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THE IMPACT OF LOGISTICS INDUSTRY ON ECONOMIC GROWTH: AN APPLICATION IN OECD COUNTRIES*

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Abstract

The most significant elements that enable us to understand economic growth and development levels of nations are economic indicators of the country of interest. As much as these indicators have positive and high values, they affect the economic, social, psychological and cultural texture of the nation positively. These effects increase the culture, living and welfare levels of the individuals in the society. Logistics is one of the tools that play an important role in the change and improvement of economic indicators. Logistics industry provides significant macro contributions to national economy by creating employment, and creating national income and foreign investment influx. On the micro scale, logistics industry is a key industry in increasing the competitive power of corporations. Furthermore, the logistics industry has an important mission in revitalizing and improvement of the competitiveness of other industries. Today, all industries are dependent on logistics sector. The present study aimed to investigate how the logistics variables of transportation and communication affected economic growth in 34 OECD countries. The effect of both transportation industry variables and communication industry variables that form the logistics industry on the increase in per capita income in OECD countries was identified.

Keywords: Logistics Industry, Economic Growth, Panel Data Analysis, OECD Countries, Foreign Trade, Transportation and Communications Industry

1. Introduction

The logistics industry, which exhibited great development during recent years globally, is the lifeblood of economies. Logistic activities are extensively important for production and trade sectors. Manufacturing corporations procure raw materials, process these raw materials in the production operations and ship their products to the end users all thanks to logistic activities. Logistics is a rather comprehensive concept. Although the concept is considered with an emphasis on transportation, its use has widened during the recent years. Generally, logistics reflects the processes of the flow of information from the origin of the raw material to the end point where the product is consumed, planning and controlling this process both in a productive and low-cost manner via storage and inventory facilities. In this context, logistics includes several types of services. These fundamental services include transportation, customs clearance, storage, handling, insurance, packaging, stocks and inventory management,

customer relations management and customer specific services. Abovementioned services increased the significance of the logistics industry and thus, the industry became the sector with the highest share in services in several countries.

In the 21st century, logistics industry is considered as one of the 3 most important industries along with microbiology and gene technology. Due to the increasing distance between the procurement and consumption points of the commodities in the global scale, logistics industry started to be considered as a significant tool for competition, which in turn increased the interest for the industry especially in developed countries. The industry has a considerable share in GDP of the US and Europe. Furthermore, as Asia became a global trade center and as the world trade volume increased beyond 27 trillion dollars, the logistics industry is in a rapid growth trend.

As a result of globalization, expanding international trade volume forced nations to increase their logistics capacities. Development of the logistics industry facilitated production, distribution and marketing, providing serious global competitive advantages to the nation that invested in the field. Accurate and active planning of logistic activities became a significant tool for countries to gain advantages in both costs and efficiency. Logistics, in the times that we live in, plays an active role in development and became an indispensable factor in trade. Accordingly, developments in logistics industry provide serious advantages in growth and development.

Logistics entails a wide spectrum of services including flow of information and transportation and distribution of raw material resources to the end market where the commodities are consumed (Rodrigue, 2012). According to Council of Supply Chain Management Professionals, which is the main global foundation for the logistics network, logistics management includes positive, active and productive planning, implementation and control of commodities, labor and related information from the starting point to the point of consumption (CSCMP, 2013). In this respect, the logistics system includes a structure related to the movement and distribution of the required infrastructure and various materials, financing, information flow in a country (Navickas *et al.* 2011). Thus, it entails logistics investments by corporations in certain components such as several transportation networks, storage systems, information and communication tools, packaging services and financial supply chain management. Logistics investments have several outputs. However, it also has significant contributions such as integration with the trade and supply chain, better utilization of national transportation resources, creating new employment opportunities, and providing more competitive imports and low costs in exports. Although institutional infrastructure investments are still at an insufficient level for load distribution, in addition, investments should be conducted to include logistics support activities and in a broader framework (Rodrigue, 2012).

