in which one of the main assumptions is that each factor of production is subject to diminishing returns. The concept of β-Convergence was further divided into conditional and absolute convergence.

- Absolute β-Convergence undertakes that the only variance in growth rates among nations is dependent on their original levels of capital. In simple terms, β-Convergence is known to be absolute when all the economies are expected to converge towards the same steady state.
- Conditional β-Convergence adds several variables to its model in order to control the differences among economies due to which the convergence takes place under certain conditions which are added to the model. In simple terms, β-Convergence is conditional when GDP per head is supposed to depend on a series of

determinants such as factor endowment or institutions, which can and may differ from one nation's economy to another even when looked at in the long run.

β-Convergence is measured via estimation of the following equation:

$$ln(\Delta y_{i,t}) = \alpha + \beta\, ln(y_{i,t-1}) + \gamma Z_{i,t} + u_{i,t}$$

Where:

- $y_{i,t}$ and $\Delta y_{i,t}$ are the level and the growth rate of GDP per head in region i and time t respectively;
- $Z_{i,t}$ contains all other factors supposedly affecting the growth rate;
- $u_{i,t}$ is the standard error term; and
- α, β and γ are the parameters to be estimated.

The second convergence concept is known as σ-Convergence. If the standard deviation in the income per capita tend to decrease over time, this is considered as indication of σ-Convergence. The standard deviation of per capita GDP of nations' over a given period is the decision criteria in σ-Convergence. If the results show a decrease in the standard deviation of GDP per capita values over time, this shows that variance in income per capita among nations have been decreasing, or else convergence does not take place.

2.2. History of convergence

It was in 1750 when the industrial revolution took place in England, which started to increase per capita income and nullified the Malthusian Trap. This revolution spread across number of European nations, the USA, Canada, New Zealand, and Australia, and it was in the next 200 years that the economic growth has been able to sustain itself and increased from there on. The main source which had aided with the growth of the economies has been technological change. The increase in the income through this growth had impacted up to 15 percent of world's population (Spence, 2011). Aside from these nations, most of the nations have stayed relatively poorer. And, due to this great divergence took place. Nevertheless, in the post WWII period, the growth had started to take place also in the developing nations as well and some now became developed. In the beginning this growth was not as strong as in the other developed nations but slowly it

had started to pick up pace, and at the same time it did not take place in all of the nations at the same time, but had spread slowly to a large number of nations across the world. Moreover, there was an increase in the growth rate of the developing nations which was up to 7 percent, which is much greater than the industrial nations during the two centuries. Two centuries later this has come to be known as the "the great divergence" (Pomeranz, 2001), and it was after the two centuries when convergence took over. The question which upholds is that what caused such change, and which factors had impacted the increase in the growth of developing nations. Though the developing nations had the growth, yet, there are number of nations which still face low-income levels, and are not able to be with the nations which are considered in the middle-income nations.

Aghion & Howitt (1992), and Jones (1998) who further developed the Schumpeterian growth theory explain that it is technology which plays a vital role in the growth of developed economies and that a large proportion of the growth is explained by the advancement in the technology. Moreover, number of theoretical models which were stimulated by Schumpeter, argue developing nations and underdeveloped nations which are far behind the advanced technology nations could benefit from this gap and grow faster than the advance nations did. Nevertheless, it is clear that low-income nations are not taking advantage of that due to other factors which play an important role in the growth of the nations. These nations still are far behind the technological leaders and though they have the advantage of growing and catching up to the advanced nations, these nations are still in trapped in low level income.

As technology is not the sole factor which impacts the growth of a nation, there are number of other factors which play a vital role in this development. One of them is transportation. If we were to look back in the history of industrialization one factor which boomed the consumer market and flourished the businesses was the advancement in the transportation system.

2.3. Economic Growth

Mankiw (2003) argues that economic growth is one of the very important elements which shows the economic well-being of the nation. In order to see which factors, impact the

economic growth of a nation, different macro-economic models and frameworks were proposed. Out of the proposed models, Solow growth model and the endogenous growth model are known to be the most prominent ones. These two models help to "explain how saving, consumption, population growth, and technological progress influences the level of growth of a country's standard of living" (Mankiw, 2003). A more detailed discussion on the models is done in the following section.

2.3.1. Production Function

Production function "relates the output of an economy (GDP) to the economy's productive inputs – physical capital stock (K) and labor employed (L), in its the most compact form. Thus, the real output Y is a function F of the capital stock K (in real terms) and labor (L)" (Gartner, 2006):

$$Y = F(K, L)$$

Production Function has three assumptions according to economists which are:

a) There is an increase in the output of economy if either one or both factors increase;
b) If for any reason one of the factors does not change and remains fixed, any increase in the other factor leads to smaller output gains;
c) If there is a similar percentage increase in both factors, the output will also increase by the same percentage (Gartner, 2006). This is called the constant-returns-to-scale (CTRS) property of production function.

2.3.2. Cobb-Douglas Function

Cobb-Douglas production function is used widely, and through this production function, "it is possible to formalize the relationship among the inputs of capital and labor and the GDP output: $Y = AK^{\alpha}L^{1-\alpha}$, where α is a parameter denoting elasticity of output with respect to capital; $0 < \alpha < 1$".

Income in this function is related to the factor inputs of physical capital stock (K) and labor employed (L) and to the productivity (production technology) which is denoted by A. Consequently, the economic growth can take place if:

a) Growth in capital stock and growing labor force (endogenously);
b) Developments in technology and/or productivity (Gartner, 2006).

Cobb-Douglas production function should always be thought of when one thinks of implementing Solow growth model which is discussed in the following sub-section.

2.3.3. The Solow Growth Model

The Solow growth model, which is also known as the neoclassical growth model, is known to be the common starting point when it comes to the analysis of economic growth all over the world (Romer, 2006; Gartner, 2006). Solow growth model's production function is described as follows:

$$Y\ (t) =\ F\ [K(t), A(t)L(t)]$$

where $A(t)$ represents technological progress or effective labor. The main assumption of the model is related to the changes which occur in the inputs of production function capital (K), labor (L), knowledge and productivity (A) (Romer, 2006). Along with that its main assumption is that the nations make use of their resources efficiently (Gartner, 2006), and the model argues that the capital and labor have constant-returns-to-scale, which denotes that if there is an increase in capital or in labor, then it would increase the productivity by the same amount. This can be explained as:

$F\ (ck, cAL) = cF\ (K, AL)$ where c is defined as a non-negative constant.

"With constant returns to scale output per unit of effective labor, $Y = \frac{Y}{AL}$, is a function of capital per unit of effective labor $\left(\frac{K}{AL} = k\right): f(k) = F(k, 1)$. Subsequently, $y = f(k)$ (Romer D. , 2006)".

It must be noted that the marginal product of capital is positive $f(k) > 0$, however it moves downwards (declines) as there is an increase (rise) in capital per unit of labor $f'(k) < 0$. Therefore, the marginal product become big when the capital stock is in small quantity, and marginal product becomes small as there is an increase in the capital stock, this can be explained through the law of diminishing returns to capital (Romer, 2006).

The Solow model is formulated as follows:

$$\dot{K}(t) = s \cdot F\,[K(t), A(t)L(t)] - \delta \cdot K(t)$$

The Solow growth model assumes that the saving rate ($s > 0$), the labor force growth rate (n), the exogenous growth rate of technological progress (g), and the capital depreciation rate ($\delta > 0$) are constant and exogenous. It is common to assume that labor force and population mean the same and hence their growth rates are equal. Though there are no specific limitations on parameter values, the sum of $n + g + \delta$ is positive (Romer D. , 2006).

