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The Relationship between Labor Productivity and Economic Growth in OECD Countries

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Abstract

In the course of globalization, the countries entered into an intense competition between each other. In order to achieve the competitive advantage, countries pay significant importance to the technological advancements. By improving the productivity, the technological innovations and developments allow the countries to make production at lower costs. The increase in factor productivities would enable higher levels of output in the economy. Since the factor productivity influences many other factors and the developed countries meet these criteria better than developing countries do, the factor productivities are higher in developed countries, when compared to those in developing countries. For this reason, in this study, the relationship between labor productivity, which is a partial factor productivity, and economic growth in seven OECD countries for the period between 2008 and 2014 by utilizing the panel data analysis method. According to the test results, we find a unidirectional causality relationship from economic growth to labor productivity.

Keywords: labor, productivity, economic growth, panel causality test

1. Introduction

Productivity is based on the economics of the firm. It is measured as the ratio of output to input (Owyong, 2001). Labor and capital productivity can be considered as productivity indicators. The labor productivity, which is the most common indicator for measuring the productivity, is the output corresponding to input obtained from the workforce or is defined as added value per each hour worked (Lieberman & Kang, 2008). There are three determinants of labor productivity. First one is human capital. Human capital comes from accumulated knowledge (education and experience), talent and expertise of an average employee in the economic process. The second factor is technological change. New inventions and innovations inspire the development of new products and services, which, in turn, increase the productivity. The third one is economies of scale that reduce manufacturing costs (Taylor et al., 2016). Capital productivity is based on gross outputs or added values. Capital productivity, as result of improvement of machinery and equipment, increase the quality of the labor. Capital productivity and return rate of capital are two different concepts. Capital productivity is a measure of physical and partial productivity whereas the other is the measure of the income that indexes capital income to the value of capital stock (OECD, 2001). Two producers, although they have the same production technology, may have quite different levels of labor productivity because they will be exposed to different factor prices if one uses more capital. Therefore, many researchers use the productivity as an invariability when they are dealing with the intensity of use of observable factor inputs. This measure is called total factor productivity (TFP) (Syverson, 2011). Total factor productivity can be calculated by dividing total output by total input. Total factor productivity index is calculated by ratio total output index to total input index. For this reason, the growth in TFP requires that the growth rate in total output to be less than the growth rate in total input (Kathuria et al., 2013).

This study tested the relationships between labor productivity per hour worked and the and economic growth among seven selected OECD countries (Belgium, Germany, Spain, France, Italy, Finland and UK). The data set covered the seven years from 2008 to 2014. Test results exhibit that there is a long run equilibrium relationship between labor productivity and economic growth and there exists unidirectional causality from economic growth to labor productivity.

2. Literatur Review

Jorgenson (1991) points out that in the United States was observed an increase in labor and capital input between the years 1947 and 1985. While the increase in capital input is the most important source of output growth, the increase in labor input is the second source after capital. The increase in productivity is less important. From this point of view, it was emphasized that it should focus on the mobilization of the sources related to the capital and labor rather than the improvements in productivity. Baily et al. (1996) point out that average labour productivity declines during recessions and increases during booms. Baier et al. (2002) 145 found out that only 14% of the increase in output per each worker in whichever country is related to the increase in TFP. Nachega and Fontaine (2006) indicate that the decrease in the output per person in Nigeria between the years 1963 and 2003 is due to the negative growth in the TFP as well as to the negative growth per person in physical capital. Yıldırım et al. (2009) used OLS technique in their research on 111 countries. Their test results show a statistically significant relationship in negative direction between the temperature and labor productivity. It means that high temperatures in a country have a negative impact on labor productivity. Rudolf and Zurlinden (2010) observed that labor and capital inputs increased the economic growth at the rate of 1.28% in Switzerland between the years 1991 and 2005. However, the results of the growth related to labor and capital productivity were less than those obtained from previous studies. Jajri and Ismail (2010) revealed that capital stock and capital-labor ratio have an important role on labor productivity and economic growth in Malaysian economy according to the data concerning the period between the years 1981 and 2007. Although the effective labor has a positive impact on economic growth, its contribution to the economic growth is less than that of the physical capital. Su and Heshmati (2011) used the Least Square Dummies Variables (LSDV) method for China between the years 2000 and 2009 and they observed that labor productivity has an important impact on economic growth according to the results obtained from analysis. Alani (2012) emphasized that the decrease in economic growth in Uganda in the period 1972 to 2008 might have been due to the increase in productivity and, in turn, unemployment and decrease in capital stock might have been due to the increase in productivity. Tabari and Reza (2012) tested the possible effects of the education and technology in agriculture sector on labor productivity in Iran in the period of 1961-2007 by using ARDL method. According to the results that they point out that the education and technology in agriculture sector have positive effects on labor productivity. So they consider the technology and education as important factors influencing labor productivity. Auzina-Emsina (2014) investigated the relationship between productivity growth and economic growth of European Union countries in the pre-crisis and post-crisis period. They proved that there is a weak relationship between productivity growth and economic growth before the crisis and no any relationship in the first stage of the post-crisis period.