The key factor in logistic activities is transportation. Thus, development of transportation infrastructure in the globalization process played a significant role in the integration of nations in global economy. Transportation costs and efficiency increasingly gain importance for all nations. Investments in this field reduced the costs, increased efficiency and facilitated trade. As a result, developments in another aspect of market and local activities, in the information and communications industry, decreased the cost of access to information, providing significant advantages for nations and corporations. Thus, the effects of considerable distances became irrelevant, facilitating research and information activities, advertising, sales, and order and transportation services. It could be argued that logistics industry plays the leading role in development and growth of nations.

Despite the importance of the logistics industry, there is insufficient number of studies that investigated the effects of logistics industry on economic growth in the literature. A literature review on the empirical studies that researched the significance of the logistics industry would demonstrate that most were single-country studies, which utilized time series analyses. Furthermore, it could also be observed that certain studies are based on panel data for certain regions and cities of a country. However, a limited number of studies covered panel data for more than one country. An important point about the studies found in the literature was their representative use of the logistics industry. Furthermore, the studies that discussed logistics industry investments as a multi-dimensional factor are a minority. In the present study that

focuses on the related insufficiencies of the past literature, the effects of the developments in the logistics industry of sample OECD member countries on the logistics industry are investigated. The present study that utilized panel data analysis, the aim was to determine which developments in the activity areas, which demonstrated a rapid growth in the logistics industry, affected the economic growth the most. It is expected that the findings of the present study would guide national growth and development policies. It was considered that the use of a wide variety of variables would contribute significantly to the field literature.

Sections are planned as follows. The first section of the study consists of a literature review. In the second section, an econometric model will be developed utilizing the variables which were used in the econometric model studies in the literature. With the help of the econometric model developed in the second section, the effect of logistics on economic growth based on per capita income will be scrutinized for 34 OECD member countries. The final section will include the results of the study and a discussion on these results.

2. Theoretical Framework and Literature Review

2.1. Theoretical Framework

Due to close relationship between economics and logistics, the concept of economics of logistics was established. Economics of logistics (Catalbas, 2012) studies the process where logistic companies would maximize their returns with the lowest cost possible to provide for the infinite demands of their customers. Naturally, this efficiency would be possible only through good management. In other words, logistics is related to how the corporations would achieve maximum returns with minimum costs in the micro sphere and in the micro sphere, it entails how productivity, employment, growth, and contribution to national economy could be improved. Studies conducted on economics of logistics were mostly on transportation and logistics for an extended number of years. Early studies started with the “Transportation economy” course given by Yale University Rector Henry Adams during 1850’s (Catalbas, 2012). The number of studies on logistics started to increase during 1950’s and 1960’s. Logistics and distribution topics changed conceivably and gained a new vision after the work “The Economy’s Dark Continent” by Peter Drucker published in 1962. In 1960’s, decreasing profit rates in the developed nation corporations forced the latter towards customer demand oriented production and development and implementation of marketing techniques. As a result of these studies, minimizing the loss of time by increasing the speed of consumer choice processes, order processes, handling and packaging and customer satisfaction became prominent. With the impact of increasing oil prices towards the mid-70’s, conducting logistics activities with lower costs became important. As a result, logistics that incorporated only physical supply and physical distribution phases previously differentiated both in meaning and activities. After this period, logistics activities included transportation, inventory management, taking orders, procurement, packaging, storage, transportation of material and information activities, changing the context of logistics activities and the necessity of a better management and organization became apparent.

Since 1970’s, advances in information and communication technologies, developments in modes of transportation and technological advances resulted in globalization of the world economy. Regional and global international trade organizations (such as GATT) removed the physical barriers in commerce and the global trade gained momentum. On the other hand, the increase in bilateral and multilateral agreements to guarantee direct foreign capital investments, incentives provided by the World Bank resulted in a new vision in global trade. As the obstacles hindering the international trade disappeared and direct foreign capital investments and the share of multinational corporations in world economy increased, the number of companies that conducted wholesale and retail activities in the national and international spheres increased as well. All these developments set the scene for the growth of international trade and the logistics industry. Along with the increase in the trade of previously untraded commodities and rapid movement of information and services between the nations, the foundations of today’s understanding of logistics were laid. Removal of the barriers in global trade and globalization increased the competition among the corporations both nationally and internationally. Increased

competition made it necessary for corporations and nations to consider policies to maintain a balance between reduced prices increase in quality and costs.

