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EFFICIENCY WAGE MODEL IN THE ROMERIAN PERSPECTIVE

Abstract. According to the Efficiency Wage Theory revealed by New Keynesian Economists in the 1960s, there is a positive relationship between wages paid to workers and labor productivity. Based on this theory, David Romer asserted that wage affects labor. Employees afraid to lose their current jobs make greater efforts in exchange for a certain wage level during high unemployment periods. Conversely, they make less efforts in a situation where other companies pay more. The purpose of this study is to analyze the effect of real wages and unemployment on labor productivity based on the Efficiency Wage Theory from the Romerian perspective. Therefore, the following G20 countries were selected for this study: the U.S., Australia, France, South Korea, Japan, Canada, Mexico, Russia and Turkey. The author used 2000–2017 data delivered by the Organization for Economic Co-operlation and Development (OECD). In the pursuit of the defined goal, the author carried out a literature review first, and then analyzed the data using a panel regression analysis, the Dumitrescu-Hurlin causality test, and the Pedroni panel cointegration test. In this study, independent variables are real wages and unemployment rate; the dependent variable is the annual growth rate of labor productivity. The Dumitrescu-Hurlin causality test used in the analysis of G20 countries found one-way causality from unemployment rate to annual growth rate of labor productivity. Moreover, a cointegration relationship was discovered between the variables in the Pedroni panel cointegration test.

Keywords: labor productivity, real wages, unemployment, panel data

INTRODUCTION

Labor productivity is one of the issues closely followed in all countries in the global competition environment. Within the framework of a general theoretical background, it is accepted that high real wages paid to employees increase labor productivity. This situation is of great importance to ensuring long-term stability in G20 countries.

However, especially in developing countries, the increase in real wages is generally higher than the increase in productivity. Basic elements that limit labor productivity are the shortage of skilled labor force, spread of trade shocks, and a loose public sector wage policy. In this context, international competition is also interrupted (Mihaljek and Saxera, 2010, 53).

According to the Efficiency Wage Theory which explains the relationship between real wages and labor

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productivity, it is accepted that firms do not have full knowledge of labor productivity and that labor productivity is a function of wages paid. In such a case, even if there is a surplus of labor supply, firms will not want to reduce wages, considering that doing so will lead to a further decline in productivity and cause an increase in labor costs. Therefore, the firms will agree to pay employees more than the wage level specified in the market. This prevents real wages from falling below a certain level and brings about stickiness in real wages (Bilir, 2017, 207).

The main purpose of this study is to evaluate a relationship between real wages, unemployment rates and annual growth rate of labor productivity in 2000–2017 in the following G20 countries: Germany, Australia, France, South Korea, Japan, Canada, Mexico, Russia and Turkey. At the same time, the other purpose of this study is to obtain findings consistent with literature. The study is limited to nine countries since the variables used – especially the annual growth rate of labor productivity – are not available for each year in all G20 countries within the OECD. It investigates the significance level, the cointegration relationship and the direction of causality between variables. Thus, econometric models are employed to tell whether there is a long-term cointegration relationship between the variables and how the increase or decrease in real wages and unemployment rates affects labor productivity.

THEORETICAL FRAMEWORK

In 1885, Alfred Marshall argued for the first time that there is a positive relationship between labor productivity and real wages in his work "Theories and facts about wages" (Agell, 1999, 145; Snowdon and Vane, 2005, 388). At a later time, this relationship was addressed by Solow within the Efficiency Wage Model (1979). In 1979, cited by Lawrence Katz, Solow stated in his work "Another possible source of wage stickiness" that enhanced wages raise the morale of employees, and this situation increases their productivity as it increases their efforts" (Bradley, 2007, 167–183; Katz, 1986, 2–5; Stiglitz, 1984, 2–42). Solow argued that wage stickiness was in the interest of employers, considering the argument that labor productivity would decline at lower real wage levels. Since cost minimization is one of the main objectives of a firm, wage rigidity minimizes costs and increases the profitability of the firm, thereby increasing labor productivity. Solow's views about the Efficiency Wage Model were developed by Yellen (1984) and Katz (1986) (Çetin and Bakırtaş, 2014, 175).

