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The Relationship Between Internet Connectivity and Labor Productivity

A Study on the correlation between Internet Connectivity and Labor Productivity In the European Union

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Abstract

The level of labor productivity differs among the European Union countries, especially when you compare a developing country to a more developed country in the EU. This is an issue because the achievement of high labor productivity is a necessary stipulation for a developing economy to realize economic growth and more economic development. On the other hand, the more individuals in an economy with access to the internet (internet connectivity) depicts how developed the economy is in terms of information and communication technology (ICT). Accordingly, the purpose of this paper is to ascertain whether there is a positive relationship between countries having high internet connectivity and labor productivity in the EU. In doing so, Political and entrepreneurial decision-makers can use these findings to decide how much attention or budget to put on the ICT sector to improve labor productivity. To understand the factors that affect labor productivity, Adam Smith and Karl Marx's theory on labor productivity is used to gain a better understanding. A panel data analysis using a fixed-effect model and pooled OLS regression model is applied in the study to predict the relationship. The result of the study indicates that internet connectivity does not have a significant impact on Labour productivity, or there was not enough evidence showing that they are positively correlated with each other.

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1. Introduction

High productivity growth has always been one of the major accomplishments for economists in the field of macroeconomics to achieve, no matter which countries or regions the economy is in. The reason for those economists to focus on achieving high productivity and solving low productivity issues, is that productivity growth is a crucial factor of economic output growth, more specifically, there is a positive relationship between them. However, the present states of the developing countries are explicit indicators of the issue of low productivity. According to Peter and Jayam, in such developing countries, the vicious cycle of low skill - low productivity - low income has become the analytically true needle which presents frequently (Peter-Cookey et al., 2017). According to the World Bank, this vicious cycle is the fundamental cause of poverty and inequality (World Bank, 2021). Therefore, it is necessary for not only economists, but also the entire human race to gain an idea of this issue.

On the other hand, communication is one of the great factors that changes the growth of productivity.

"The Internet is becoming the town square for the global village of tomorrow."

-Bill Gates (Bosky, 2012)

Overtime, the world has shifted priority in the advocacy of development in communication between humans, and the rapid increase in productivity across the world is evidential. Myriad countries received a gigantic boost in their economic development, thus granting them a title of "Developed Countries". On the same note, Steindel and Stiroh (2011) state that the major sector which strengthens productivity growth is the industry of manufacturing, where it is exceedingly related to High tech capitals such as computers, semiconductors, and communication equipment (Steindel et al., 2001). Therefore, the purpose of this paper is to ascertain this positive relationship between productivity and communication through internet connectivity. This paper will focus on the European Union because most of the countries in this region are developed. Therefore, if we find a positive relationship between the two variables in this region then it could encourage countries that are relatively undeveloped in productivity to pay more attention to the development of internet connectivity. Thereby, considering it as a possible solution and policy to overcome some sort of productivity shortage or insufficiency.

Previously, there have been studies on the relationship between technological tools (that enable frequent communication and information) and factors of productivity already in different parts of the world and sectors. For instance, it was found that the low level of human capital apparent in South Africa compared to most developed countries is consistent with university students having less access to the internet (Oyedemi, 2012). Another study considers the effect that broadband access has on firm productivity in New Zealand (Grimes et al., 2011). Here, broadband access is what they take to represent the technological tool that enables frequent communication and information. In addition, this study uses the method of propensity score matching to compare productivity differences between firms where one firm uses broadband and its competitors do not. The Propensity score method is a way to construct an artificial control group by matching a firm that uses broadband with another firm of similar characteristics that does not use broadband. The study finds that firms who use broadband experience increased labor productivity of 7-10% compared to their counterparts. However, it is important to note that none of the papers offer any insight into this relationship in a region where there is a disparity in the level of development amongst the countries. Therefore, our paper looks to observe whether the positive relationship realized in the past studies still holds when we apply a different method to an area including multiple countries. In doing so, we can either reinforce the previous conclusion or offer a completely new insight.

To investigate our topic, we first collect data on internet connectivity, labor productivity, and the other variables we will control for. Then we regress this using a fixed effect regression model (FEM) with year dummies and a pooled OLS regression model containing year dummies respectively. This is done to examine whether the parameter of interest (Internet connectivity) is positive and significant. Furthermore, we conduct a robustness test where we carry out the same procedure but in countries not part of the EU. This is done to see whether the same observations from the main sample still hold under the new conditions. We find that the parameter of internet connectivity is positive but not significant under the FEM. But when the pooled OLS model is applied then the parameter becomes positive and significant. Furthermore, we find that the parameter of internet connectivity is not significant albeit positive under both models of regression in the robustness test.

The rest of the thesis will be structured as follows: Section 2 provides a background on the European Union. Section 3 presents the theoretical background on labor productivity as well as past findings on the topic based on previous empirical studies. Section 4 portrays the main hypothesis of this paper. In section 5, the method of data collection, method of data analysis as well as the variables included in the models are illustrated. Section 6 includes the main findings of our study followed by the analysis. In section 7, we conclude the paper and provide implications for future studies.

2. Background

The European Union is an international organisation which consists of 27 countries. It is dedicated to formulating economic and political related policies, and is known for its high proportion of developed countries within its area. There have been established agreements for a better convenience of development within the memberships such as the European Union Free Trade Agreements. Nevertheless there are developing countries such as Albania and North Macedonia (World Population Review, 2022). The developed countries within this union, such as Belgium, Sweden, and Denmark, have an elevated level of education (Higher human capital index) and access to technology compared to the minor countries in this union that are considered at a developing stage. Particularly, the most recent rate of individuals using the Internet as a percentage of countries' population of the mentioned countries is significantly higher (at an average of around 95%) compared to other countries such as Romania, Croatia and Bulgaria (at an average of around 75%) (World Bank, 2022).

This disparity is a momentous issue for the economists in the European Union to pay consequential attention to. This is because, from an economic development perspective, the development of countries tends to diverge through time (Keefer et al., 1997). This means that the countries which are at a lower development stage would have a slower developing ramp, whereas the developed countries would use their innovative technology such as the internet and communication technologies to power up their productivity more and more. This implies that in the future the developed countries would provide amenities and high levels of standard of living which is much more ideal for living than in developing countries. This could cause several issues such as income inequality between developing and developed countries and over-concentration in developed cities due to immigration from countries at a lower stage of development. According to Chen et al. (2013), the consequences of over-concentration could be, for instance, 1) unemployment or an increased informal employment, 2) insufficient capacity in various public sectors such as health care and educational facilities, for migrants to achieve the same level of living standard. 3) due to low development stage immigrants, there might be a reduction in overall human capital. Through our research, we aim to possibly offer a method through which developing countries could catch up if we find this relationship is positive

3. Theoretical Framework and Literature Review

3.1 Adam Smith's theory on labour productivity

The idea behind this theory is that laborers will be more productive when there is a division of labor so that each worker is doing what they are technically good at. The division of labor using the same manpower creates a scenario where the skill of each worker is put in the right place. In other words, productivity is improved if the skill of the worker completing the specific task is the best out of all the available manpower. Furthermore, this theory emphasizes that when there is a division of labor and not just a few people doing everything then the amount of time wasted from switching from one individual task to another will be reduced. The third element of the theory of Labor by Smith that explains improved productivity is the use of machines that facilitate the individual working steps. This part utters that technological progress shortens working hours and enables workers to complete the work of many workers alone (Brem, 2013).