It was determined that as a result of this interaction between logistics and economy; logistic system affected the economy positively. Especially, it became obvious that for the rapid movement of produced goods and services both in national and international arena and to increase the competitive power, the significance of highway, railroad, seaway, airline transportation and investments in wholescale transportations capabilities became obvious. It is apparent that the effectiveness of logistic processes improves the competitiveness of corporations in the micro scale and national economies in the macro scale. As a result of past developments, today, the importance of physical possibilities such transportation infrastructure and storage is understood. Active customer services that complement the abovementioned developments provide further superiority for corporate competitiveness at the current state.

2.2. Literature Review

The logistics industry that plays a significant role in global economy as well as in Turkey and is one of the major revenue item in national economies due to its direct relation affects growth in several countries and create superior competitiveness. However, despite its importance, there is not sufficient number of studies in economics literature on logistics industry. One of the main reasons for that is the lack of empirical data on the industry that could form the basis of such studies.

Logistics industry has a long history both in the world and in Turkey. Thus, access to time series on industry data is not available in many countries. Since existing data are mostly related to types of transportation, conducted empirical studies are limited to the sub-industry of transportation. Related literature review shows that most studies on the logistics industry were conducted using qualitative methods. The numbers of quantitative studies are very limited. There are also empirical studies on the economic effects of the logistics industry in the literature, albeit few. Studies conducted internationally are mostly research that assessed the correlation between economic growth and logistics industry and conducted in China. China has the highest economic growth rate in the world and significant developments were experienced in the logistics industry in China. The studies conducted there basically scrutinized the relationship between the developments in the logistics industry and economic growth.

We can summarize the studies carried out in the literature investigating the correlation between the logistics industry and economic growth as follows: Madden and Savage (1998) studied OECD, Transitional Countries in Central and Eastern Europe for 1990-1991. They use panel data analysis and they results of their study, a strong correlation was found between telecommunication investments and economic growth. It was determined that especially telephone lines affected growth significantly and positively. Madden and Savage (2000) studied 43 Countries from 1975-1990 with they used OLS and random effects model. It was found in the study that telecommunication (communications) investments improved marketing information and increased international trade, which in turn positively affected economic growth. Roller and Waverman (2001) investigated for 21 OECD member countries 1970-1990. They used panel data analysis and as a result, It was identified that information technology investments increased economic growth more in developed OECD countries when compared to undeveloped OECD countries. It was stated that especially the number of Internet and telephone users created a very positive effects. It was also determined that logistics investments increased the demand for goods and services. Anusua and Agarwal (2004) studied 22 OECD countries from 1980-1992 with they used dynamic panel data analysis fixed effects. The study concluded that telecommunications investments increased per capita income. Lu and Yang (2006) investigated for Kaohiung, Hong Kong, Shanghai regions Taiwan manufacturers. They used survey method, factor analysis of survey data and ANOVA. It was determined as a result of conducted analysis that political risk, selection of location, transportation and logistics infrastructure investments, and available logistics services were important for the companies in making logistics infrastructure investment decisions. In short, it was determined that logistics zoning areas attracted investments. Kanwall *et al.* (2008) investigated for Middle, high and low