3. Variables and Data Set

This study tested the relationships between labor productivity per hour worked (LP) and the and economic growth (GDP) among seven selected OECD countries (Belgium, Germany, Spain, France, Italy, Finland and UK). The data set covered the seven years from 2008 to 2014. The LP per hour worked is calculated as real output (reference year 2010) per unit of labor input. For GDP, the annual percentage growth rate was taken. LP variables are logarithmic. LP variables were taken from the Eurostat electronic database, GDP variables were taken from the World Bank's electronic database.

3.1 Panel Unit Root Tests

Before the analysis, we must conduct a unit root test to avoid spurious regression and gather meaningful results. Various panel unit root tests have been developed (Baltagi & Kao, 2000), such as Levin and Lin (1992), Quah (1994), Im et al. (1997) , Maddala and Wu (1999), Choi (1999, 2001), Kao (1999), Harris and Tzavalis (1999), Hadri (1999), Levin et al. (2002) , Breitung (2000), and Harris and Sollis (2003).

Levin and Lin (1992) limited the normal distribution in panel test statistics on univariate time series data against the standard distribution of a unit root test. They accepted that $N \rightarrow \infty$ and $T \rightarrow \infty$ values tend toward infinity in every situation. However, when N/T ratio goes to zero, T goes to infinite faster than N (Maddala & Wu, 1999). According to Im et al. (2003), under a standard normal distribution, the time dimension tends to $T \rightarrow \infty$, while the diagonal section also follows it and goes to $N \rightarrow \infty$ as well. Under $N/T \rightarrow k$, the k value is finite and hypothetically below a non-negative constant, which results after diagonal convergence as T and $N \rightarrow \infty$ (Im et al., 2003).

In our study, the stability of the constants was examined by using first generation stability tests such as the LLC, IPS, ADF, and PP tests. In all tests, for the LP and GDP series at first difference, the 5% significance level was constant and fixed stationary. The LP and GDP series unit root test results are shown in Table 1.

Table 1. Panel unit root test results

		Level		First difference	
Variables	Method	Statistic	Prob*	Statistic	Prob*
	LLC	-11.401	0.000*	-14.112	0.000*
LLP	IPS W-stat	-1.053	0.146	-4.663	0.000*
	ADF-FisherChi-Square	31.883	0.004*	50.217	0.000*
	PP-FisherChi-Square	59.433	0.000*	69.048	0.000*
	LLC	-7.277	0.000*	-11.477	0.000*
GDP	IPS W-stat	-0.225	0.411	-3.665	0.000*
	ADF-FisherChi-Square	17.532	0.228	43.324	0.000*
	PP-FisherChi-Square	30.391	0.006*	52.713	0.000*

*IPS, ADF, LLC and PP implies Im, Pesaran and Shin Test; ADF Fisher Chi Square; Levin, Lin and Chu Test and PP Fisher Chi Square Test respectively. *,**,*** represent 1%, 5% and 10% level of significance respectively.

3.2 Panel Cointegration Test

A panel cointegration test was then conducted to determine the existence of a long-term relationship between the variables. In the literature, one of the most commonly used cointegration tests is that provided by Pedroni (2004). This test allows the cointegration vector to be heterogeneous as well as different between sections under the alternative hypothesis. The Pedroni cointegration test, which is based on the Engle–Granger (1987) method, is presented below:

$$y_{i,t} = \alpha_i + \delta_{it} + \beta_i X_{i,t} + e_{i,t} \tag{1}$$

t=1,…, T; i=1,…, N; m=1,2,…, M where T is the number of observations, N is the number the individual units in the panel, and M is the number of the variables in the regression. Equation (1) shows that X_i is a specific intersection element and δ_{it} is the determinative time trend, all of which properly pertain to individual panel membership. The presence of the cointegration relationship between the variables is tested by means of the stability of the above error terms. The null hypothesis suggests no cointegration, which accepts that the Y_{it} and X_{it} variables are also cointegrated in the first degree I(1) with the e_{it} error term.