It is useful to discuss the relationships between the assumptions and variables in the model from David Romer's perspective as it deals with the Efficiency Wage Model. In this context, according to David Romer's advanced macro-analysis, the assumptions behind the Efficiency Wage Model and the knowledge of the model analysis can be expressed as follows (Romer, 2012, 459–464):

Identical and competitive firms are subject in N number. The representative firm aims to maximize its profits as indicated below:

$$\pi = Y - wL \tag{1}$$

In Equation 1, Y is the output of the firm, w is the wage paid, and L is the amount of labor hired by the firm. The output of a firm depends on the number of labor employed and their efforts. For the sake of simplicity, other inputs are ignored and it is assumed that labor and efforts are multiplicatively incorporated into the production function. Thus, the output of the representative firm is expressed as follows:

$$Y = F(eL) \quad F'() > 0 \quad F''() < 0 \tag{2}$$

According to Equation 2, e reflects the employees' effort. In the Efficiency Wage Model, assuming that all employees are subject to the same wage, the effort of the employees has a positive relationship with wages paid to them. The most important factor determining their effort is wage. This can be expressed as follows:

$$e = e(w), e' > 0 \tag{3}$$

Hence, when wages increase, so does productivity.

Finally, there are $\bar{L}$ equal employees, each of whom offers 1 unit of labor force in an inelastic manner.

The problem that firms need to solve in order to maximize their profits can be formulated as:

$$\max L,\ wF(e(w)L) - wL \tag{4}$$

As long as there is unemployment, the firm freely determines the wages to be paid to the labor force. If the unemployment rate is zero, the firm must pay at least the wage that other firms will pay.

Primary conditions for L and w when the firm is not restricted:

$$F'(e(w)L)e(w) - w = 0 \tag{5}$$

$$F'(e(w)L)Le'(w) - L = 0 \tag{6}$$

Equation 5 can be rewritten as follows:

$$F'e(w)L) = \frac{w}{e(w)}, \quad (7)$$

Equation 7 implies that a negative change in effort can reduce output. Therefore, those who are not enthusiastic and who do not want to work can reduce the output.

Placing the equation $F'e(w)L) = \frac{w}{e(w)}$, in equation $F'(e(w)L)Le'(w) - L = 0$ and dividing it by L results in the following expression:

$$\frac{we'(w)}{e(w)} = 1 \quad (8)$$

Equation 8 is provided where the optimal wage level is w and the elasticity of the effort relative to the wage is 1. The basis of this condition is that the output is a function of the effective labor force eL. In this case, the firm wants to hire as much labor as possible.

When the firm employs a worker, it derives $e(w)$ units of effective labor force from a cost of w. Hence, the effective labor cost per unit is $\frac{w}{e(w)}$. When the elasticity of e with respect to w is 1, the marginal change in w has no effect on this rate. The wage that meets the requirement in Equation 8 is considered to be the efficiency wage.

Equation $F'e(w)L) = \frac{w}{e(w)}$, reveals that the firm employs workers until the marginal product value of the effective labor force is equal to the cost of the effective labor force.

The firm's behavior is expressed with the following equations: $F'e(w)L) = \frac{w}{e(w)}$, and $\frac{we'(w)}{e(w)} = 1$. When adjusted across the economy, $w^\star$ and $L^\star$ shall be expressed as w and L in $F'e(w)L) = \frac{w}{e(w)}$, and $\frac{we'(w)}{e(w)} = 1$. Since the firms are identical, each of them chooses the same w and L values. Therefore, total demand for labor is $NL^\star$. If labor supply $\bar{L}$ exceeds this amount, firms are not restricted in their wage preferences. Then, the wage becomes $w^\star$, the employment is $NL^\star$ and there is unemployment in the amount of $\bar{L} - NL^\star$. On the other hand, firms will be restricted in a case where $NL^\star$ exceeds $\bar{L}$. Should this happen, the wage will increase to the point where supply and demand are in equilibrium, and unemployment will not occur (Romer, 2002, 466).