The key prediction of the Solow growth model is that low income economies which have low GDP ($Y(0)$) and low capital stock ($K(0)$) tend to grow up to ones which are high income, or in other words, they converge. Barro & Grilli (1994) explain the developing economies tendency to converge as: if the starting values of $Y(0)$ and $K(0)$ in these nations is lower, than the growth rate will be faster, and if the values are high, than they will grow slower. Therefore, sooner or later these low-income nations will reach the convergence point.

2.3.4. Convergence and Economic Growth

Growth of any economy has become one of the main concerns of the economists as it not only concerns with the standard of living or welfare of the state, but also it helps the nation's political and social standings among other nations (Milanovic & Squire, 2007). United States could be taken as an example. The GDP per capita of the US economy for almost 150 years has been growing at a stable average rate of 2 percent yearly. From 1870 with $3,000 GDP per capita it hiked up almost to $50,000 in 2014, an increase around 17-

fold (Jones, 2016). In recent times, this rapid growth which once was seen in the US can now be seen in the growth of China's economy along with several other nations. Therefore, it is important to understand which factors affect the growth of the economy. There are number of studies conducted which look into the reasons why some nations do not excel as they should and why some are able to grow at such a fast pace. These studies have studied the factors which help the nations to accelerate their growth rate to converge to the development level.

Convergence gained great attention when Romer (1986), questioned previous neoclassical growth model, also known as the Solow growth model which was proposed by Solow (1956). It was the Solow's growth model which had given attention to the concept of convergence in the beginning. According to Solow (1956), "if there was a diminishing return to capital and labor, an economy is converging to a unique steady state, whether it is higher or lower than the equilibrium capital level". This neoclassical model had one issue that it was not able to explain: the long-term growth of a nation. According to Romer (1990), Solow's model does not provide any insight on the determinants of technological progress in which technological growth rate is given, hence, Romer proposed a growth model known as the Romer model (endogenous growth model). In Endogenous growth model, two of the main assumptions of the neoclassical model are questioned: diminishing returns to capital and the exogeneity of technology. New model avoids these two assumptions in order to describe the long-run economic growth. In the endogenous growth model, technology is represented as endogenous, nations are able to grow in the long-run, hence, it shows that there is no convergence across nations.

Nevertheless, empirical studies and evidence has shown that convergence is taking place, nations which are known as developing nations are increasing their growth rate and are catching up to the advanced rich nations. This proves that Romer's endogenous growth model is also insufficient. It is important to understand that there is interaction across nations through different dimensions such as: human capital, institutions, research and development, natural resources, transportation, and so on. Due to number of factors which affect the growth rate of nations and across nations, there have been number various

concepts, factors, models, and methodologies proposed as of how convergence takes place.

One of the main aspects in the development of a model is to bring changes to the function by either adding or subtracting new variables. In growth models, researchers tend to add or subtract factors which might affect the steady growth of nations. Mankiw, Romer, & Weil (1992) proposed an addition to the Solow's growth model, the addition was of human capital. This addition was proposed with the explanation that "80 percent of cross nation income differences can be explained by this model". Whereas, several researchers have argued that human capital or physical capital can only have a limited impact on the differences in the output per worker, and that instead, it is the changes which take place in total factor productivity (TFP) or the technological changes that take place can explain the large proportion of the difference which takes place (Redek & Sušjan, 2005; Caselli, Esquivel, & Lefort, 1996; Easterly & Levine, 1997; Pomeranz, 2001).

Additionally, with the endogenous growth model it is possible to clarify these differences by endogenizing technology (stock of knowledge) via various channels. Researchers have given convergence a great deal of importance and been searching for the best channels through which technology can impact TFP, and growth of economy. Human capital is known to be one of the vital channels via which the knowledge stock can affect growth. Lucas (1988), in his work, has been able to use the externality characteristic of human capital in addition to its investment in education role. Along with Lucas, number of other scholars in the field of economy have introduced spillover effects by incorporating number of other factors which can impact the growth via human capital. Among the factors, one can list knowledge accumulation, transfer of technology, imitation of technology, trade, and innovation (Eberhadt & Teal, 2011; Madsen, 2008; Harris, 2011).

Research done on conditional convergence has produced fruitful models for the growth literature. Through studying convergence, it can be seen that number of facts are produced which help to understand the growth across nations. Another point for studying convergence is that it shows the significant changes which take place in the technological sectors across nations, which helps to develop models and quantify the differences.

Moreover, when convergence is selected as the criterion for growth models it makes it even more important. As researchers have mentioned that through testing the hypothesis of convergence, they can validate the models.

2.4. OECD Integration

This section will cover explain what exactly is the Organization for Economic Co-Operation and Development (OECD), OECD integration and formation, development of OECD, and the effects OECD integration.

2.4.1. OECD Background (Integration and Formation)

The Organization for Economic Co-operation and Development (OECD) is a union of 36 member nations from across the world. OECD was formed as an intergovernmental economic organization in order to stimulate the economic progress between the member states and throughout the world. It was formed in 1961. OECD was formed in order to replace Organization for European Economic Corporation (OEEC) which was formed after the WWII 1945 for the reconstruction of Europe. OECD was formed in order to boost the economies of the member nations, improve the efficiency of the markets, refine market systems, expand the boundaries of free trade, and as well to help the development of industrialization in the developing nations. There were 20 original members of OECD which consisted of mainly European nations along with United States and Canada, and today OECD consists of 36 member states (see table 1).

Table 1- OECD Members and Joining Years (Source: oecd.org/member countries list 2019)

Country	**Joining Year**	**Country**	**Joining Year**
Australia	1971	Korea	1996
Austria	1961	Latvia	2016
Belgium	1961	Lithuania	2018
Canada	1961	Luxembourg	1961
Chile	2010	Mexico	1994
Czech Republic	1995	Netherlands	1961
Denmark	1961	New Zealand	1973
Estonia	2010	Norway	1961
Finland	1969	Poland	1996
France	1961	Portugal	1961
Germany	1961	Slovak Republic	2000
Greece	1961	Slovenia	2010
Hungary	1996	Spain	1961
Iceland	1961	Sweden	1961
Ireland	1961	Switzerland	1961
Israel	2010	Turkey	1961
Italy	1962	United Kingdom	1961
Japan	1964	United States	1961

The OECD member nations believe themselves to be committed and representing democracy and the market economy. OECD has given the nations a platform where they can compare policy experience, find answers to the questions which the members might have, look over problems which they might be facing, classify practices which are good and bad, and manage policies which are both domestic and international of its members. Most of the OECD members are the developed economies of the world, and they score really high in the Human Development Index (HDI) (UNDP, 2019).

2.4.2. Effects of OECD Integration on Member Countries

OECD has been around for well over a half century and has been able to help its members with solutions for their economic problems. It has helped its members' financial issues and economic growth. Along with helping its members, it has also helped over 100 developing economies with their economic and financial issues. It stands 36 strong as of

today, but initially it started off with 20 members. Collectively OECD member states account for 60% percent of world's production of goods and services. The membership of OECD is limited by a nation's commitment to a market economy and a diverse democracy.