income group countries (24 countries) between 1985-2003. They used both dynamic fixed effects and random effects in panel data analysis. It was determined that telecommunication investments (direct foreign capital investments) increased per capita income. Mohamad (2012) studied for Indonesia between 1988-2010 and he used regression analysis. He a powerful correlation was found between logistics industry and economic growth. Farhadi and Rahmah (2014) investigated 159countries divided into four sub-categories for 2000-2009. They used panel data analysis. The categories were high income group countries (51), medium-high income group countries (39), low-medium income group countries (40) and low income group countries (29). In this time period, a significant correlation was discovered between information technology (BT) investments and per capita income. Hayaloglu (2015) investigated 32 OECD countries for 1994-2011. They used static panel data analysis. As a result of the conducted analysis, different variables were used as an indicator of the developments in the logistics industry and it was determined that the correlation between the logistics industry and economic growth differed based on the data used. Boopen (2006) investigated Sub-Saharan African nations and developing nations. They used horizontal section panel data analysis. It was found that transportation infrastructure contributed to economic growth in both country groups. Berechman *et al.* (2006) investigated US states and municipalities for 1990-2000. They used time series. It was determined that in counties (municipality level), the penetration effect of transportation investments were higher. However, the same effect decreased in the state and national levels. Egert *et al.* (2009) investigated 24 OECD member countries for 1960-2005. They used time series. It was determined that infrastructure investments had a significant effect on economic growth. Furthermore, section analysis demonstrated that infrastructure investments in communications and electrical power industries had a powerful and positive effect on long term growth. Kayode *et al.* (2013) investigated Nigeria for 1977-2009. They used Granger causality test. It was determined that transportation infrastructure investments had an insignificant role in determination of economic growth. Aschauer (1989) investigated USA for 1949-1985. He used input-output analysis. Correlation between infrastructure investments and economic growth was analyzed. For this purpose, public infrastructure investments (i.e. airline, land route, maritime, transit) were added as an input to the production function and neoclassical production function was estimated. As a result, it was determined that public sector transportation investments had a positive effect on economic growth. Fernald (1999) investigated USA for 1953-1989. He used productivity measured for 29 sectors with input-output analysis. It was found that public sector highway investments increased the total production productivity in the US. Groote *et al.* (1999) investigated Netherlands for 1853-1913. He used vector auto regression (VAR) and Granger causality test. It was found that transportation infrastructure investments in Holland had a positive effect on economic growth. Greenstein and Spiller (1996) investigated USA for 1986-1992. They used least squares method. The study investigated the effect of communications infrastructure in the US (measured by fiber optic and cable lines) on economic growth. It was determined that communications investments and local communications services had a significant impact on the increase in users and commercial revenues during recent years. It was identified that this affected economic growth positively. Norton (1992) investigated 47 countries for 1957-1977. He used panel data analysis. It was determined that increase in communications infrastructure investments had positive effect on economic growth. It was found that this effect was due to the facts that operation costs decreased when infrastructure was present, communications promoted the growth in all industries, and thus triggered the economic growth. Hardy (1980) investigated 60 countries for 1960-1973. He used panel data analysis and fixed effects. In the study, it was determined that per capita telephone lines had an impact on per capita GDP increase in 15 developed and 45 developing nations. However, when all scrutinized countries were evaluated, it was observed that above mentioned effect was not valid, but when the countries were grouped as developed and developing nations, increase in per capita telephone lines positively affected the economic growth. Laszuk and Ryciuk (2016) investigated security of supply chain in the international goods turnover for 28 countries. Supply chain is very important and effect for logistics sector. As a result of the article, it has emerged that all efforts to secure the supply chain should provide

better protection, uninterrupted and smooth flow of goods. It is also emphasized that managing supply chain security is a prerequisite for supply chain competitiveness.

We see that the majority of studies in the literature are made for the provinces of China and China. Liu *et al.* (2006) investigated China for 1952-2004. They used Granger causality test. Study findings demonstrated that there was a short term negative and a long term positive correlation between per capita income and cargo turnover rate that represents logistics investments in China during the related period. Hong (2007) investigated Chinese provinces for 1997-2006. He used regression analysis. It was identified in the study that the corporations assessed maritime, land route, railroad lines, market size, quality of labor, economies of scale and government incentives when making investment decisions. It was found that foreign investments improved further in regions where land route transportation is developed and infrastructure investments are made. Ding *et al.* (2008) investigated Chinese provinces for 1986-2002. They used system GMM, OLS, fixed effects. A significant and positive correlation between telecommunication (communications) infrastructure investments and regional growth in Chinese provinces was found. Shuang (2009) investigated China for 2001-2008. He used principal components analysis and analysis of variance regression. It was determined that added value variables of the logistics industry; logistics industry employment, new fixed capital investments, cargo volume, cargo turnover rate were all effective on economic growth, however the variable that affected economic growth the most was cargo turnover rate. Wang and Wang (2010) investigated China for 1998-2008. They used regression analysis. It was determined that increase in foreign investments in the logistics industry had a significant and positive effect on economic growth. Li *et al.* (2010) investigated Xuzhou region in China for 2000-2009. They used analysis of variance. The study identified that there was a more powerful correlation between the growth in logistics industry and economic growth between 2000 and 2008, this correlation weakened between 2000 and 2009. The study recommended the local governments to implement region-specific political incentives. Ana (2010) investigated Anhui Province, China for 1990-2009. She Granger causality test. In the study, cargo space was used as a logistic activity indicator and the findings demonstrated that logistics activities had an insignificant effect on economic growth. It was argued that logistics could be improved and economic growth could be triggered in Anhui Province by regional incentives. Chu and Liu (2013) investigated Henan Province, China for 1990-2010. They used regression analysis. It was determined that logistics industry had a positive effect on economic growth in Henan Province. However, it was also mentioned that scrutinized variables did not reflect the logistics industry adequately and further studies that would include other factors that represent the logistics industry and policy recommendations are needed. Chu (2012) investigated China for 1993-2007 with dynamic panel data analysis and GMM. A positive and significant correlation between logistics industry investments (transportation, storage, mail and communications) and growth was found in the study. However, it was also identified that the effect of logistics investments on growth was higher in underdeveloped continental provinces in China when compared to coastal provinces. Hu *et al.* (2012) investigated central regions of China for 1986-2007 with time series and granger causality test. It was found that factors such as increasing logistics investments, optimization of environmental factors for investments, increasing the logistics capacity and reduction of logistics costs would develop the logistics industry even further. It was stated that this would trigger the economic development. Hooi *et al.* (2014) investigated China with granger causality test and dynamic structural model. Transportation infrastructure investments were used to represent the logistics industry. It was determined that although railroad infrastructure investments had an indirect effect, developments in the land route and maritime transportation had a more profound effect on economic growth.