Smith's work in developing a theory that explains labor productivity was important at the time and for some years to come because his theory had been the first fully systematic treatment of the subject of Labor economics (McNulty, 1973). The implication of Smith's theory is ultimately that specialization is required in the workforce because this would result in interpersonal differences between men and not the other way around (McNulty, 1973).

3.2 Karl Marx's Theory on Labour Productivity

Another theory on labor productivity was established by Karl Marx (Marx, 1887). In his theory, Marx asserts that productivity depends on the real appropriation of the means of production. In other words, there has to be a right combination between the subjective element of the labor process; that is the work itself, and the objective element of the labor process; that is the tools and objects used for the work. Therefore, the more ability and skill direct producers have, the more they can really appropriate the means of production, thus increasing productivity (Gartman, 1978).

3.3 Previous literature on Labour Productivity and Internet Connectivity

Both Smith and Marx's theory on labor productivity provides the first general framework of what it is one needs to consider when pondering labor productivity. However, to pinpoint the relationship between internet connectivity and productivity we need to consider other measurable specific factors that could influence productivity. The ability of other economists after Smith and Marx to comprehend specific variables that could affect productivity and then investigate it was made possible through the theoretical framework their body of work provided. In the twentieth century after Smith and Marx, Charles Cobb and Paul Douglas developed a production function that measures the productive potential of a country (Hajkova et al., 2007). This past research is linked to the theory of productivity by Smith and is thus useful for this paper as the developed production function indirectly shows that the level of the average product of labor depends on specific variables such as capital and technical change. The Cobb Douglas production function is as follows: $X = AL^aK^b$ where X, A, L, and K represent output at either firm/country level, technical change, labor, and capital respectively

(Zellner et al., 1966). Rearranged as $\frac{\partial X}{\partial L} = AL^{a-1}K^{b} = \frac{X}{L}$, the Cobb Douglas function predicts a positive impact of technical change and capital on labor productivity. It is important to note that this production function makes certain assumptions that one could consider restrictive. For instance, the share of labor and capital in output is assumed to be constant at 75% and 25% respectively (Hajkova et al., 2007). In addition, it presumes constant returns to scale which restricts the elasticity of output concerning labor and capital to values between zero and one and their sum to being equal to one (Hajkova et al., 2007).

Another study that will help guide the process of answering the research question is on the effect of human capital on labor productivity. There have been several past studies on human capital theory including what the most important components are to consider when measuring human capital. Schooling is an element that many researchers on the topic find integral to increasing human capital (Delsen et al., 1999). However, it is up to debate which stage of schooling has the most effect on labor productivity. In the view of Nelson et al. (1966), higher initial education which is a component of human capital is a source of productivity growth. The idea is that if you improve the higher education of laborers, you will increase the human capital they possess, thus their labor productivity. However, after applying their new model using data on 10 out of the 14 UK industries from 1995 to 1999, Delsen et al. (1999) suggest that investments in lower and intermediate education may be more profitable to obtain a high productivity level. The reason is that higher qualifications in education are useful for more flexible work as well as a role where one takes care of the efficient allocation of inputs. This fosters productivity but according to them, intermediate education contributes more to the static worker effect which is a more significant component of labor productivity (Delsen et al., 1999). All in all, the conclusion drawn from both studies is that human capital influences productivity in a positive way. A further study by Corvers (1997) on the impact of human capital on labor productivity in about 15 manufacturing sectors in each of the 7 European Union countries studied comes to the same conclusion. The years studied in this research are from 1988-to 1991. In this paper, human capital is measured by the employment shares of intermediate and highly -skilled workers, and labor productivity reflect the worker and the allocative effect of their labor (Corvers, 1997). The main finding of this paper is that the effect of intermediate and highly-skilled labor on sectoral labor productivity is positive. However, it is only the worker and allocative effect of highly-skilled labor that is found to be significantly positive in the low-skilled sector.

Furthermore to be discussed is the role the demography of a country has on its productivity. This paper aims to ascertain the effect the proportion of individuals with access to the internet in a region has on the productivity of that region. The region in question here is the EU. To pinpoint this relationship it is also important to control for the effect the demography of the population has on productivity. There have been studies in the past on the effect the aging population has on labor productivity. In a study by Rangelova and Sariiski (2011), they find that an aging population hurts labor productivity in Bulgaria. They utilize a sensitivity test where they change assumptions of population number and age distribution to investigate this topic. Bulgaria at the time of the study ranked among the five countries in the world with the largest share of the population over 60. This came as a result of a low fertility rate and increased life expectancy (Rangelova et al., 2011). The theory behind their query is that aging leads to a reduction in labor supply as well as the quality of the workforce. This they assumed would shrink productivity as technological progress in an aged developed country has every chance to be realized by a smaller and older workforce. Therefore, they predicted the labor productivity of Bulgaria from 2008 and 2050 in absolute terms, growth, and indexes under three assumptions of improvement in life expectancy at birth; slow, medium, and fast. They found that the faster the improvement in life expectancy at birth which increases the aging population, the lower the growth of labor productivity was (Rangelova et al., 2011). Moreover, there is evidence of difficulty in measuring this effect in other studies. This is partly because the age-profile productivity can be measured by hourly earnings and there may be a divergence between wages and productivity in the older age brackets due to the payment of seniority wages (Hellerstein et al., 1999). There are also theories on an aging workforce that have been put forth which suggest older workers as being more dependable and have better credentials

(Barth et al., 1993). However, there is a consensus by Hellerstein (1999) and Skirbekk (2003) that this is only visible until 50 years old after which a significant drop in productivity becomes apparent as a result of abridgment in perception speed. This theory is consistent with the one mentioned earlier that the more the population ages the lesser the quality of the workforce.

As briefly touched upon in the introduction, there have been previous studies that are similar to ours that try to investigate the effect that having better access to the internet has on labor productivity itself or its factors such as human capital, etc. One of these studies is carried out by Grimes et al. (2011). He investigates the same topic and relationship that we try to investigate in this paper. He tries to see the effect of having better access to the internet on the productivity of 6000 firms in New Zealand in 2006. However, the approach is different. The main idea of the study is to use propensity score matching to compare firms that are similar where some use dial-up and some use broadband and then to observe the productivity difference. In their study having broadband access translates to better internet connectivity. In our study, the greater the percentage of the population with access to the internet signifies better internet connectivity. In addition, our metric does not only apply to firms but to households in the countries as well. According to Grimes et al. (2011), broadband-enabled firms in comparison to dial-up enabled firms will have more positive externalities, spillovers, and complementaries. They will likely increase their output while reducing working time because they will use the internet to carry out commercial transactions. In addition, because of broadband access, they are more likely to have a web page, purchase goods, and services, enter new export markets and make sales over the internet than firms without broadband. These elements they thought would lead to broadband-enabled firms having a higher level of labor productivity. Grimes et al. (2011) find this to be the case in their study of both urban and rural firms in New Zealand, as the productivity of broadband-enabled firms relative to no broadband is greater by 7-10%.