Being a member of OECD has its advantages that allow the nation to reach its full potential in developing its economy. It gives the member state the equal collaboration with the members who are the major economic players in the world today, they help the member in establishing its global standards of good practice and good governance in number of different areas. As OECD sets the global standards for economic and social development areas such as investment, financial markets, international corruption, education, employment, transportation, environment and many other areas. Along with these areas, there are number of specialized fields which OECD sets standards for such as biotechnology and nuclear energy. For the members it is important to follow these standards, and through the implementation of standards the nations can be compared which allows international investors to make decisions upon investing in a nation. One of the main and most important benefit of the membership of OECD for any nation is the reputation which a member country gets in world, which allows them to attract investors, as the membership of OECD automatically means having high global standards (OECD, 2019).

One of the major impacts of the OECD integration has been the collaboration of all the member states towards economic growth of the nations and of the world's economy. Integration has allowed the nations to work together in developing policies which would impact their economic growth collectively and help with any financial crisis faced by any of the member states. Integration of OECD allows the member states to develop themselves according to the standards set by the OECD which are usually high as most of the members are developed nations and account for most of world's production.

2.5. Transportation

Transportation across the world has been one of the major factors for enabling trade centuries across nations. Transportation has not only been used for the purpose of trade

but also for the movement of people within a nation or across nations. Transportation can be defined in simple terms as movement of people, goods, and services from one place to another. This movement could take place domestically or across borders. One of the major fruits of advancement in the transportation system was of physical movement of goods: this advancement helped economies to grow with a great pace. Efficiency in transportation made consumer goods, investment goods, and intermediate goods available in areas where they were not native or available. Transportation is vital as any other main factors as it helps the economy it transits economies from middle to high income (IMF, 2015).

Another impact which transportation has on the economy is of public (passenger) transportation. The efficiency of transportation has affected the growth of economy in number of ways. It had allowed for the people to efficiently reach places in order to carry out their work activities which contributes to the economy. Passenger transport connectivity within an economy impacts the enhancement of production capacity of a nation (Graham, 2014).

2.5.1. Transportation in OECD

Transportation, being one of the main factors for economic growth, has been given importance by every nation across the world. OECD countries have been trying build their transportation infrastructure for decades in the public sector. It should be mentioned that the amount of investment put into the transportation infrastructure varies in the various stages of a nation's economic development (OECD, 2015). For instance, nations which have low-income, investing in the simple transportation infrastructure will make a big difference as it will help to provide access to the public to education, services, and jobs (UN, 2015). As the income of the nation increases, it asks for a better transportation infrastructure in order to be efficient and for the growth of businesses (production and export). In economies which are known to be mature, the importance of the infrastructure moves towards emphasizing on problems related to congestion which asks for maintenance of current infrastructure and for upgrades which leads to innovations. According to Eddington (2006), when it comes to transportation infrastructure making an impact on the economy, low-income countries have the most gains from it as the

development takes place at low levels, whereas, the effect of investment into transportation declines when it takes place at advancement levels.

As overtime the transportation infrastructure develops it helps the economies in various ways. According to the OECD transportation division RTR program report, OECD nations between the period of 1990 and 2000 were able to reduce the overall road fatalities by 21 percent. This reduction in the fatalities is due to the development in the transportation infrastructure. The Vancouver Conference (1996) which was held on "towards sustainable transportation" theme mentioned number of factors which had contributed to the passenger traffic's growth in OECD nations: automobile ownership, affluence, residential density, gender and age, number of trips, purpose of trips, mode of trips, cost of trips, relative costs of ownership and use, role of telecommunications, the Jevons principle, and power and weight of automobile. All the factors impacted the passenger traffic growth and on the ownership of an automobile, which showed how the transportation infrastructure can cause the increase of the automobile ownership as the facilities are provided to the public (due to the impact of cost). Report showed that the public transport had been greatly used by high-income households in the UK, and that they used public transport more (three folds) than lower-income households. Alongside, the high-income families represented the major owners of the automobiles as well.

2.5.2. Transportation and Convergence

Convergence in transportation has been studied by various researchers in the past. The empirical literature shows that there is a relationship between income and transportation. The relation between income and transportation supports the idea of convergence in transportation. One of the recent studies which has looked upon convergence in transportation is carried out by Beyzatlar & Yetkiner (2017). This study used Difference GMM and System GMM methods, using panel data from 15 EU countries (EU-15) from the periods of 1970 – 2013. The results of the study show existence of unconditional convergence in two transportation measures. These transportation measures are the inland per capita freight transportation and inland per capita passenger transportation. Along with the transportation measures, the study found income is also a factor which impacts the transportation sector of the EU-15.

Transportation literature has provided evidence for the interaction which takes place between income and transportation, and this evidence also supports the idea of convergence in transportation. There are two main aspects which have been mentioned in the evidence. First evidence is of instruments which relate transportation impacts on income dynamics. There are three instruments which have been discussed in the literature: i) improved transportation facilities affect economic growth and welfare by reducing the cost of accessing goods and services (Patterson, 1985) and stimulating the trade (Baier & Bergstrand, 2001). ii) improved transportation has impact on the mobility of production (Jiang et al. (2015)), which draws direct investment, and direct foreign investment (Hong, 2007), and this helps with increase in the travel quality (Banister, 2012). iii) availability of transportation has a great impact on the distribution of knowledge, and technological spillover, therefore, transportation is vital for improvement of human capital development.

The second aspect mentioned in the evidence is related to the positive impact of income and productivity on transportation of a nation. According to the study carried out by Paulley et al. (2006) income growth within a nation also increases the demand of transportation. Study carried out by Yu et al. (2012) shows great impact of the transportation at regional and national levels due to the economic growth of China. Another study which studied the economic growth and transportation found that public investment in transportation is impacted greatly due to the economic growth (Bose & Haque, 2005). A study carried out on EU nations found a positive impact of economic growth on transportation (Beyzatlar, Karacal, & Yetkiner, 2014).

Figure 1 and 2 show the average growth rates of a transportation measure of 23-OECD nations from years 1970 to 2015 plotted against the initial value of the transportation measure. in the figures, which is an indicator of transportation convergence.

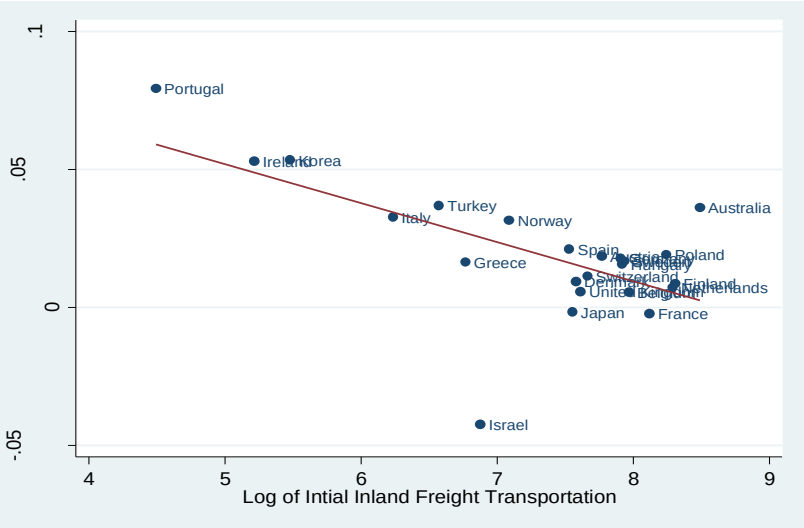

Figure 1. Inland Fright Transportation Convergence. (Source unctad.org)