Mody and Wang (1997) investigated 23 manufacturing industry corporation data located in coastal China for 1985-1989. It was concluded in the study that increasing transportation and communication infrastructure investments and the growth in this industry positively affected economic growth. Demurger (2001) investigated 24 Chinese Provinces for 1985-1998 with Granger causality test. It was found that transportation and communication investments in 24 Chinese provinces positively and significantly affected economic growth. Cheng *et al.* (2010) investigated Henan Province in China for 1978-2008 with panel data analysis. It was concluded

that logistics industry played a significant role in economic growth. Yuan and Kuang (2010) investigated eastern, central and western regions in China. They used panel data analysis. It was determined that logistics industry had important effects on economic growth; however these effects were in different magnitudes in different regions. It was found that logistic infrastructure investments played a significant role in economic growth in more developed regions; however this effect was less significant in less developed regions. Hu *et al.* (2012) investigated correlation between logistic infrastructure investments and regional economic growth was scrutinized in central China. They used times series analysis. Based on cointegration analysis conducted in the study, three cointegration correlations were found between the variables. Based on Granger causality analysis results, it was observed that there was a one-way causality from logistic infrastructure investments to GDP and two-way causality between logistic infrastructure investments and acceleration value of logistics. Banerjee *et al.* (2012) investigated China for 1995-2010 with Granger causality test. It was found that proximity to transportation networks had an average, significant and causal effect on GDP. Furthermore, it was found that per capita GDP and income inequality were the highest in regions that are close to historical transportation networks and where more number of corporations is active and the revenues of these corporations were high as well. Cheng and Peng (2006) investigated Anhui province China for 1990-2004 with Granger causality test and VAR. Freight turnover was used to represent logistics industry and correlation between logistics and economic growth was analyzed. A positive correlation was determined between the logistics industry and regional economic growth. Fan and Chan-Kang (2008) investigated China for 1982-1999. They used random effects model. It was determined that railroad, highway and communications investments that were used to represent logistics had a significant contribution to economic growth. Studies in the literature have found that growth in the logistics sector supports economic growth.

3. Methodology and Dataset

In this section of the study, the effect of logistics industry on 34 OECD member countries (Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Turkey, Ireland, United Kingdom, Italy, USA, Japan, Finland, Australia, New Zealand, Mexico, Czech Republic, Estonia, South Korea, Slovakia, Slovenia, Chile, Israel, Hungary, Poland) using unbalanced panel data analysis. 1970-2014 data was selected as the time period. In the study, the models were established using transportation and communication variables that represent the logistics industry and also utilized in empirical studies found in the literature. Statistical data utilized in the study were obtained from OECD and the World Bank web sites.