Another piece of past literature similar to what we examine in this paper is the study by Espinoza et al. (2020) on the impact of the internet of things (IoT) on labor productivity growth in the US and European Union. Internet of things here refers to interconnected devices and objects such as smartphones etc. that transmit and process data via the internet. Similar to us they test whether having more access to the internet contributes anything at all to the labor productivity growth. They studied this from 2008 to 2014. But just like the study by Grimes et al. (2011), they go about it differently. They approach their investigation of internet connectivity through the medium that enables one to use the internet. That is, they assume that more of these devices such as simple sensors, smartphones, laptops, and wearable devices are utilized in the economy as an indicator of having frequent access to the internet. In addition, Espinoza et al. (2020) also employ a growth accounting approach to observe the contribution of IoT to labor productivity growth in the US and 10 developed countries in the EU. This is a method completely different from the method employed by Grimes et al. (2011). It is also a method completely different from the fixed effect and pooled OLS model we will apply in this paper. Espinoza expected IoT to have a positive impact and contribute to labor productivity growth. This is a result of IoT technology offering the possibility to transform agriculture, industry, as well as energy production and distribution by increasing the availability of information along the value chain of production using network sensors (Espinoza et al., 2020). They find this positive impact in their empirical study albeit small as IoT contributes 0.66 percent to the labor productivity growth in the EU and 1 percent to the growth in the US (Espinoza et al., 2020).

Our study will extend the knowledge that these past papers on internet connectivity have generated by possibly providing further evidence of this positive relationship realized in the past literature. Thereby reinforcing the previous conclusions and making them concrete. Especially as we will use a different measurement for internet connectivity than the one used in the past papers, a different estimation model (fixed effect regression model and pooled OLS regression model respectively). We will also look at a whole region where the disparity in the level of development amongst the economies is visible in contrast to the past studies. This is important because we don’t know as of yet whether this could affect this positive relationship that several works of literature have found. For instance, the past research by Espinoza et al. (2020) only examines 10 developed countries in the EU namely: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Sweden, and the United Kingdom. So we will test for this to see if we come up with the same conclusion.

4. Hypothesis

According to the study by Grimes et al. (2011), internet connectivity can be considered a metric through which the development of an economy in terms of information and communication technology can be judged. Based on this study the development of information and communication technology leads to positive externalities and spillovers as it increases the number of tasks that can be carried out in the same amount of time. Therefore, we assume that internet connectivity is positively correlated to labor productivity. We put forth that the argument by our opposition to this hypothesis is that the internet could hinder productivity when it helps enable imperfect information. However, to help reinforce why we assume what we assume is the theory of production by Cobb and Douglas (Hajkova et al., 2007). Internet connectivity enters the Cobb Douglas production function through the technical change parameter. The more internet connectivity there is, the more positive technical change the economy is experiencing. Based on the indirect production equation, technical change positively impacts labor productivity. Therefore, the hypothesis is:

Hypothesis: Internet connectivity is positively correlated to labor productivity in the European Union. (H0: Internet connectivity is not correlated to labor productivity; H1: Internet connectivity is correlated to labor productivity)

5. Method of Data collection and Analysis

In this section we will discuss the method used to answer the research question, as well as the data and variables chosen for this study.

5.1 Data

To answer the research question, panel macro data on internet connectivity and productivity is collected for all 27 member states of the EU. Internet connectivity is measured as individuals who have used the internet from any location in any of the countries in the last 3 months as a proportion of the total population. This data is derived from the World Bank (World Bank, n.d.). The primary advantage of using this database is that it contains data on each of the member states and it follows each of the countries over the years without adjusting how this variable is measured in any way that makes it less consistent.

Data on the other independent factors that we will control for, as well as data on labor productivity, was collected in the same manner as described above. However, the World Bank at times did not have measures for the other factors that we felt were appropriate in describing what the factors represent. Therefore, we derived a measure for human capital from the federal reserve of economic data (FRED). Data on productivity, capital, and aging population for each member state over the years we are interested in, were taken from the organization of economic co-operation and development database (OECD). Lastly, data on technical change was derived from past reports on the global innovation index (Gii, n.d.).

To examine what relationship, if any, exists between internet connectivity and productivity in the EU, data was obtained from 2008 to 2019. The timeline 2008-2019 is chosen to ensure a consistent basis for data analysis. As you might know, 10 European countries only just joined the EU in 2004 including Bulgaria and Romania in 2007 (European Union, n.d.). In addition, The United Kingdom left the EU at the end of 2020. The implication of taking this initiative is that it enables us to control for a scenario where countries entering and leaving the EU might impact productivity. For example, the United Kingdom leaving the EU could impact the productivity of other countries because they stop exporting new advanced machinery under the free trade agreement.

5.2 Method of Data Analysis

To analyze the data we felt it was appropriate to use both a fixed effect regression model as well as a pooled OLS regression model, respectively. Firstly, we applied a fixed effect regression model (FEM) because we did a Hausman test originally established by Hausam (1978) as can be seen in "Appendix B" and the result suggests that the FEM model is the most suitable. In addition, we felt the sign of the coefficient of internet connectivity in this model, if it turned out to be significant, would tell us if internet connectivity is positively correlated to labor productivity. Additionally, similar to our research direction, this method of data analysis has been applied in previous research by Raharjo et al. (2014) to study the determinant factors of the commercial banks' interest margin in Indonesia. Therefore, the equation for the fixed effect regression model utilized is as follows:

$$Y_{it} = a_1 + \sum_{j=2}^{n} \beta_{ji} x_{jit} + u_{it}$$

where Y_{it} corresponds to the natural logarithm of labor productivity in a country i at time t, a_i represents the individual intercept, x_{jit} corresponds to $x_{2it}, ..., x_{nit}$ which corresponds to n observable variables (in our case 5) used to explain productivity, and u_{it} is the error term. In addition, year dummies will be applied to the model as seen in *"Appendix M"*. In *"Appendix C*", we did a Breusch-Pagan test, first established by Breusch et al. (1979) as well as a Wooldridge test (Wooldridge, 2002) in "*Appendix D"* to test for heteroscedasticity and autocorrelation respectively and we found both. Therefore, we included robust standard errors in the model as you will see later on in "*Table C"*. We also constructed a correlation matrix table in "*Appendix I"* to see if there is a multicollinearity issue. We did not find any in the FEM. This model is the most appropriate as suggested by the Hausman test so we have to use it. But our ability to observe whether internet connectivity is positively correlated to productivity using this model depends on the within-country variation. That is to say that if the period we are examining is too small to observe any noticeable change in internet connectivity for each country then the fixed effect will not work. Because there is a chance this could be the case we will also analyze the data using pooled OLS regression model even though the Hausman test suggests the fixed model. Again, year dummies is applied as seen in "Appendix N". We tested for heteroscedasticity and autocorrelation and they were both present. Therefore we included robust standard errors in the pooled OLS regression model as can be seen in "*Table D"*. A correlation matrix table is constructed in "Appendix J" to test for multicollinearity. We find internet connectivity and global innovation index to be correlated (-0.7329). Index of human capital and population over 65 also have a minor issue of multicollinearity (0.5405). The main difference between the FEM and pooled OLS is that the parameter for internet connectivity will not depend on the country.