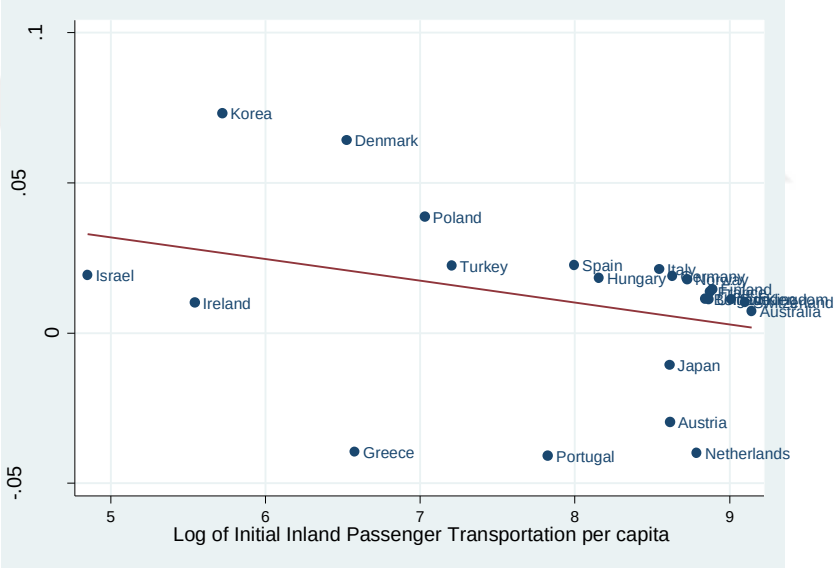

Figure 2. Inland Passenger Transportation Convergence. (Source unctad.org)

According to these figures, there is a convergence in the two transportation measures, as those countries having low (high) initial values of the transportation measure have high (low) growth rates and hence all countries will converge to a single point for the transportation measure (absolute convergence) or their long run values, conditional convergence.

CHAPTER 3: THEORETICAL BACKGROUND, METHODOLOGY, DATA AND FINDINGS

3.1. Introduction

There are number of questions associated with the nation's growth and convergence. One of the main questions which is associated with convergence is whether poor nations can converge with the nations that are already developed? Another question which has been studied is whether the growth in the high-income nations affects the growth of low-income nations in a positive way? The answers to these questions can be found in the history by looking how convergence and economic growth have been associated. The following section will look at concept of convergence, and section 3.3 will look at the growth models and convergence. Followed over the methodology applied for carrying out the research. Data collection and research method are presented in detail.

3.2. General Concepts of Convergence

Hume and Tucker have been known for pioneering the concept of convergence, cf., (Elmslie, 1995), although they had different views. Hume had the believe that poor nations had the ability to converge with the rich nations. Whereas, Tucker believed that there is a persistency of disparity among nations. It was not until the beginning of 19th century when economists around the world had started to take interest in disparities due to the divergence which had taken place around the whole world.

The concept of divergence later on was divided into two as Micro Convergence and Macro Convergence. Micro convergence was defined as "income of identical factors across countries will equalize based on the factor price equalization theory under the Hecksher-Ohlin model" (O'Rourke, Taylor, & Williamson, 1996). Macro convergence mainly emphasized on the aggregate factors such as per capita income and the productivity. Economists which supported macro convergence concept believed that economies around

the world tend to converge based on the per income capita and productivity of a nation over time. Both of the concepts had a relationship between them as the aggregate variables are weighted average of factor price.

3.3. Growth Model and Convergence

This section is to look over the growth models of convergence. It will cover exogenous and endogenous growth models and how convergence is defined within the two-growth model.

3.3.1. Exogenous Growth model and the Concept of Convergence

Quantitative growth models have been around for a long period. Economists in their early studies had the believe that physical capital was the main factor which had affected the growth of the nations. Harrod (1939), and Domar (1946) initially came up with models which had shown the impact of capital on the growth of nations. The main sources which form capital are the increase in the volume of production and aggregate demand. Physical capital accumulation and the fluctuation of the whole production are related to each other. The model assumes that the capital rises as the labor rises; production takes place in fixed quantity of labor and capital. Whatsoever, irregular growth rates in several nations imply that physical capital individually could not be the explanation of the whole fluctuation in growth of an economy, and this is what led to the ultimate development of neoclassical growth models.

If looked back at the modern growth models, they all had evolved from Solow's (1956), and Swan's (1956) studies. Both models assumed existence of a diminishing return to capital and labor. Convergence mainly is predicted based on this assumption. Other assumptions of their model are the constant-returns-to-scale and Inada conditions. Some economists criticizing these assumptions have argued that these assumptions may bring unrealistic results. Solow (1956) had argued that if the assumptions which are used for research purposed do not bring sound results, they are not to be called wrong. The results of the assumptions show that the policies which were assumed to bring changes in the long-run growth patterns, could not impact the growth due to the fact that those policies were only effective in the short-run growth rate. Results of both Solow (1956) and Swan

(1956) had also emphasized that exogenous variables like technological progress, savings rate, and the growth rate of the nation's population could have an impact on the growth rate of the economy (Solow, 1956). Hence, the neoclassical growth theory concluded that economic growth in the long-run is determined only by population growth rate and rate of technological change. Hence, it can be clearly seen in the model that it is the exogenous variables which determine the long-run growth of the economy and that other variables such as policies and saving rate does not have any impact (Barro & Sala-i-Martin, 1997). Steady state for a nation can be obtained through its savings rate, population growth rate and by its depreciation; if nations have various steady states, then convergence does not take place between them. Thus, the only factor which determines the growth rate in the long-run is the exogenous technological progress rate that takes place.

3.3.2. Endogenous Growth model and the Concept of Convergence

Studies carried out have showed empirically that neoclassical model was not capable of explaining the differences which take across growth rates of nations. Economists had believed that technological progress of nations as an endogenous factor could help to determine an economy's growth performance. Since then attempts have been started to endogenize technology progress. Though this model faced a problem which was of assumption of increasing returns in a general equilibrium framework rather than decreasing returns, which was the main assumption made by the neoclassical model. If worded differently, Walrasian theory of general equilibrium says that all factors must be paid their marginal products. Nevertheless, Euler theory argues that on assuming increasing returns, that all of the factors cannot be paid their marginal products.

It was Arrow (1962), who had attempted to endogenize technological progress (technology) into the growth models. According to him, commodities which were produced by labor based on the experience they had determines the growth of technological progress. To put it simply, technology was determined by the knowledge and skills which the workers (labor) possessed. This concluded that labor productivity is endogenous. This model assumes that factor of learning (knowledge and skills) of labor is free for all the firms, as a public commodity. This model had a problem that it only worked if the capital-labor was fixed. This basically meant that the long-term growth rate

of the nation was limited to the labor growth rate, therefore, the saving rate of the nation did not play any role as the model was not depended on it.

Nordhaus (1969) had also tried to endogenize technology (technological progress). His assumption regarding economic growth rate was based on the neoclassical model except for the factor of knowledge production. Aggregate production function are the basis of capital and labor producing output. This model is different from others before in that it adds another factor into the analysis of economic growth rate, which is invention. The meaning of invention in the model was the expansion of technology. Nordhaus' incorporation of invention into the model was different than of the Schumpeter tradition which took invention as an exogenous factor. Nordhaus had believed that invention and economic activities were related. In his model he endogenized technology by equating the rate of technology which took place in an economy as an increasing function of how many innovations took place. In the model, he introduced invention as a factor which is produced as separate new production processes in the system. This new factor of invention was available for any firm to use for free and was viewed as a public commodity. This invention by the inventor could be kept as a secret and could be used for a certain time, but after that period it had to be revealed publicly and other firms could use it. Nevertheless, in Nordhaus's model like Arrow's model, the growth rate could not be sustained without having to account for the growth in the population due to the assumptions which were made of increasing returns.