Two different econometric models were constructed. Per capita GDP was accepted as the dependent variable. The control variables that are determined to affect per capita GDP in economic theory, namely fixed capital investments, public expenditures, human capital and employment were accepted as control variables in both models. The logarithms of all variables were taken except HC, FT and MCS variables.

Pairwise correlation and probability values for the variables used in model estimates for logistics and communication industries are presented in Table 1. Accordingly, it was determined that there was a positive and significant correlation between GFCE, EMP, GROSS and HC variables and per capita GDP variable used in the prediction of the models that included logistics industry variables. This finding was consistent with the coefficient sign and magnitudes obtained in models that included logistics industry variables. However, the existence of a positive but insignificant and positive and significant at a significance level of 5% correlation between LRAIL and LENGTH_RAILWAY variables and per capita GDP variable respectively in the general model where all the variables were used was not consistent with the coefficient signs that were obtained with the general model. Especially the lack of sufficient observation and frequency for the related variables during the period of analysis was an important factor for this inconsistent finding.

Table 1. Pairwise correlations and significance of the variables used in the analysis

	EMP	FT	GFCE	GROSS	HC	INT	INV_TE~M	INVEST	KBDG_PER	LAIR	LENGH_~S	LENGHT~Y	LRAIL	MCS
EMP	1													
FT	0.4813*	1												
GFCE	0.0236	0.4648*	1											
GROSS	0.2129*	0.644*	0.424*	1										
HC	0.1625*	0.0845**	0.0571	0.1517*	1									
INT	0.3138*	0.1874*	0.2249*	0.1589*	0.4341*	1								
INV_TELCM	0.2334	-0.0308	0.7793*	-0.5194*	0.0341	0.1768	1							
INVEST	0.0292	-0.4059*	0.2197	-0.2077	0.2364	0.3429*	0.178*	1						
KBDG_PER	0.4517*	0.8494*	0.3787*	0.6148*	0.220*1	0.4022*	-0.0909	-0.1062	1					
LAIR	0.0315	0.1368*	0.0331	0.1407*	0.036*	0.0661***	0.2589**	0.1818	0.0533***	1				
LENGH_HIGH~S	0.1512*	0.4249*	0.828*	0.2619*	0.0184	0.161*	0.7366*	0.4584*	0.3658*	0.0617**	1			
LENGHT_RAI~Y	0.0467	0.082**	0.6917*	-0.1468*	-0.2354*	-0.0163	0.4782*	0.2879**	0.0802**	-0.1581*	0.6889*	1		
LRAIL	0.1962*	0.0666**	0.2906*	-0.1065*	0.0822***	0.0422	0.3354*	0.4369*	0.0511	0.3755*	0.414*	0.455*	1	
MCS	0.1161*	0.3397*	0.3103*	0.3695*	0.3599*	0.8882*	0.1565	0.3145**	0.3241*	0.1394*	0.16*	-0.1011*	-0.0702**	1

Note: *,** and *** demonstrates that related correlation coefficient was different than zero at 1%, 5% and 10% significance levels, respectively.

It was observed that interactions of variables related to the models that included communications industry variables were not consistent with the values obtained with correlation coefficients with the exception of the first three models. While there was a positive and significant correlation between MCS variable and per capita GDP, in the model predicted for model 3, the same correlation had a negative value. INV-TELECOM variable exhibited a similar condition. As mentioned above, the most active factor for these results was the lack of sufficient observation and observation frequency, thus, the methods used in the model estimation excluded the variables, preventing the expectations to materialize with respect to coefficient signs and magnitudes.

3.1. First Model

3.1.1. Analysis and Interpretation of First Model Data

Based on the findings in model 1, fixed capital investments, human capital and employment have a boosting effect on per capita income and the results are statistically significant at 1% level of significance. Based on model 2 findings, rail road freight volume, one of the variables representing the logistics industry, has no effect on per capita income. According to the model 3, it was observed that airline freight volume, again one of the variables representing the logistics industry, statistically significantly increased per capita income.