When Romer assessed the Efficiency Wage Model in a general way, he assumed that wages affected efforts because firms were unable to precisely control their work, and that employees were concerned about losing their jobs if they are found to shirk their responsibilities. In this case, the cost of expulsion for an employee depends not only on the wages that he/she receives from the job, but also on how easy it is to get another job and on the wages paid for it. Therefore, it is possible that employees will make more efforts for a certain wage when the unemployment rate is high, and that they will make less efforts when other firms pay higher wages (Romer, 2002, 466).

LITERATURE REVIEW

There are many studies in the international literature that explain the relationship between real wages and labor productivity. However, this study concentrates on the relevant literature relating to G20 countries.

A study by Appelbaum and Schettkat (1995) discussed the relationship between wages and labor productivity for 11 sectors in Australia (the period covered was 1979–1989). The analysis concluded that there is a weak relationship between productivity and wages.

A study by Dibooğlu and Enders (2001) found a cointegration relationship between variables such as real wages, productivity and unemployment in Canadian and U.S. economies between 1973 and 1988.

Fuess and Millea (2002) examined the relationship between real wages and labor productivity using the Granger causality test in Japan in 1975–1997. According to the findings, there was a one-way causality from labor productivity to real wages.

Pazarlıoğlu and Çevik (2007) analyzed the relationship between productivity, wages and unemployment rates in two separate periods (1945–1966 and 1969–2005) using the cointegration test. They discovered a cointegration relationship between three variables, and a causality relationship among variables.

Narayan and Smyth (2009) tried to explain the effect of real wages and inflation on productivity in G7 countries with the use of panel data and panel cointegration analysis. According to the results, a 1% increase in real wages leads to a 0.6% increase in productivity. Moreover, there is no significant relationship between inflation and productivity.

Kumar, Webber and Perry (2009) examined the relationship between real wages, inflation and labor productivity in Australia between 1965 and 2007 using the

cointegration analysis, Granger causality test and structural change test. According to their findings, real wages and inflation were the drivers of labor productivity. As a result of a 1% increase in real wages, labor productivity increases by 0.5–0.8%. There was also a negative relationship between inflation and labor productivity.

Çetin and Bakırtaş (2014) examined the relationship between the annual growth rate of average real wages and annual growth rate of labor productivity in 34 OECD member countries through the panel Pedroni cointegration analysis in 2000–2010. They found a cointegration relationship between labor productivity and real wages in OECD countries.

DATASET

In this study, two separate econometric analyses are performed based on 2000–2017 annual data. The first analysis relied on variables such as real wages, unemployment rate and labor productivity (which Romer indicated in his study relating to the Efficiency Wage Model) for selected G20 countries[1] (U.S., Australia, France, South Korea, Japan, Canada, Mexico, Russia and Turkey). The variables are logarithmized in order to provide a more accurate analysis, and are evaluated using the panel data analysis.

Real wages, unemployment rates and annual growth rates of labor productivity used in the econometric analysis were retrieved from the OECD database.

ANALYSIS AND RESULTS

Firstly, the panel regression analysis was carried out to test the effect of real wages and unemployment rates on the annual growth rate of labor productivity. Then, the Dumitrescu-Hurlin causality test was used in order to determine the direction of causality between the variables. Finally, the panel Pedroni cointegration analysis was used to determine whether the variables are cointegrated. The analyses were performed for Turkey and selected G20 countries.

[1] In the context of 2000–2017 OECD data, certain countries were excluded from this study due to unavailability of annual growth rates of labor productivity. The analysis continued with nine G20 countries.