The variables included in both models consist of our main explanatory variable internet connectivity as well as other variables that explain productivity; index of human capital, global innovation index, investment, and percentage of the population aged 65 and above. To perform a precise panel data analysis, before the parameters are estimated, a unit root test was executed for all the variables, in both the main sample and the Sample 2. The rationale behind this decision is to check the stationarity of all the variables. If the values of variables in the data set are nonstationary, then the result of the regression would not be reliable or efficient, causing issues such as spurious regression, unless there is cointegration involved. The Levin-Lin-Chiu test (2002) with time trend is chosen from the unit root tests as it is one of the most commonly used tests. The result of the test is that all the variables in both samples are stationary as can be seen in "Appendix A".

5.3 Variables included in the regression

Outcome Variable

The outcome variable in our regression is the natural logarithm of labor productivity. This variable is measured by dividing the gross domestic product by total labor input (The OECD, n.d.). Total labor input refers to the total number of working hours. Similar to our study, other empirical studies in the past have looked to observe the relationship between some explanatory variable and the outcome variable, labor productivity. For instance, Jajri et al. (2010), used this variable as the outcome variable in their empirical design to observe the extent quality of labor has benefited productivity and thus economic growth (Jajri et al., 2010)

Index of Human Capital per Person

This variable was included in the regression to account for the positive effect human capital has on labor productivity as confirmed in the work of Nelson et al. (1966), Delson et al. (1999), and Corvers, (1997). Therefore, we expect the index of human capital per person to be positively correlated to labor productivity as well. This index is calculated based on years of schooling and returns to education. In the regression, this variable will not be logged because it is not common practice to log indices.

Percentage of the Population aged 65 and above

This variable is another independent variable included in the regression that is used to explain labor productivity. It is a percentage so it is not logged in the regression. It is included in the regression to account for the effect the dynamics or make-up of a distinct demographic has on the labor productivity of that economy. We expect that the more a population ages, that is, the higher this variable is in a country the less labor productivity the country will have. We anticipate this based on the simulation study carried out by Rangelova et al. (2011) as well as the empirical research executed by Hellerstein, (1999) and Skirbekk, (2003). In the regression, this variable is measured by dividing the number of residents aged 65 and above in an economy regardless of marital status or citizenship, by the total population in the same economy and then multiplying by 100 (Data World Bank, 2022). The aggregation method is a weighted average.

Investment/Gross Fixed Capital Formation

The acquisition and utilization of capital in a country may affect the growth of labor productivity. This is why we have included this variable in the regression to control for this effect. The idea behind this variable as an indicator for capital is that the more investment in produced assets including the production of assets by producers for their use, the more capital an economy possesses. Therefore, we expect this to have a positive effect on the growth of productivity, the same way Cobb and Douglas proposed in their production function (Hajkova et al., 2007). Again this variable will not be logged in the regression as it measures the quarterly percentage change over the course of each year. For the regression, we took data on the rate of investment at quarter one of each year for every country.

Global Innovation Index

We included this variable because technical change, that is, innovation is assumed to play a significant role in productivity growth. This variable is supposed to enable us to observe how innovative an economy is. The higher this score is for a country the more innovation is apparent in that country. This variable is measured as an index therefore it is not logged in the regression. Moreover, it is the average of two other indices. Namely, the innovation input sub-index and innovation output sub-index. What this variable entails more so as an index compared to any other form of measurement is that it delineates how inventive an economy is as it pertains to its infrastructure, institutions, technology output, creative output, business sophistication, etc (Gii, n.d.). What is expected is that countries with a higher GII score will experience productivity growth. This outlook coincides with the Cobb Douglas production function which enforces the positive impact of technical change on productivity.

6. Result and Analysis

6.1 Report on data

First of all, the two descriptive tables below are shown for the main sample (i.e. sample for the European Union countries) and Sample 2 (i.e. sample for a chosen group of 7 countries outside of the main sample, which are Canada, Israel, Japan, South Korea, Russia, United Kingdom, and the United States) respectively. According to “Table A”, the average percentage of populations using the internet is 74.46, which is lower than the median of the variable. This is an implication of a leftward skewness of the distribution of the data. Simply put, there are more countries with less internet connectivity than countries with high internet connectivity within the European Union. The same applies to other variables as well, so as the same results, except for the variable "GII". The average of our dependent variable - labor productivity, that is "Ln(GDP/h)", is 98.24, which is smaller than the median at 99.15. It is also worth mentioning that regarding the investments, that is "Gross fixed capital formation", is extremely leftward skewed compared to other variables.

"Table A" - Descriptive statistic for main sample

Main sample	Ave.	N	St.Dev.	Range	Sum	Min.	Med.	Max.
GDP/h	98.24	300.00	7.06	54.20	29470.5	67.30	99.15	121.50
Ln(GDP/h)	4.58	300.00	0.07	0.59	1375.4	4.21	4.60	4.80
Internet %	74.46	324.00	13.84	65.72	24125.4	32.42	75.97	98.14
Human Capital	3.24	324.00	0.29	1.54	1049.2	2.31	3.24	3.85
Gross fixed capital formation	-0.50	288.00	7.76	77.70	-142.6	-53.00	0.15	24.70
GII	50.49	324.00	7.89	37.11	16359.0	34.18	49.85	71.29
Pop 65+ %	17.71	324.00	2.61	12.28	5737.2	10.73	18.07	23.01

Aside from that, "Table B" is representing descriptive statistics under a more developed condition where the chosen countries are usually considered the economies which have the greatest impact in the world. The overall skewness is towards the minimum value, which is similar to the descriptive statistics for the main sample in "Table A". However, the range and standard deviation are significantly smaller in various variables, especially in labor productivity and investment. This is probably because all countries from the Sample 2 are probably in a better development stage compared to the European Union overall. When comparing the actual level of labor productivity in both tables there does not seem to be much disparity between the values. However, when comparing internet connectivity, human capital, investments, and the global innovation index, it is observed that the level is generally higher in countries in the Sample 2 than in EU countries overall. This is a sign of a high level of economic development. It is also observed that the countries in the Sample 2 have a less severe indication of aging in population than EU countries, which is assumed to be having a negative impacton labor productivity.