Table 2. First model: Variables used in the model specific to transportation

Data	Data Description	Resource
GDP per capita	Per capita GSMH (current U.S.$)	World Bank
GFCE	Fixed capital investments (General government final consumption expenditure% of GDP)	World Bank
GROSS	Public expenditure (current U.S.$)	World Bank
HC	Human capital - Labor force with (% of total)	World Bank
EMP	Employment (Employment to population ratio, 15+ total %)	World Bank
LRAIL	Freight transported by railroad (million ton-km)	World Bank
LAIR	Freight transported by airlines (million ton-km)	World Bank
INVEST	Private sector transportation investments (Current U.S.$)	World Bank
LENGHT-HIGHWAYS	Length of highways (total route-km)	World Bank
LENGHT-RAILWAY	Length of railroads (total route-km)	World Bank

Table 3. Estimates for transportation industry variables representing the logistics industry

	Model 1	Model2	Model 3	Model4	Model 5	Model 6	General	General-Significance
GFCE	0.2346*	0.2416*	0.2315*	0,0445	0.2047*	0.2441*	0.2115*	0.2137*
	(25.49)	(8.72)	(25.11)	(1.15)	(19.98)	(24.58)	(18.56)	(21.46)
GROSS	0,0002	0,0003	0,0005	-0,0007	-3,6E-05	3,36E-05	0,0003	
	(0.54)	0.56	(1.11)	(-0.71)	(-0.08)	(0.07)	(0.66)	
HC	0.0032*	0.0029**	0.0031*	0.0093*	0.0031*	0.0038*	0.0035*	0.0036*
	(3.49)	(2.34)	(3.52)	(3.14)	(3.60)	(3.83)	(3.83)	(4.19)
EMP	0.0092*	0.0095*	0.0096*	0,0085	0.0092*	0.0082*	0.0087*	0.0109*
	(4.81)	(2.93)	(5.10)	(1.38)	(5.00)	(4.02)	(4.52)	(6.72)
LRAIL		0,0033					-0.0534	
		(0.06)					(-1.95)	
LAIR			0.0272*				0.07332*	0.0183**
			(2.71)				(4.44)	(2.28)
INVEST				0,0019				
				(0.34)				
LENGH_ HIGHWAYS					0.0775*		0.0767*	0.0738*
					(5.79)		(5.16)	(6.02)
LENGHT_ RAILWAY						-0.2338*	-0.2031**	-0.1727*
						(-2.70)	(-2.52)	(-3.49)
SABİT	3.6802*	3.3899*	3.5464*	8.8356*	3.5401*	5.4986*	5.1204*	4.5889*
	(15.78)	(5.54)	(15.28)	(7.51)	(15.80)	(6.67)	(6.34)	(9.41)
R-KARE	0,73	0,7505	0,7502	0,8454		0,761	0.8158	0.8078
F-DEĞER	228,26	33,75	191,04	16,4	207,95	170,66	131.22	210.19
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Note: *and ** demonstrate significance at 1% and 5% level of significance, respectively.

In model 4, the effect of private investments in logistics industry was scrutinized; however it was found that this variable had no positive effect on income. Model 5 demonstrated that the length of highways, representing the transportation industry, has a boosting effect on per capita income and the correlation is statistically significant. Model 6 findings demonstrated that the length of railroads, representing the transportation industry, increased per capita income and the correlation was statistically significant. A general look at the model related to transportation variables representing the logistics industry would demonstrate that R-square and F prob. values were generally significant (Table 2 and 3).

3.2. Second Model

3.2.1. Analysis and Interpretation of the Second Model Data

Findings concerning the model estimated with communications data are presented above. Control variables used in the transportation version were reused in model 1. Model 1 results are similar to the transportation data. In other words, fixed capital investments, human capital, and employment increase per capita income. Statistical results for the variables were also significant (Table 4).