Analysis results for G20 countries and Turkey

The regression analysis reveals the mutual relationships between variables that comprise the model. The analysis resulted in determining the mathematical format of the relationship and the significance of the model. The findings for nine G20 countries are as follows:

Table 1. Classical model (Pooled Ordinary Least Squares)

Dependent variables: LP	Coefficient	Standard error	t-value	Probability value
Log UR	1.242098	0.134001	9.269336	0.8134
Log RW	3.470885	0.287435	12.07536	0.0016

F-statistic 5.169051
F-probability: 0.006685
R^2: 0.061050

According to Table 1, since the probability value of F-statistic was below 5%, the model was statistically significant. However, the explanatory variables in the model could not completely explain the model because the R^2 value was low. The inadequate number of explanatory variables can be identified as the reason. Alternatively, this can be because the model includes some variables which should not be covered by the analysis. That problem can be solved by taking these two points into consideration.

In the Panel Regression Model (derived from Pooled Ordinary Least Squares), the fact that the probability value for the logarithmized unemployment rate was quite higher than 5% means that the unemployment rate has no significant relationship with labor productivity in G20 countries. However, the fact that the probability for real wages was below 5% suggests that real wages proportionally affect labor productivity (at low levels).

$LnLPit = \alpha it + \beta i1 lnRW + \beta i2\ lnUR + uit$

The cross-sectional dependency test is a method for determining the analyses to be used. The decision regarding the tests to be applied was made on that basis. The causality test to be used in the study will be determined by the results obtained below.

The cross-sectional dependency hypothesis is as follows:

H_0: There is no cross-sectional dependency.

H_1: There is a cross-sectional dependency.

Table 2. Cross-sectional dependency test

Test	Statistical value	Significance value
Breusch-Pagan LM	70.35560	0.0005
Pesaran scaled LM	4.048846	0.0001
Pesaran CD	5.438170	0.0000

Note: H_0 is rejected because the significance value is (0.00) < 0.05.

As shown in Table 2, the study determined that there was cross-sectional dependency in the data series. The hypothesis H_0 was rejected because all probability values were below the 5% significance level in Breusch-Pagan LM, Pesaran scaled LM and Pesaran CD tests. Accordingly, the tests to be carried out should take cross-sectional dependency into account. Hence, it was decided to use the Dumitrescu-Hurlin causality test in this context.

Testing the concept of causality was first suggested by Granger. The causality tests used in panel analyses are based on Granger-causality tests which reveal the direction of the relationship between two variables.

In this study, the Dumitrescu-Hurlin causality test was used because of the need to include cross-sectional dependency of the variables.

As seen in Table 3, the results of the Dumitrescu-Hurlin causality test described the relationship between labor productivity and unemployment rate; real wages and labor productivity; and real wages and unemployment rate for G20 countries.

According to the test results, there was a causality relationship from the unemployment rate to labor productivity at a 5% significance level. Thus, the null hypothesis was rejected. However, there was no causal relationship from labor productivity to real wages. Consequently, there was one-way causality from unemployment rate to labor productivity. No causal relationship between labor productivity and real wages was determined. Finally, there was no causal relationship between real wages and unemployment rates.

The Pedroni panel cointegration test was used to test whether a cointegration relationship exists between the variables of the Efficiency Wage Model for G20 countries in an analysis which uses real wages and unemployment rate as independent variables and the annual growth rate of labor productivity as the dependent variable.

Table 4 shows eight different statistical results for the annual growth rate of labor productivity. The null hypothesis which states "there is no cointegration relationship between real wages, unemployment rate and labor

Table 3. Dumitrescu-Hurlin causality test

Null hypothesis	W-statistic	Z-bar statistic	Significance value	Decision
UR is not the cause of LP	4.61900	2.12894	0.0333	Unemployment rate ⇒ Labor productivity
LP is not the cause of UR	1.58943	-0.83708	0.4025	Labor productivity ⇏ Unemployment rate
RW is not the cause of LP	2.54835	0.10173	0.9190	Real wages ⇏ Labor productivity
LP is not the cause of RW	4.28071	1.79775	0.0722	Labor productivity ⇏ Real wages
RW is not the cause of UR	2.98333	0.52758	0.5978	Real wages ⇏ Unemployment rate
UR is not the cause of RW	2.45281	0.000819	0.9935	Unemployment rate ⇏ Real wages

Table 4. Results of the Pedroni panel cointegration test (with LP as the dependent variable)

	Test statistic	Probability	Test statistic	Probability
Panel v- statistic	–0.595303	0.7242	–1.054800	0.8542
Panel rho- statistic	–3.592220	0.0002	–2.454054	0.0071
Panel PP- statistic	7.162837	0.0000	–6.601551	0.0000
Panel ADF- statistic	–3.681023	0.0001	–3.869647	0.0001

productivity" was rejected based on 6 statistics but was accepted based on 2 statistics according to these results. Therefore, based on the above, it was concluded that a long-term cointegration relationship exists between the variables.