"Table B" - Descriptive statistic for Sample 2

Sample 2	**Ave.**	**N**	**St.Dev.**	**Range**	**Sum**	**Min.**	**Med.**	**Max.**
GDP/h	98.61	84.00	5.05	31.60	8283.6	82.50	98.90	114.10
Ln(GDP/h)	4.59	84.00	0.05	0.32	385.6	4.41	4.59	4.74
Internet %	80.60	84.00	11.94	64.50	6770.4	32.00	83.00	96.50
Human Capital	3.61	84.00	0.14	0.62	303.2	3.27	3.66	3.89
Gross fixed capital formation	0.38	84.00	2.89	15.90	32.3	-10.10	1.00	5.80
GII	55.83	84.00	8.16	39.58	4690.1	35.85	56.30	75.43
Pop 65+ %	15.57	84.00	4.47	18.08	1307.9	9.92	14.34	28.00

6.2 Result

The research proceeded by applying the models mentioned in the method section. Some tests were done before estimating the parameters as mentioned in the method section, including the unit-root test and the Hausman test. The results would be shown in the appendix section, and referring to them, there are no unit-roots to cause a spurious regression and the model suggested by the Hausman test is FEM. Once again, the models applied are the fixed-effect model and pooled OLS regression model to see if the explanatory variables are having an impact or relationship with the dependent variable "Ln(GDP/h)", i.e. the natural logarithm transformation of GDP worked per hour respectively. Here is the result table of the fixed-effect model for the main sample.

"Table C" - FEM - European Union

LnGDPh	Coefficient	Robust Std. err.	t	P>|t|	[95% conf. interval]	
Internet %	0.002	0.003	0.54	0.597	-0.005	0.009
Human Capital	-0.144	0.154	-0.93	0.361	-0.463	0.175
Gross Fixed Capital Formation	-0.001	0.001	-1.47	0.156	-0.003	0.000
GII	0.004	0.003	1.51	0.145	-0.002	0.010

Pop 65+ %	0.016	0.012	1.32	0.201	-0.009	0.040

R-squared = 0.541

The upcoming table is the estimators of the Pooled OLS regression model for the main sample.

"Table D" - Pooled OLS - European Union

LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
Internet %	0.001	0.001	2.08	0.039	0.000	0.003
HumanCapital	0.014	0.011	1.27	0.206	-0.008	0.035
Gross Fixed Capital Formation	-0.001	0.001	-1.64	0.102	-0.002	0.000
GII	-0.002	0.001	-2.01	0.045	-0.004	0.000
Pop 65+ %	0.009	0.002	3.81	0.000	0.004	0.014

R-squared = 0.502

On the other hand, the table below is the fixed effect model estimation of coefficients of the variables in the Sample 2.

"Table E" - FEM - Sample 2

LnGDPh	Coefficient	Robust Std. err.	t	P>|t|	[95% conf. interval]	
Internet %	0.001	0.001	0.79	0.458	-0.001	0.003
Human Capital	0.504	0.175	2.89	0.028	0.077	0.932
Gross fixed capital formation	0.000	0.001	0.47	0.652	-0.002	0.003
GII	-0.002	0.001	-1.12	0.304	-0.005	0.002
Pop 65+ %	0.014	0.011	1.33	0.232	-0.012	0.040

R-squared = 0.938

Finally, the last table represents estimators done by applying the Pooled OLS regression model for the Sample 2.

"Table E" - Pooled OLS - Sample 2

LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
Internet %	0.001	0.001	0.79	0.458	-0.0007	0.0009
Human Capital	0.2742	0.0583	4.71	0.000	0.1579	0.3905
Gross fixed capital formation	-0.0008	0.0014	-0.62	0.537	-0.0036	0.0019
GII	-0.0051	0.0010	-5.22	0.000	-0.0070	-0.0031

Pop 65+ %	0.0012	0.0009	1.42	0.160	-0.0005	0.0029

R-squared = 0.858

Before heading into the analysis section, tests for heteroscedasticity and serial correlation were done, and the result can be found in the appendix section. Simply put, both heteroscedasticity and serial correlation issues exist for our regression. In addition, according to our correlation matrix from *"Appendix I/J/K/L"*, some multicollinearity also exists, which might cause the prediction of parameters to be inaccurate. The R-squared values are generally above 0.5, which indicates that there is a good fit in the chosen regression models.

6.3 Analysis

According to *"Table C - FEM - European Union"*, the variable "Internet %" is not significant under any significance level. At first glance, the parameter of internet connectivity is positive as is expected because Smith's theory on labor productivity suggests that any improvement in machines/technology that facilitates the individual working steps should increase labor productivity. Therefore, internet connectivity should increase productivity as it facilitates the individual working steps by making more information available to workers. But we cannot conclude this as the parameter of internet connectivity is not significant, not even at the 10% level. This means that the variability of internet connectivity does not significantly predict the outcome of labor productivity. In our FEM model, variability of internet connectivity in any of the countries over the examined 12-year span does not account for variability in labor productivity in any of the 27 member states. This is the case as well when examining the other explanatory variables. Neither the global innovation index, index of human capital, pop 65+ %, nor gross fixed capital formation are significant at any significance level. Because none of the predictors are significant we cannot say that any of them affect productivity in any way. Using the FEM to analyze the data seems to suggest that there is no relationship or correlation between any of the variables including internet connectivity on labor productivity. This result is contradictory, both to what we anticipated and to what past studies have proclaimed as it pertains to the effect each of the predictors should have on productivity which is either a positive or negative significant effect. But one could understand why the result is the way it is from two aspects upon examination of the FEM model more closely. Firstly, as can be seen from *"Table C"* none of the coefficients are significantly greater than 0, to begin with. The parameter of internet connectivity implies that a 1% increase in internet connectivity should increase labor productivity by only 0.2%. This could imply that the impact of internet connectivity on labor productivity is not great enough to be detected by the fixed effect model. This leads to the second point that it could be the case that the within-country variation of each predictor for each country is too minimal to observe any significant change in labor productivity. One year might not be enough to observe any eloquent variation in internet connectivity. The only other regressor that is measured based on quarterly growth (since we couldn't find annual growth) is the gross fixed capital formation and its coefficient turns out to be even 100% less than the parameter of internet connectivity.

Aside from "Internet %", in the *"Table C - FEM - European Union",* none of the theories mentioned could be applied for the FEM done to the main sample, since all the variables are insignificant under the model. These are also counterintuitive to our theoretical framework. According to Ga rtman (1978), the more ability and skill direct producers have, the higher productivity they will achieve. This is almost echoing the definition of the variable "Human Capital". However, in our FEM, "Human Capital" has a negative and insignificant relationship. An aging population, on the other hand, is assumed to bring a negative impact on labor productivity as it causes the quantity and quality of the labor force to drop in a mentioned study (Rangelova et al., 2011). However, our FEM provides a result that the mentioned theory is insufficiently evident due to the insignificance and positivity of the coefficient estimation of "Pop 65+ %".