3.4. Methodology

Dynamic panel methodology has been adopted by the researcher for estimating unconditional and conditional transportation convergence. The Dynamic panel methodology is traditionally proposed by Islam (1995), and Caselli et al. (1996). Particularly two estimators are implemented in the study, firstly, Difference GMM estimator which was originally proposed by Arellano and Bond (1991), and Secondly, System GMM estimator which was originally proposed by Arellano & Bover (1995) and later by Blundell & Bond (1998) as a two-step panel econometric analysis. Nevertheless, there are various other estimation methods available today that could be used, but they might be either biased or irreconcilable time invariant country effects are excluded in a

dynamic panel data model (Nickell, 1981; Hsiao, 2003). Another reason for applying Difference GMM Estimator and System GMM Estimator are the advantages for convergence models that have many cross-sections and have a comparatively small amount of time limitations (Arellano & Bover, 1995; Blundell, Bond, & Windmeijer, 2001). As of the endogeneity issue, it is resolved through implementing instrumental variables, through which consistent estimation can be obtained, and slip of initial efficiency can be avoided (Bond, Hoeffler, & Temple, 2001).

For several reasons, System GMM estimator is known to be more efficient than the Difference GMM estimator (Blundell & Bond, 1998). System GMM estimator comprises of original equation in levels in its system, and of transformed equation in first differences. Respectively, in System GMM estimator's original and transformed equation there is addition of instructions which are lagged first difference of explanatory variables and the lagged levels of regressors. Along with that, the first differences of the instruments in system GMM estimator are uncorrelated which have the fixed effects; therefore, it allows to include additional instruments which is of an advantage (Roodman, 2009). Difference GMM estimator initiates by having to transform all present regressors, generally done by differencing, and makes use of Generalized Method of Moments (Hansen, 1982; Roodman, 2009). In the Difference GMM estimator, time -invariant regressors are no not present, but are present in the System GMM estimator. According to Blundell & Bond (1998), System GMM estimator tends to be more efficient when the series are close to being random walks, however there can be an impact of large finite sample bases in Difference GMM estimator.

The transportation convergence equation which is to be applied in this study is similar to the income convergence equation. The starting point is the final good production function:

$$\mathrm{Y} = \mathrm{K}^{\alpha} \cdot (\mathrm{A} \cdot \mathrm{L})^{1-\alpha}$$

where K is physical capital, L is labor force growing at exogenous rate n, and A is overall technological progress growing at exogenous rate x. The fundamental equation of growth in per effective capita is

$$\dot{\tilde{k}}_t = s \cdot \tilde{k}_t^{\alpha} - (n + \delta + x)\tilde{k}_t$$

Using $\tilde{y}_t = \tilde{k}_t^{\alpha}$, one can express the fundamental equation as follows:

$$\left(\frac{1}{\alpha}\right)\frac{\dot{\tilde{y}}_t}{\tilde{y}_t} = s \cdot \tilde{y}_t^{\frac{\alpha-1}{\alpha}} - (n + \delta + x)$$

The log-linearization of the fundamental equation of growth through Taylor's approximation yields:

$$\frac{dLn[\tilde{y}_t]}{dt} \approx -v \cdot [Ln[\tilde{y}_t] - Ln[\tilde{y}_{ss}]]$$

where $\tilde{y} =$ income per effective capita, $v = (1 - \alpha) \cdot (n + \delta + x)$, δ is the depreciation rate, and t *is* time. $\frac{\frac{dLn[\tilde{y}_t]}{dt}}{dLn[\tilde{y}_t]} = -v$ is known as the convergence rate, as it measures the speed $Ln[\tilde{y}_t]$ approaches its long run equilibrium, $Ln[\tilde{y}_{ss}]$. The solution of the log-linearized differential equation yields $Ln[\tilde{y}_t] = Ln[\tilde{y}_{ss}] + constant \cdot e^{-\nu \cdot t}$. assuming that there are two time points t_2 and t_1 rolling, one can obtain $constant = \{Ln[\tilde{y}_{t_1}] - Ln[\tilde{y}_{ss}]\} \cdot e^{\nu \cdot t_1}$. Using this information at time t_2, one obtains

$$Ln[\tilde{y}_{t_2}] = (1 - e^{-\nu \cdot \tau})Ln[\tilde{y}_{ss}] + Ln[\tilde{y}_{t_1}] \cdot e^{-\nu \cdot \tau}$$

Expansion of this equation yields:

$$\begin{aligned} Ln[y_{t_2}] - Ln[y_{t_1}] &= -(1 - e^{-\nu \cdot \tau})Ln[y_{t_1}] + (1 - e^{-\nu \cdot \tau})\frac{\alpha}{1 - \alpha}Ln[s] \\ &- (1 - e^{-\nu \cdot \tau})\frac{\alpha}{1 - \alpha}Ln[n + \delta + x] + (1 - e^{-\nu \cdot \tau})Ln[A(0)] + x \\ &\cdot (t_2 - e^{-\nu \cdot \tau}t_1) \end{aligned}$$

where y is income per worker. Based on the income convergence equation provided above, the following equation will be used in order to estimate the transportation convergence:

$$\mathrm{Ln}\left[\mathrm{TRA}_{\mathrm{i,t}}\right] = \beta \cdot \mathrm{Ln}\left[\mathrm{TRA}_{\mathrm{i,t-1}}\right] + \gamma \cdot \mathrm{Ln}\left[\mathrm{X}_{\mathrm{i,t}}\right] + \mu + \phi_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \quad (1)$$

The measure of transportation variable is represented by $\mathrm{Ln}\left[TRA_{i,t}\right]$ which is the inland freight per capita or passenger transportation per capital in 4-yr time span. The past 4-yr span transportation variable is represented by β. In order for it be consistence with the concept of convergence, it has to be between 0 and 1. Nation's specific effects and the time specific effects are measured by μ and ϕ_t. Several variables are used as control variables which are believed to have an impact on the transportation convergence, which are openness, per capita GDP, inward FDI stock, and urbanization. Therefore, $\mathrm{Ln}\left[\mathrm{X}_{\mathrm{i,t}}\right]$ and γ represent the control variables and their coefficients. Lastly, $\varepsilon_{\mathrm{it}}$ represents the error term where i represents the country indices, and t represents the time period.

3.5. Data Collection

Data for the study was collected from different sources. The data was collected for 23 OECD countries from the period of 1970 to 2015, and it was collected in the form of panel data.[1] The dependent variable for carrying out the analysis is kept as either inland per capita freight transportation or the inland per capita passenger transportation as the transportation convergence is being looked up. Due to the data being accumulated through the online available data, the list of transportation measures is limited to the data which is available. OECD statistics was used for attaining the data for inland passenger transportation (in million passenger-km) and inland freight transportation (in million ton-km). Inland passenger transportation includes the transportation which is available to the passengers within the nation's boundaries in form of rail and road, whereas, inland freight transportation consists of means of transportation for freight via road, rail, pipelines, and waterways that are available in the nation's boundaries. United Nations (UN) statistics database was used for attaining data for urban population, total population, per capita GDP (in million USD at constant prices of year 2010), and inward FDI stock as a percentage of the GDP for all 23-OECD countries. Whereas, the data for openness was attained from

[1] 23-OECD countries member: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Pen World Tables. Once the data was accumulated, it was converted into 4-yr spans in order to remove the effect of business cycle fluctuations, and to abate the serial correlation. Therefore, 11 data (time) points were obtained for total of 23-OECD countries. All the series are kept in their natural logs.