CONCLUSION

The literature studies referred to in this paper indicate that a strong or weak relationship exists between real wages and labor productivity. The reason for the differences in the results between the studies is that the time intervals used, the countries covered and the econometric analyses applied reveal a change. However, the Effective Wage Theory emphasizes that an increase in real wages generally enhances labor productivity. Therefore, this situation helps ensuring macroeconomic stability in the long run.

The relationship between real wages and labor productivity is notably important for taking account many key factors, such as employment, resource use, and price levels in G20 countries like the U.S., Australia, France, South Korea, Japan, Canada, Mexico, Russia and Turkey.

According to panel data regression analysis for G20 countries, real wages had an effect on labor productivity. When viewed from this aspect, it can be said that there is a relationship in the same direction in the Romerian perspective, too. According to the Dumitrescu-Hurlin causality test, there is a one-way causality relationship from unemployment rates to labor productivity in G20 countries. It can be concluded that the results of both analyses are consistent with the Romanian perspective.

In summary, the cointegration relationship between unemployment rates, real wages and labor productivity was tested with the panel Pedrioni cointegration analysis. This study concluded that a mutual relationship exists between real wages, unemployment rate and annual growth rate of labor productivity in G20 countries, and therefore the time series for groups of countries exhibits cointegration.

These nine countries covered by the study should focus on sectoral education policies in order to increase the productive labor force which is dominated by high technology. At the same time, support should be provided to sectors that provide high wages and add great value.

Countries should run to sectors where they will not have qualified labor problems.

Policies should be established to solve the unemployment problem which is one of the most important issues facing the global competitive environment.

Creating job opportunities which meet the demand and skills of individuals, and increasing their employability could be a way to improve their motivation.

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MODEL EFEKTYWNOŚCI W PERSPEKTYWIE ROMERA

Abstrakt. Według teorii efektywności płac z lat 60. XX wieku istnieje pozytywny związek między płacami pracowników a wydajnością pracy. Na podstawie tej teorii David Romer stwierdził, że płaca wpływa na pracę. Pracownicy, obawiając się, że stracą obecną pracę, dokładają większych starań, aby uzyskać określone wynagrodzenie w okresach wysokiego bezrobocia, podczas gdy pracują mniej wydajnie w przypadku wyższych płac oferowanych przez inne firmy. Celem badania jest analiza wpływu realnych płac i bezrobocia na produktywność pracy za pomocą teorii efektywności płacy rozpatrywana z perspektywy Romera. Jako podmioty analizy wybrano państwa należące do G20 tj. USA, Australię, Francję, Koreę Południową, Japonię, Kanadę, Meksyk, Rosję i Turcję. Wykorzystano dane z lat 2000–2017 zebrane przez OECD. Do realizacji celu dokonano przeglądu literatury, a następnie przeanalizowano dane za pomocą regresji panelowej, testu przyczynowości Dumitrescu-Hurlin oraz panelowego testu kointegracji Pedroni. W badaniu zmiennymi niezależnymi były płace realne i stopa bezrobocia; zmienną zależną – roczne tempo wzrostu wydajności pracy. Na podstawie wyników testu przyczynowego Dumitrescu-Hurlin w analizie krajów G20 stwierdzono jednokierunkową zależność zmian stopy bezrobocia do rocznej stopy wzrostu wydajności pracy. Ponadto na postawie testu Pedroni stwierdzono związek kointegracyjny między badanymi zmiennymi.

Słowa kluczowe: wydajność pracy, płace realne, bezrobocie, dane panelowe