On the other hand, in *"Table D - Pooled OLS - European Union",* the variable "Internet %" is significant under a significance level of 0.05. The estimator indicates that it is having a positive relationship with labor productivity. The parameter implies that a 0.1% increase in labor productivity is observed when there is a 1% increase in "Internet %". Although the relationship between the two variables is not ideally strong, this is still considered to be approved by our expectations as well as comply with the previous study (Grimes et al., 2011), which empirically emphasizes the importance of internet connectivity on productivity. However, since the result came from a Pooled OLS model, it does not indicate if the variable is impactful or not. The only speculation that is formed is that where there is a higher level of internet connectivity, there will be a higher level of labor productivity. Therefore, we cannot assume that it is a change in internet connectivity that causes labor productivity to vary. Our assumption to the reason behind the pooled OLS being more precise in complying with other studies is probably because there are some time-variant unobservables within the model. One example could be, that labor productivity tends to vary between business cycles. Aside from that, the variables "Human capital" and "Gross fixed capital formation" are insignificant under any common significance level. The variable "GII" is significant under a significance level of 0.05 and the relationship it has to labor productivity is negative. In addition, the variable "Pop 65+ %" is significant under any significance level where the coefficient indicates a positive relationship between it and labor productivity.

Regarding our robustness test, as depicted in *"Table E - FEM - Sample 2"* for our Sample 2, the variable "Internet %" is also not significant under any common significance level similar to the main sample. This implies that the impact of internet connectivity on labor productivity is not observed in this model for the 7 countries we chose. Since the Sample 2 countries were in the same range of development states as the countries in the European Union, it is assumed that the regression result from the Sample 2 is a complement to our main research in the EU region. Also, previously we assumed that the within-country variation of each predictor for each country is too small to observe any significant change in labor productivity for the EU countries. This is assumed to be the reason here as well. This made our assumption on the reason for insignificant results one step more reliable. Other than internet connectivity, other explanatory variables except for "Human Capital" are not significant under the general significance level of 0.1 and 0.05. The variable "Human Capital" is significant under 0.05 significance level, and the coefficient "0.504" indicates a positive effect between it and labor productivity, as the model had observed a notable impact of it on the "LGDP" variable.

Lastly, referring to *"Table F - Pooled OLS - Sample 2",* the estimators of the variable "Internet %" are still insignificant under any common significance level, indicating that no relationship is large enough to be observed between it and labor productivity. The P-value was the greatest of all the models we did for estimating parameters for internet connectivity. This is implying that there is very little evidence indicating the parameter is not equal to 0. We assume that this is because there could be a probability of Japan not having the same intercept as the US. This would cause the Pooled OLS model to produce a biased outcome. The solution to this is to add a country dummy variable to the model, which is using the FEM as a preferred model. It is important to note that in the sub-sample under pooled OLS, "Human capital", has a positive relationship with labor productivity under any common significance level. The coefficient implies that a 27% higher level of labor productivity is observed where there is a 1% higher level of "Human Capital". It is contradictory for us to assume that the model applied is wrong at this moment since this is approved by Delsen et al. (1999) and Corvers, (1997) in the theoretical framework. The variables "Gross fixed capital formation" and "Pop 65+ %" are not significant enough under common levels, and "GII" is having a negative relationship with labor productivity at any level. Overall, not enough evidence is observed to conclude that internet connectivity is having a relationship to labor productivity in the pooled OLS model for the Sample 2.

7. Conclusion

According to previous tables, it is easily observed that the parameters for internet connectivity are under-evidential in the result of most of the models that are included in the paper. Both the FEM iterates that the parameter of internet connectivity is insignificant as well as the one Pooled OLS regression model applied for our Sample 2. Hence, it is not reasonable for us to assume that the hypothesis, "Internet connectivity is positively correlated to labor productivity in the European Union" is true.

Although the results are insignificant as mentioned, the paper still delivers the information to policy-makers. Decision-makers of individual firms could utilize this study to see whether an increase in spending on information and communication technologies is gaining a proportional increase in productivity. The government could use this study to see if a subsidy on internet-related products would help labor productivity. It is suggested that through the study the role of internet connectivity is not significant to make an impact on labor productivity. Therefore, we assume that an increase in spending on ICT or an application of subsidy on internet products will most likely not be visualized on labour productivity.

One of the limitations of this study is in the measurement of our main variable (internet connectivity). Any individual who uses the internet for only a few minutes in the last three months is included in the calculation. In other words, it is difficult to ascertain whether the internet is something that is used regularly by the individuals included. This is important because we assume this when we say internet connectivity. The penetration rate would be a more suitable data as it is the share of households with access to telecommunications. However, it is only in the past years that more information on information and communication technology use has become available from households and business surveys. Another criticism of this paper is that an early test of restricted F-test should be performed to see whether a pooled OLS or a REM/FEM is more suitable before performing the Hausman test. In our scenario, since there are no clear indicators for choosing between Pooled OLS model and FEM, it resulted in a more complicated “4-models” analytical part. In addition, multicollinearity issues in variables are also having a negative impact on the result of estimations, which might cause the coefficient parameters to be biassed. This will be included as “Appendix I/J/K/L” in the Appendix section.

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9. Appendix

"Appendix A" *- Unit root test for variables in the main sample*

Unit-root Levin-Lin-Chu test with trend H0: There is a unit root H1: The variable is stationary				
Variables		Statistic	P-value	Result
Internet %	Unadjusted t	-13,0921		
	Adjusted t*	-6,3697	0	Reject H0
Ln(GDP/h)	Unadjusted t	-15,8385		
	Adjusted t*	-9,2663	0	Reject H0
Human Capital	Unadjusted t	-110		
	Adjusted t*	-110	0	Reject H0
Gross fixed capital formation	Unadjusted t	-19,165		
	Adjusted t*	-9,4955	0	Reject H0
GII	Unadjusted t	-14,42		
	Adjusted t*	-7,2552	0	Reject H0
Pop 65+ %	Unadjusted t	-14,3374		
	Adjusted t*	-11,1399	0	Reject H0

Result: none of the variables has any unit root, unit root will not be a problem causing issues such as spurious regression.

"Appendix B" *- Hausman test for panel models for main sample*

Hausman test

H0: Random effect model is preferred

H1: Fixed effect model is preferred

Coefficients				
Variables	Fixed (b)	Random (B)	Difference (b-B)	Std. err. sqrt(diag(V_b-V_B))
Internet %	0,00254	0,002764	-0,000224	0,000658
Human Capital	0,006678	0,0216861	-0,015008	0,084224
Gross fixed capital formation	-0,000727	-0,0007942	0,0000671	
GII	0,0006857	-0,0033006	0,0039863	0,0009362
Pop 65+ %	0,0291482	0,0155411	0,0136071	0,0043409
Tests		Result		
chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)	25,59			
Prob > chi2	0,0001	Reject H0		

Result: Fixed effect model is preferred.

"Appendix C" *- Breusch-Pagan test for Heteroscedasticity in the main sample*

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity Assumption: Normal error terms Variable: Fitted values of LnGDPh H0: Homoscedasticity H1: Heteroscedasticity	
chi2(1)	6,55
Prob > chi2	0,0105

Result: Reject the null Hypothesis under significance level 0.05, implying that there is an issue of heteroskedasticity under the certain significance level.