Descriptive statistics of the data attained are presented in Table 2 which consist of the average, minimum, maximum, SD (standard deviation), and the dispersion statistics of the series. Clearly, all of the variables of the study are collinearity-free, due to the variance inflation factor (VIF) is kept less than 10, and the tolerance value (TV) is more than 0.10, and the critical value is at 10% level. Following section goes over the analysis and findings of the study.

3.6. Analysis and Findings

Table 2 shows the descriptive statistics of data in natural log, Tables 3, 4, 5 and 6 show the results of 4-yr span data for 23-OECD nations for the years 1970 to 2015 which were obtained through One-Step Difference GMM estimation and Two-Step System GMM estimation.

3.6.1. Descriptive Analysis

Estimation results of difference GMM and System GMM of 4-year averaged data for the OECD-23 (listed in Chapter 2) countries are reported in Tables 3, 4, 5 and 6 accordingly. The report covers the results of one-step System GMM estimators due to the downward bias of asymptotic standard errors of the two-step System GMM (Hoeffler, 2002; Blundell & Bond, 1998). In Tables 3 and 4 the dependent variable is the inland per capita freight transportation and in Tables 5 and 6 the dependent variable is inland per capita passenger transportation. The estimations for lagged inland per capita freight transportation is reported in Tables 3 and 4 and the estimations for lagged inland per capita passenger transportation is reported in Tables 5 and 6, implying the first row as β. The value of β is and indicator of convergence which is expected to be between 0 and 1; in other words, β-1 takes values between -1 and 0. The column (1) in all Tables are showing the absolute convergence and columns (2) to (5) illustrate conditional convergence estimations using

different control variables. The higher the value of β-1 in absolute term the stronger the convergence process is meant (Beyzatlar & Yetkiner, 2017).

Table 2- Descriptive statistics of data in natural log forms

Variables	Observations	Mean	Min.	Max.	Sd.	VIF	1/VIF
Inland per capita freight transportation (ton-km)	276	7.873	4.517	10.13	0.983	2.09	0.47
Inland per capita passenger transportation (passenger-km)	276	8.440	3.634	9.602	1.367	2.00	0.49
Per capita GDP (US dollars in 2010)	276	10.17	7.619	11.41	0.684	1.76	0.56
Openness (%)	276	3.870	2.311	5.336	0.605	2.33	0.42
Inward FDI stock (%)	220	2.750	-1.173	5.403	1.225	2.40	0.41
Urbanization (%)	276	4.280	3.670	4.583	0.177	1.08	0.92

Min., Max., Sd., VIF and 1/VIF symbolize minimum, standard deviation, variance inflation factor and tolerance value correspondingly

The estimations in the Table 3 are the result of applying Equation (1) as one-step Difference GMM on dependent variable inland per capita freight transportation. The coefficients between 0 and 1 for lagged inland per capita freight transportation is consider as highly significant in all regressors as an indication of convergence between OECD-23 countries in inland freight transportation in terms of absolute and conditional.

Table 3- Dynamic panel-data estimation of 4-year averaged data, one-step difference GMM

Inland per capita freight transportation as dependent variable					
	(1)	(2)	(3)	(4)	(5)
Inland per capita freight transportation of the previous period	0.629*** (0.136)	0.253** (0.103)	0.282*** (0.0864)	0.531*** (0.146)	0.314** (0.121)
Per capita GDP	.	0.547* (0.302)	.	.	.
Openness (%)	.	.	0.315 (0.193)	.	.
Inward FDI stock (%)	.	.	.	0.0431 (0.0613)	.
Urbanization (%)	.	.	.	.	1.860 (1.913)
Observations	230	230	230	197	230
Groups	23	23	23	23	23
Instruments	10	19	19	17	19
Hansen p value	0.018	0.244	0.208	0.240	0.047
AR (2)	0.676	0.643	0.574	0.459	0.592

All values in parentheses are presenting heteroscedasticity-consistent standard errors. The previous period of inland per capita freight transportation is treated as predetermined in all GMM regressions, and endogenous regressors are treated all of control variables. Values of AR (2) are presented as p values in the first difference equation for the second order autocorrelated disturbances

Note: ***, ** and * represent the significance at 1, 5 and 10 % level, respectively

The highest value (in conditional term) was found in column (2), which is -0.747 (=0.253-1), with the control variable as GDP per capita. The unconditional run shows that the lowest coefficient of lagged freight transportation is -0.371 (=0.629-1). It is when we take the dependent (per capita inland fright transportation) variable in its first lag. If control variables are added, the convergence becomes faster. Alongside, it was found that all the coefficients of the control variables were positive, just as expected, and all the control variables were statistically significant at 1 and 5 % levels.

Table 4 - Dynamic panel-data estimation of 4-year averaged data, two-step system GMM

Inland per capita freight transportation as dependent variable					
	(1)	(2)	(3)	(4)	(5)
Inland per capita freight transportation of the previous period	0.887*** (0.0775)	0.843*** (0.0810)	0.866*** (0.0810)	0.890*** (0.0838)	0.537* (0.259)
Per capita GDP	.	0.0424 (0.0466)	.	.	.
Openness (%)	.	.	0.0101 (0.0358)	.	.
Inward FDI stock (%)	.	.	.	0.0438* (0.0225)	.
Urbanization (%)	.	.	.	.	0.261 (0.559)
Observations	253	253	253	220	253
Groups	23	23	23	23	23
Instruments	26	25	23	25	10
Hansen p value	0.310	0.218	0.145	0.234	0.165
AR (2)	0.676	0.678	0.677	0.911	0.749

All values in parentheses are presenting heteroscedasticity-consistent standard errors. The previous period of inland per capita freight transportation is treated as predetermined in all GMM regressions, and endogenous regressors are treated all of control variables. Values of AR (2) are presented as p values in the first difference equation for the second order autocorrelated disturbances

Note: ***, ** and * represent the significance at 1, 5 and 10 % level, respectively

Estimations in Table 4 are the result of applying Equation (1) on inland per capita freight transportation as dependent variable. The coefficients between 0 and 1 for lagged inland per capita freight transportation is consider as highly significant in all regressors as an indication of convergence between OECD-23 countries in inland freight transportation in terms of absolute and conditional. The highest value was found in column (5), which is -0.463 (=0.537-1), here the control variable is Urbanization. The unconditional run shows that the lowest coefficient of lagged freight transportation is -0.113 (=0.887-1), it is when we take the dependent (inland fright transportation per capita) variable in its first lag. If control variables are added, the convergence becomes fasters. Alongside, it was found that all the coefficients of the control variables were positive, just as expected, and all the control variables were statistically significant at 1 and 10 % levels.