Table 4. Second model: Variables used in the model related to communications

Data	Data Description	Resource
GDP per capita	Per capita GSMH (current U.S.$)	World Bank
GFCE	Fixed capital investments (General government final consumption expenditure% of GDP)	World Bank
GROSS	Public expenditure (current U.S.$)	World Bank
HC	Human capital - Labor force with (% of total)	World Bank
EMP	Employment (Employment to population ratio, 15+ total %)	World Bank
FT	Landlines (per 100 people)	World Bank
MCS	Cellular line subscription (per 100 people)	World Bank
INV-TELCM	Public telecommunication investments (U.S.$ million)	World Bank
INTERNET	Internet users (per 100 people)	World Bank

Table 5. Estimates for communications variables

	Model 1	Model2	Model 3	Model4	Model 5	General
GFCE	0.2346*	0.1834*	0.2744*	0.1259*	0.2600*	0.2152 *
	(25.49)	(19.46)	(18.01)	(5.75)	(10.229	(3.45)
GROSS	0,0002	-0.0002	0.0003	0.0004	-0.0001	-0.0014
	(0.54)	(-0.48)	(0.70)	(0.36)	(-0.11)	(-0.61)
HC	0.0032*	0.0031*	0 .0037*	-0.0001	0.0039**	-0.0005
	(3.49)	(3.95)	(4.06)	(-0.11)	(2.69)	(-0.67)
EMP	0.0091*	0.0092*	0.0083*	0.0175*	0.0084*	0.0211 *
	(4.81)	(5.61)	(4.40)	(2.71)	(2.88)	(3.55)
FT		0.0082*				0,0067
		(10.29)				(1.52)
MCS			-0.0006*			-0.0029
			(-3.25)			(-1.40)
INV_TELCM				0.0111**		0.0071
				(2.37)		(1.50)
INTERNET					0.0007**	0.0018
					(2.12)	(0.62)
SABİT	3.6802*	4.6211*	2.7401*	5.2984*	3.1191*	2.8985**
	(15.78)	(20.77)	(7.42)	(7.66)	(4.95)	(2.17)
R-KARE	0,73	0.8021	0.7458	0.8876	0.7434	0.9394
F-DEĞER	228,26	262.71	190.11	18.95	41.66	17.45
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Note: *and ** demonstrate significance at 1% and 5% levels of significance, respectively.

In model 2, landlines communications data were used. It was observed that this variable increased per capita income and the effect was statistically significant. It was determined that cellular line subscriptions used in model 3 had a boosting effect on per capita income and statistical result was also significant. It was found that public telecommunications investments used in model 4 increased per capita incomes statistically significantly. Number of Internet users' variable used in model 5 increased per capita incomes as well and the model was statistically significant. A general look on the models constructed with communications data demonstrated that the models were significant based on R-square and F prob. values. It was observed that communications variables increased per capita income more when compared to transportation related variables (Table 5).

4. Conclusion

In the application section of the present study, the effects of developments in the logistics industry in 34 OECD countries during the period of 1970-2014 on economic growth were

analyzed. In the present study, panel data analysis was used and the variables that were the indicators of the development of the logistics industry were investigated in two groups. In the first group, the variables of railroad and airline freight volumes, private sector logistics investments lengths of highway and railroad networks that represent transportation, which is one of the development indicators of the logistics industry, were scrutinized. No significant correlation was found between railroad freight transportation and economic growth. However, it was determined that infrastructure investments such as airline freight transportation, the length of highway network and the length of railroad network were effective on economic growth.

In the second econometric model, telecommunications and communications variables related to the logistics industry indicator of communications were utilized. These variables were landline and cellular phone subscriptions, public telecommunications investments and number of Internet users. It was found that all utilized variables contributed to the economic growth positively.

The reason for the general significance of econometric models in empirical studies in the literature is the use of single-country data or utilization of countries that are similar in terms of development level; it was observed in conducted econometric model studies that it is important to obtain accurate data for these countries easily. If a panel data analysis would be conducted with logistics industry data, it is considered that the study should be conducted with data that belongs to similar nations and within a limited period of time. Because, if the realities pertaining to the industries would be revealed accurately in the analyses, more rational roadmaps could be designed for competitiveness and economic growth of the nations as well as the growth of global economy.

As a result, it could be argued that the developments in the logistics industry in OECD countries were one of the most important determinants of economic growth. For instance, services provided by the transportation infrastructure, which represents a significant aspect of the logistics industry, play an important role in national economic activities. Investments in this field would reduce transportation costs and increase the movement of commodities and services, promoting the development of commerce. Similarly, developments in telecommunications services facilitate and expedite the improvement of research, information technology activities, advertising, sales, ordering, and transportation services. As a result, it could be stated that development of this industry in OECD countries facilitated the growth and development process by providing significant competitive advantages.

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