"Appendix D" *- Wooldridge test for Autocorrelation in the main sample*

Linear regression	
Number of obs	264
F(5, 23)	10,48
Prob > F	0
R-squared	0,2434

Root MSE	0,02511

(Std. err. adjusted for 24 clusters
in CountryNR)

D.LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
Internet % D1.	0,000212	0,0009726	0,22	0,829	-0,0018	0,0022241
Human Capital D1.	0,1247115	0,146238	0,85	0,403	-0,1778048	0,4272277
Gross fixed capital formation D1.	0,0003144	0,0001786	1,76	0,092	-0,0000551	0,0006839
GII D1.	0,0002992	0,0005083	0,59	0,562	-0,0007524	0,0013507
Pop 65+ % D1.	0,0339232	0,0081426	4,17	0	0,0170789	0,0507675

Wooldridge test for autocorrelation in panel data H0: no first-order autocorrelation H1: First-order autocorrelation detected	
F(1, 23)	155,185
Prob > F	0

Result: Reject the null Hypothesis under any significance level, implying that there is an issue of autocorrelation under any significance level.

"Appendix E" *- Unit root test for variables in the Sample 2*

Unit-root Levin-Lin-Chu test with trend H0: There is a unit root H1: The variable is stationary				
Variables		Statistic	P-value	Result
Internet %	Unadjusted t	-5,5448		
	Adjusted t*	-2,239	0,0126	Reject H0
Ln(GDP/h)	Unadjusted t	-8,8493		
	Adjusted t*	-3,8476	0,0001	Reject H0
Human Capital	Unadjusted t	-46,504		
	Adjusted t*	-46,0353	0	Reject H0
Gross fixed capital formation	Unadjusted t	-9,3889		

	Adjusted t*	-4,7745	0	Reject H0
GII	Unadjusted t	-6,3316		
	Adjusted t*	-2,8	0,0026	Reject H0
Pop 65+ %	Unadjusted t	-2,9055		
	Adjusted t*	-0,9659	0,167	Accept H0

Since there is a unit root in variable "Pop 65+ %", we did the test again without including time trend.

Unit-root Levin-Lin-Chu test				
Variables		Statistic	P-value	Result
Pop 65+ %	Unadjusted t	-4,4259		
	Adjusted t*	-4,038	0	Reject H0

Result: None of the variables except for "Pop 65+ %" has unit root when there is a time trend included in the test, while "Pop 65+ %" does not have a unit root when doing the test without including a trend, unit root will not be a problem causing issues such as spurious regression.

"Appendix F" *- Hausman test for Sample 2*

Hausman test

H0: Random effect model is preferred

H1: Fixed effect model is preferred

Coefficients				
Variables	Fixed (b)	Random (B)	Difference (b-B)	Std. err. sqrt(diag(V_b-V_B))
Internet %	0,0000558	0,0005972	-0,0005413	
Human Capital	0,4761314	0,3113041	0,1648272	0,0254332
Gross fixed capital formation	0,0009965	0,0008527	0,0001438	
GII	-0,0009801	-0,0056849	0,0047047	0,0003493
Pop 65+ %	0,0105681	0,0016055	0,0089626	0,0022484
Tests		Results		

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)	112,38	
Prob > chi2	0	Reject H0

Result: Fixed effect model is preferred.

"Appendix G" *- Breusch-Pagan test for Heteroscedasticity in the Sample 2*

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity Assumption: Normal error terms Variable: Fitted values of LnGDPh H0: Homoscedasticity H1: Heteroscedasticity	
chi2(1)	4,28
Prob > chi2	0,0386

Result: Reject the null Hypothesis under significance level 0.05, implying that there is an issue of heteroskedasticity under the certain significance level.

"Appendix H" *- Wooldridge test for autocorrelation in the Sample 2*

Linear regression	
Number of obs	77
F(5, 6)	16,38
Prob > F	0,0019
R-squared	0,5695
Root MSE	0,01388

(Std. err. adjusted for 7 clusters in CountryNR)

D.LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
Internet % D1.	-0,0002516	0,0007061	-0,36	0,734	-0,0019794	0,0014762
Human Capital D1.	0,4890191	0,1247667	3,92	0,008	0,1837261	0,7943121
Gross fixed capital formation D1.	0,0011868	0,0007984	1,49	0,188	-0,0007667	0,0031404
GII D1.	-0,0007014	0,0005662	-1,24	0,262	-0,0020867	0,000684
Pop 65+ % D1.	0,0131931	0,0055476	2,38	0,055	-0,0003815	0,0267677

Wooldridge test for autocorrelation in panel data H0: no first-order autocorrelation H1: First-order autocorrelation detected	
F(1, 6)	22,754
Prob > F	0,0031

Result: Reject the null Hypothesis under significance level 0.01, implying that there is an issue of autocorrelation under the mentioned significance level.

"Appendix I" *- Correlation matrix for FEM - Main sample*

e(V)	Internet	HumanC~l	Grossf~n	GII	Pop65	_cons
Internet	1.0000					
HumanCapital	-0.4374	1.0000				
Grossfixed~n	-0.1632	0.0357	1.0000			
GII	0.2471	0.0363	-0.0824	1.0000		
Pop65	-0.6564	0.0392	-0.1638	-0.0101	1.0000	
_cons	0.1063	-0.8422	0.1790	-0.3699	-0.1273	1.0000

Result: We can see a slight multicollinearity issue between Internet and Pop65, as the absolute value of the parameter is greater than 0.5.

"Appendix J" *- Correlation matrix for Pooled OLS regression model - Main sample*

e(V)	Internet	HumanC~l	Grossf~n	GII	Pop65	_cons
Internet	1.0000					
HumanCapital	-0.2647	1.0000				
Grossfixed~n	-0.1994	-0.1168	1.0000			
GII	-0.7329	-0.0652	0.2860	1.0000		
Pop65	-0.1620	0.5405	-0.1702	-0.1675	1.0000	
_cons	0.0258	-0.8032	0.1497	0.0420	-0.7720	1.0000

Result: We can see a multicollinearity issue between Internet and GII, as well as a minor issue between human capital and Pop65, as the absolute values of the parameters are greater than 0.5.

"Appendix K" *- Correlation matrix for FEM - Sample 2*

e(V)	Internet	HumanC~l	Grossf~n	GII	Pop65	_cons
Internet	1.0000					
HumanCapital	-0.5921	1.0000				
Grossfixed~n	0.6436	0.0157	1.0000			
GII	-0.2499	0.0329	-0.3561	1.0000		
Pop65	-0.6106	-0.1810	-0.6471	-0.0719	1.0000	
_cons	0.6325	-0.9977	0.0194	-0.0401	0.1210	1.0000

Result: We can see quite many multicollinearity issues between Internet and GII, Internet and HumanCapital, Internet and Pop65, e.t.c., as the absolute values of the parameters are greater than 0.5.

"Appendix L" - *Correlation matrix for Pooled OLS regression model - Sample 2*

e(V)	Internet	HumanC~l	Grossf~n	GII	Pop65	_cons
Internet	1.0000					
HumanCapital	-0.5145	1.0000				
Grossfixed~n	-0.1614	-0.1090	1.0000			
GII	0.0030	-0.6698	0.0512	1.0000		
Pop65	-0.7863	0.4295	0.1008	-0.0935	1.0000	
_cons	0.4350	-0.9783	0.1640	0.5789	-0.3963	1.0000

Result: We can see multicollinearity issues between Internet and Pop65, Internet and HumanCapital, and HumanCapital and GII, as the absolute values of the parameters are greater than 0.5.