Table 5- Dynamic panel-data estimation of 4-year averaged data, one-step difference GMM

Inland per capita passenger transportation as dependent variable					
	(1)	(2)	(3)	(4)	(5)
Inland per capita passenger transportation of the previous period	0.970*** (0.057)	0.501** (0.179)	0.587*** (0.204)	0.335*** (0.083)	0.661*** (0.189)
Per capita GDP	.	0.374 (0.267)	.	.	.
Openness (%)	.	.	0.047 (0.063)	.	.
Inward FDI stock (%)	.	.	.	0.334 (0.223)	.
Urbanization (%)	.	.	.	.	0.355 (0.351)
Observations	230	230	230	197	230
Groups	23	23	23	23	23
Instruments	19	12	14	12	19
Hansen p value	0.345	0.453	0.723	0.298	0.164
AR (2)	0.438	0.785	0.346	0.675	0.578

All values in parentheses are presenting heteroscedasticity-consistent standard errors. The previous period of inland per capita freight transportation is treated as predetermined in all GMM regressions, and endogenous regressors are treated all of control variables. Values of AR (2) are presented as p values in the first difference equation for the second order autocorrelated disturbances

Note: ***, ** and * represent the significance at 1, 5 and 10 % level, respectively

The estimations in Table 5 are the result of applying Equation (1) as one-step Difference GMM on dependent variable inland per capita passenger transportation. The coefficients between 0 and 1 for lagged inland per capita passenger transportation is consider as highly significant in all regressors as an indication of convergence between OECD-23 countries in inland passenger transportation in terms of absolute and conditional. The highest value (in conditional term) was found in column (4), which is -0.066 (=0334-1), here the control variable is inward FDI stock as percentage of GDP. The unconditional run shows that the lowest coefficient of lagged friend transportation is -0.03 (=0.970-1), it is when we take the dependent (inland per capita passenger transportation) variable in its first lag. If control variables are added, the convergence becomes fasters. Alongside, it was found that all the coefficients of the control variables were positive, just as expected, and all the control variables were statistically significant at 1 and 5 % levels.

Table 6- Dynamic panel-data estimation of 4-year averaged data, two-step system GMM

Inland per capita passenger transportation as dependent variable					
	(1)	(2)	(3)	(4)	(5)
Per capita inland transportation of the previous period	0.719*** (0.213)	0.810*** (0.132)	0.575* (0.299)	0.806*** (0.276)	0.650*** (0.199)
Per capita GDP	.	0.370 (0.131)	.	.	.
Openness (%)	.	.	0.064 (0.032)	.	.
Inward FDI stock (%)	.	.	.	0.037 (0.093)	.
Urbanization (%)	.	.	.	.	1.954 (0.025)
Observations	253	253	253	220	253
Groups	23	23	23	23	23
Instruments	13	17	16	13	17
Hansen p value	0.795	0.274	0.214	0.201	0.101
AR (2)	0.564	0.621	0.469	0.598	0.384

All values in parentheses are presenting heteroscedasticity-consistent standard errors. The previous period of inland per capita passenger transportation is treated as predetermined in all GMM regressions, and endogenous regressors are treated all of control variables Values of AR (2) are presented as p values in the first difference equation for the second order autocorrelated disturbances

Note: ***, ** and * represent the significance at 1, 5 and 10 % level, respectively

The estimations in the Table 6 are the result of applying Equation (1) as two-step System GMM on dependent variable inland per capita passenger transportation. The coefficients between 0 and 1 for lagged inland per capita passenger transportation is consider as highly significant in all regressors as an indication of convergence between OECD-23 countries in inland passenger transportation in terms of absolute and conditional. The highest value (absolute) was found in column (3), which is -0.425 (=0.575-1), here the control variable is openness. The unconditional run shows that the lowest coefficient of lagged passenger transportation is -0.281 (=0.719-1), it is when we take the dependent (inland per capita passenger transportation) variable in its first lag. If control variables are added, the convergence becomes fasters. Alongside, it was found that all the coefficients of the control variables were positive, just as expected, and all the control variables were statistically significant at 1 and 10 % levels.

To summarize the findings, in all the estimations, $\hat{\beta}$'s, the coefficients of lagged inland passenger and freight transportation per capita are in between the values of 0 and 1, and are statistically significant at 1%. This shows that there is both conditional and unconditional convergence in the transportation measures used. The tests applied in the study were used in order to check the consistency of both estimators applied. The Hansen test illustrates the p-values for the null hypothesis of validity of the over-identifying restrictions (Hansen, 1982). No null hypotheses were rejected.

CHAPTER 4: CONCLUSION AND POLICY IMPLICATOINS

4.1. Conclusion

The study applied a transportation convergence equation for measuring whether there exists a convergence behavior for 23-OECD nations for the years 1970 to 2015, through the panel data with 4-yr span. The results which were obtained through Difference GMM estimator and System GMM Estimator have estimated for both the absolute and conditional convergence, which show the existence of convergence both for passenger and inland per capita freight transportation in the 23-OECD nations. The results also showed that the convergence takes place faster if controlled variables are placed. The overall results of all the specifications are generally robust when speaking of validity, for the significance levels and signs, and for the control variables which were used in the study. Hence, it is concluded that our study found similar patterns which were found earlier by other studies regarding the income convergence of EU nations in the process of economic integration which are also present in the transportation sector.

4.2. Policy Implications

Most of the studies has been going on regions which are geographically located in the same continent and are part of economic unions with their neighbor countries. The economic policies which are implemented are based on the conditions of that geography. However, when it comes to the cross-continental economic union policies it may change the game because of the distance which these countries are located. In terms of transportation convergence within OECD countries which is carried out in this paper can shed light on cross-continental Common Transport Policy. The most important policy implication of this study is that the front-end income convergence has been so strong among these OECD countries that led to convergence in the back-end transportation sector, although most member countries are scattered throughout the globe.

It can be recommended to the researchers to carry out future research transportation convergence with different nations which have some sort of economic integration. There are number of economies in world which are integrated at different level. Another recommendation is to carry out comparison study between EU nations and OECD nations (OECD member nations which are Non-EU members vs EU) in order to see how convergence differs among these nations.

Alongside, it can be also recommended for future studies to carry out study on the other back-end sectors of economies as they might not be studied and are undermined by current researchers. This will help to enlighten the importance and existence of small sectors which make a big difference in the economies.

REFERENCES

Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind . *The Journal of Economic History, 46*(2), 385-406 .

Aghion, P., & Howitt, P. (1992). "A Model of Growth through Creative Destruction. *Econometrica, 60*, 323–351.

Aghion, P., & Howitt, P. (1998). *Endogenous Growth Theory*. Cambridge, MA: MIT Press.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: monte carlo evidence and an application to employment equations. *Rev. Econ. Stud., 58*(2), 277–297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *J. Economet., 68*(1), 29–51.

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, 155-173.

Baier, S., & Bergstrand, J. (2001). The growth of world trade: tariffs, transport costs and income similarity. *J. Int. Econ, 53*(1), 1-27.

Banister, D. (2012). Transport and economic development: reviewing the evidence. *Transport Reviews , 32*(1), 1-2.

Barro, R. J. (1991, May). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics, 106*(2), 407-443.

Barro, R. J., & Grilli, V. (1994). Convergence. In *European Macroeconomics* (pp. 282-283). The Macmilian Press LTD.

Barro, R. J., & Sala-i-Martin, X. (2003). Two Concepts of Convergence. In *Economic Growth* (pp. 462-482). Cambridge, Massachusetts, London, England: The MIT Press.

Barro, R. J., & Sala-i-Martin, X. X. (1997). Technological Diffusion, Convergence, and Growth. *Journal of Economic Growth, 2*(1), 1-26.

Baumol, W. (1986). Productivity Growth, Convergence, and Welfare: what the Long-run Data Show. *American Economic Review, 76*, 1072-1085.

Beyzatlar, M. A., & Yetkiner, H. (2017). Convergence in transportation measures across the EU-15. *Transportation, 44*(5), 927-940.

Beyzatlar, M., Karacal, M., & Yetkiner, H. (2014). Granger-causality between transportation and GDP: a panel data approach. *Transp. Res., 63*, 43-55.

Blundell, R., & Bond, S. (1998). Initial conditions and Moment restrictions in dynamic panel data model. *J. Economet., 87*(1), 115–143.