The equation for the non-parametric statistical estimation is (Pedroni, 1999).

$$\hat{e}_{i,t} = \hat{\gamma}_i \hat{e}_{i,t-1} + \hat{u}_{i,t} \tag{2}$$

and that for the parametric test estimation is (Pedroni, 1999).

$$\hat{e}_{i,t} = \hat{\gamma}_i \hat{e}_{i,t-1} + \sum_{k=1}^{K_i} \hat{\gamma}_{i,k} \Delta\hat{e}_{i,t-k} + \hat{u}^*_{i,t} \tag{3}$$

The null (H_0) hypothesis stating that there is no cointegration for all units, whereas the alternative (H_1) hypothesis stating that there is cointegration for all units. The alternative hypothesis does not make common first-order autoregressive coefficient pre-assumption for all units, and the test statistics have a normal distribution:

$$\frac{X_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Longrightarrow N(0,1) \tag{4}$$

where $X_{N,T}$ is the test statistic. The μ and v values refer to the mean and variance, respectively (Pedroni, 1999).

Table 2. Pedroni cointegration test results (only with constant)

Model : $\Delta GDP_{it} = \alpha_{it} + \beta\Delta LLP_{it} + u_{it}$				
	Statistics	Prob.	Weighted Statistics	Prob.
Panel v-Statistic	-0.099	0.539	-0.212	0.584
Panel rho-Statistic	0.309	0.621	0.442	0.671
Panel PP-Statistic	-3.852	0.000	-1.937	0.026
Panel ADF-Statistic	-5.804	0.000	-4.709	0.000
Alternative hypothesis: individiul AR coefs. (between-dimension)				
	Statistics	Prob.		
Group rho-Statistic	1.803	0.964		
Group PP-Statistic	-2.428	0.007		
Group ADF-Statistic	-7.848	0.000		

H_0= No cointegration.

H_1= Cointegration exist

The test statistics in Table 2 have a value above $Z_{0.05}$=1.96, thereby rejecting the null hypothesis of no cointegration between LP and GDP at the 5% significance level. These results exhibit that there is a long run equilibrium relationship between LP and GDP variables.

3.3 Granger Causality Test

In our analysis, by keeping the variable constant, we used the Granger causality test to examine the direction of the relations among these variables (Granger, 1969):

$$\Delta LLP_t = \alpha_1 + \sum_{j=1}^{P_1} \beta_j \Delta LLP_{t-j} + \sum_{j=1}^{P_1} \delta_j \Delta GDP_{t-j} + u_{1t} \quad (5)$$

$$\Delta GDP_t = \alpha_2 + \sum_{j=1}^{P_2} \Upsilon_j \Delta LLP_{t-j} + \sum_{j=1}^{P_2} \varphi_j \Delta GDP_{t-j} + u_{2t} \quad (6)$$

Table 3. Granger causality test results

Null Hypothesis:	Obs.	F-statistics	Prob.
ΔLLP does not Granger cause ΔGDP	28	0.436	0.651
ΔGDP does not Granger cause ΔLLP		4.328	0.025*

Table 3 also shows for the LP–GDP relation that the probability value is larger than 5%, accepting H_0 (LLP does not cause GDP). Hence, there is no causality relation between LP and GDP. For the GDP–LP relation, this table shows that the probability result is lower than 5%, rejecting H_0 (GDP does not cause LLP), thus suggesting unidirectional causality from GDP to LP.

4. Conclusions

The efficient use of economic resources is one of the important problems of the economy. As the resources are scarce in the economy, their efficient use is a necessity. There is a production level set for each country that can be attained if they use their resources with full and efficiency. The increase in the production level will be an expected result if the factors used in production full and efficiency or the productivity of these factors has been increased. From the production factor used, the productivity of capital, labor or raw material can be increased. The most frequently used partial efficiency in the economy is the labor productivity which, in turn, is ensured by the increase in knowledge and skills. Another factor that increases the efficiency of the workforce is the technological innovations developed through research and development activities. Work conditions and climate also influence the productivity of the workforce. Productivity is one of the most important factors contributing to the economic growth. It has effects on economic growth by means of reducing input costs and efficient use of the production factor. While the productivity triggers the economic development and growth in developing countries, it leads to sustainable economic growth in developed countries. It is a fact that the labor productivity of developed countries is higher than that of developing countries for the reason that these first ones have strong economic, education and health infrastructures and they are engaged in technological innovations.

Provided that the productivity shows us the most general meaning the relationship between production factors and production itself, technological developments will provide more physical output with less input or either by improving the efficiency of production factors. It is necessary that the countries invest more in research and development activities in order to realize technological developments. Developed countries are more successful in doing this than developing countries. For this reason, our research consists on examining seven technologically advanced OECD countries using panel data analysis. The data of concern is that between the years 2008 and 2014. It is revealed there is a long run equilibrium relationship between labor productivity and economic growth between these years. Moreover, the causality test points out that there is a unidirectional causality relationship from economic growth to labor productivity. The findings from the test results support the opinion that labor productivity is better in countries that provide economic development.

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