“Appendix M” - FEM model with year dummies - Main Sample

Fixed-effects (within) regression		Number of obs		288		
Group variable: CountryNR		Number of groups		24		
	R-squared:			Obs per group:		
	Within	0.541		min	12	
	Between	0.037		avg	12	
	Overall	0.228		max	12	
				F(16,23)	13.01	
corr(u_i, Xb)	-0.71			Prob > F	0	
Std, err, adjusted for 24 clusters in CountryNR						
LnGDPh	Coefficient	Robust Std. err.	t	P>|t|	[95% conf. interval]	
Internet %	0.002	0.003	0.54	0.597	-0.005	0.009
Human Capital	-0.144	0.154	-0.93	0.361	-0.463	0.175
Gross fixed capital formation	-0.001	0.001	-1.47	0.156	-0.003	0.000
GII	0.004	0.003	1.51	0.145	-0.002	0.010
Pop 65+ %	0.016	0.012	1.32	0.201	-0.009	0.040
Yearbase2008						
2	-0.026	0.013	-2.03	0.054	-0.052	0.000
3	0.006	0.022	0.25	0.805	-0.040	0.051
4	0.055	0.045	1.22	0.236	-0.038	0.148
5	0.038	0.045	0.84	0.408	-0.056	0.132
6	0.043	0.052	0.83	0.418	-0.065	0.150
7	0.051	0.058	0.87	0.392	-0.070	0.172
8	0.066	0.065	1.02	0.318	-0.068	0.199
9	0.065	0.071	0.92	0.368	-0.082	0.212
10	0.085	0.078	1.09	0.285	-0.076	0.247
11	0.099	0.085	1.15	0.26	-0.078	0.275
12	0.111	0.095	1.17	0.256	-0.086	0.308
_cons	4.374	0.643	6.8	0	3.043	5.704
sigma_u	0.066					
sigma_e	0.050					
rho	0.639	(fraction of variance due to u_i)				

“Appendix N” - Pooled OLS regression model with year dummies - Main Sample

LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
Internet	0.001	0.001	2.08	0.039	0.000	0.003
HumanCapital	0.014	0.011	1.27	0.206	-0.008	0.035
Grossfixedcapitalformation	-0.001	0.001	-1.64	0.102	-0.002	0.000
GII	-0.002	0.001	-2.01	0.045	-0.004	0.000
Pop65	0.009	0.002	3.81	0.000	0.004	0.014
Yearbase2008						
2	-0.024	0.025	-0.97	0.334	-0.072	0.025
3	0.006	0.023	0.27	0.787	-0.038	0.051
4	-0.002	0.025	-0.06	0.950	-0.051	0.048
5	0.003	0.023	0.15	0.880	-0.042	0.049
6	0.005	0.025	0.20	0.843	-0.044	0.054
7	0.012	0.025	0.47	0.636	-0.037	0.061
8	0.031	0.025	1.24	0.216	-0.018	0.080
9	0.028	0.026	1.06	0.288	-0.024	0.080
10	0.049	0.027	1.77	0.078	-0.005	0.103
11	0.059	0.030	1.94	0.053	-0.001	0.118
12	0.069	0.031	2.18	0.030	0.007	0.131
_cons	4.356	0.060	72.22	0.000	4.238	4.475

Number of obs	288
F(16, 271)	14.31
Prob > F	0
R-squared	0.502
Root MSE	0.054

"Appendix O" *- FEM model with year dummies - Sample 2*

Fixed-effects (within) regression		Number of obs		84		
Group variable: CountryNR		Number of groups		7		
	R-squared:			Obs per group:		
	Within	0.938		min	12	
	Between	0.017		avg	12	
	Overall	0.087		max	12	
				F(7,6)		
corr(u_i, Xb)	-0.957			Prob > F		
Std, err, adjusted for 7 clusters in CountryNR						
LnGDPh	Coefficient	Robust Std. err.	t	P>|t|	[95% conf, interval]	
Internet %	-0.001	0.000	-3.51	0.013	-0.002	0.000
Human Capital	-0.222	0.115	-1.93	0.102	-0.504	0.060
Gross fixed capital formation	-0.001	0.000	-1.10	0.314	-0.002	0.001
GII	-0.002	0.001	-1.73	0.134	-0.005	0.001
Pop 65+ %	0.010	0.002	5.69	0.001	0.005	0.014
Yearbase2008						
2	-0.017	0.004	-3.82	0.009	-0.028	-0.006
3	0.012	0.005	2.35	0.057	0.000	0.025
4	0.004	0.017	0.24	0.816	-0.038	0.047
5	0.012	0.015	0.80	0.456	-0.025	0.048
6	0.025	0.016	1.61	0.159	-0.013	0.063
7	0.032	0.018	1.76	0.129	-0.013	0.077
8	0.041	0.017	2.44	0.050	0.000	0.082
9	0.047	0.018	2.67	0.037	0.004	0.090
10	0.060	0.020	3.05	0.022	0.012	0.108
11	0.065	0.021	3.08	0.022	0.013	0.116
12	0.075	0.021	3.66	0.011	0.025	0.126
_cons	5.372	0.337	15.92	0.000	4.546	6.198
sigma_u	0.101					
sigma_e	0.008					
rho	0.993	(fraction of variance due to u_i)				

"Appendix P" *- Pooled OLS regression model with year dummies - Sample 2*

LnGDPh	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]		Number of obs	84
Internet	-0.0005	0.0002	-2.63	0.011	-0.0009	-0.0001	F(16, 271)	27.33
HumanCapital	0.0172	0.0076	2.27	0.027	0.0021	0.0324	Prob > F	0
Grossfixedcapitalformation	-0.0007	0.0008	-0.86	0.393	-0.0023	0.0009	R-squared	0.858
GII	-0.0010	0.0007	-1.43	0.156	-0.0024	0.0004	Root MSE	0.012
Pop65	-0.0010	0.0005	-2.02	0.048	-0.0020	0.0000		
Yearbase2008								
2	-0.0170	0.0120	-1.42	0.161	-0.0409	0.0070		
3	0.0106	0.0106	1.00	0.323	-0.0106	0.0318		
4	0.0112	0.0138	0.81	0.420	-0.0164	0.0389		
5	0.0165	0.0125	1.32	0.191	-0.0084	0.0413		
6	0.0281	0.0116	2.43	0.018	0.0050	0.0512		
7	0.0371	0.0121	3.07	0.003	0.0130	0.0612		
8	0.0462	0.0120	3.85	0.000	0.0222	0.0702		
9	0.0506	0.0121	4.17	0.000	0.0264	0.0748		
10	0.0645	0.0133	4.83	0.000	0.0378	0.0911		
11	0.0683	0.0125	5.49	0.000	0.0435	0.0932		
12	0.0776	0.0124	6.28	0.000	0.0530	0.1023		
_cons	4.6128	0.0323	142.60	0.000	4.5482	4.6773		