Blundell, R., Bond, S., & Windmeijer, F. (2001). Estimation in dynamic panel data models: Improving on the performance of the standard GMM Estimator. In B. Baltagi, T. Fomby, & R. Carter Hill, *Nonstationary Panels, Panel Cointegration, and Dynamic Panels* (Vol. 15, pp. 53-91). Bingley: Emerald Group Publishing Limited.

Bond, S., Hoeffler, A., & Temple, J. (2001). GMM Estimation of Empirical Growth Models. *Nuffield College, Working Paper*.

Bose, N., & Haque, M. (2005). Causality between public investment in transport and communication and economic growth. *J. Econ. Dev., 30*(1), 95–106.

Caselli, F., Esquivel, G., & Lefort, F. (1996). Reopening the convergence debate: a new look at cross-country growth empirics. *Journal of Economic Growth, 1*(3), 363-389.

Caselli, F., Esquivel, G., & Lefort, F. (1996). Reopening the convergence debate: a new look at cross-country growth empirics. *J. Econ. Growth, 1*(3), 363–389.

De Long, J. B. (1988). Productivity Growth, Convergence, and Welfare: Comment. *American Economic Review, 78*(5), 1138-54.

Domar, E. D. (1946). Capital expansion, rate of growth, and employment. *Econometrica, Journal of the Econometric Society*, 137-147.

Easterly, W., & Levine, R. (1997). Africa's growth tragedy: policies and ethnic divisions. *Quarterly Journal of Economics, 112*(4), 1203-1250.

Eberhadt, M., & Teal, F. (2011). Econometrics for Grumblers: A new look at the literature on cross-country growth empirics. *Journal of Economic Surveys, 25*(1), 109-155.

Eddington, S. R. (2006). *Transport's role in sustaining the UK's productivity and competitivenes.* Department for Transport.

Elmslie, B. T. (1995). Retrospectives: The Convergence Debate Between David Hume and Josiah Tucker . *The Journal of Economic Perspectives, 9*, 207-216 .

Gartner, M. (2006). The production function and growth accounting. In *Macroeconomics* (2 ed., pp. 230-237). Financial Times/ Prentice Hall.

Graham, D. (2014). *Causal Influence for Ex-post Evaluation of Transport Interventions.* International Transpor Forum Disscussion Papers. Retrieved from http://hdl.handle.net/10419/109182

Hansen, L. (1982). Large sample properties of generalized method of moments estimators. *Econometrica, 50*(4), 1029–1054.

Harris, R. (2011). Modles of regional growth: past, present and future. *Journal of Economic Surveys, 25*(5), 913-951.

Harrod, R. F. (1939). An essay in dynamic theory. *The Economic Journal, 14*(193), 14-33.

Hoeffler, A. (2002). The Augmented Solow Model and the African growth debate. *Oxford Bull. Econ. Stat., 64*(2), 135–158.

Hong, J. (2007). Transport and the location of foreign logistics firms: the Chinese experience. *Transp. Res. A Policy Pract. , 41*, 597–609 .

Hsiao, C. (2003). Analysis of Panel Data, 2nd Edition. *Cambridge University Press*.

IMF. (2015). *Making Puclic Investment More Efficient* . Washingto, D.C.: International Monetary Fund.

Islam, N. (1995). Growth empirics: a panel data approach. *Quart. J. Econ., 110*(4), 1127–1170.

Jiang, X., Zhang, L., Xiong, C., & Wang, R. (2015). Transportation and regional economic development: analysis of spatial spillovers in China provincial regions. *Networks and Spatial Economics.* doi:10.1007/s11067-015-9298-2

Jones, C. I. (1998). Introduction to Economic Growth.

Jones, C. I. (2016). The Facts of Economic Growth. In J. B. Taylor, & U. Harald (Eds.), *Handbook of Macroeconomics* (Vol. 2A, pp. 5-7). North-Holland: Elsevier.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics , 22*(1), 3-42.

Madsen, J. B. (2008). Economic Growth, TFP Convergence and the World Export of Ideas: A Century of Evidence. *The Scandinavian Journals of Economics, 110*(1), 145-167.

Mankiw, N. G. (2003). Economic Growth I: Capital Accumulation and Population Growth. In *Macroeconomics* (5 ed., pp. 191-221). Worth Publishers: Harvard University.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, *107*(2), 407-437.

Milanovic, B., & Squire, L. (2007). Does Tariff Liberalization Increase Wage Inequality? Some Empirical Evidence. (A. Harrison, Ed.) *National Bureau of Economic Research, 0-226-31794-3*, 143-181.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica, 49*(6), 1399–1416.

Nordhaus, W. D. (1969). An economic theory of technological change. *The American Economic Review, 59*(2), 18-28.

O'Rourke, K., Taylor, A., & Williamson, J. G. (1996). Factor Price Convergence in the Late Nineteenth Century. *International Economic Review, 37*(3), 499–530.

OECD. (1996). Towards Sustainable Transportation. *The Vancouver Conference.* OECD.

OECD. (2015). *Better Policies.* Retrieved 2019, from OECD iLibrary: https://dx.doi.org/10.1787/9789264251182-en

OECD. (2019). *Eonomic and Public Dipomacy*. Retrieved from GOV.SI Portal: http://www.mzz.gov.si/en/economic_and_public_diplomacy/oecd/oecds_role_mission_and_significance/

Patterson, S. (1985). Trade creation and trade diversion and transport costs. *Atlantic Economic Journal, 11*(4), 34-38.

Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., . . . White, P. (2006). The demand for public transport: the effects of fares, quality of service, income and car ownership. *Transp. Policy , 13*, 295–306 .

Pomeranz, K. (2001). LUXURY CONSUMPTION ANDTHE RISE OF CAPITALISM. In *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (pp. 116-140). Princeton Univercity Press.

Redek, T., & Sušjan, A. (2005). The impact of institutions on economic growth: the case of transition economies. *Journal of Economic Issues*, 995-1027.

Romer, D. (2006). The Solow Growth Model. In *Advanced Macroeconomics* (3 ed., pp. 5-26). The McGraw-Hill.

Romer, M. P. (1986). Increasing Returns and Long_Run Growth. *Journal of Political Economy, 95*(5), 1002-1037.

Romer, M. Paul. (1990). *Journal of Polictical Economy, 98*(5), S71-S102.

Roodman, D. (2009). A note on the theme of too many instruments. *Oxf. Bull. Econ. Stat., 71*(1), 135–158.

Sachs, J. (2003). The United States as a Coastal Nation*. *Journal of Economic Growth, 8*, 5-46.

Sala-i-Martin, X. X. (1996). The Classical Approach to Convergence Analysis. *The Economic Journal, 106*, 1019-1036.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics, 70*(1), 65-94.

Spence, M. (2011). *The Next Convergence: The Future of Economic Growth in a Multispeed World.* New York: Farrar, Straus and Giroux.

Swan, T. W. (1956). Economic growth and capital accumulation. *Economic record, 32*(2), 334-361.

UN. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. Retrieved 2019, from Sustainable Development Goals: https://sustainabledevelopment.un.org/post2015/transformingourworld

UNDP, U. N. (2019). *Human Development Reports*. Retrieved from Human Development Index (HDI): http://hdr.undp.org/en/content/human-development-index-hdi

Yu, N., De Jong, M., Storm, S., & Mi, J. (2012). Transport infrastructure, spatial clusters and regional economic growth in China. *Transp. Rev., 32*(1), 3–28 .