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Labor Productivity and Real Unit Wage Index in Turkey

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Abstract

We provide the causality between real wage and productivity in the Turkish economy. The results are also provided at the sectoral levels. We employ a Granger causality analysis to observe the flow of causation. We find that labor productivity statistically causes real wage movements. This estimation is also valid for the manufacturing sector and the electricity, gas, steam, and air conditioning supply sectors. Besides, there exists a bi-directional relationship in the mining and quarrying sector.

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1. Introduction

Even though several studies indicate the relationship between labor productivity and unit labor cost, the economic theory has difficulty discovering an effective and convincing causal relationship between these variables. Several explanations, in theory, can be split into two groups. The orthodox microeconomic theory insists that changes in labor productivity bring about changes in real wages. In contrast, remaining theories claim to opposite this causality by indicating changes in labor productivity stem from changes in real wages.

The empirical literature gives mixed causality between labor productivity and unit labor cost. Several studies aim to reverse the orthodox theory in developed economies such as G7 and OECD countries (Nayoran and Smyth, 2009; Veerger and Kleinknecht, 2011 and 2014; Storm and Noostegad, 2009; Madsen and Domania, 2001; Hein and Tarassow, 2009; Pyo, 2018) while some studies focus on individual countries (Weisskopf et al. 1983 for the U.S.; Sylos and Labini, 1983 for U.S. and Italy; Valadkhani, 2003 for Australia; Marquetti, 2004 for the U.S.; Brida et al. 2010 for Mexico; Vera, 2021 for Venezuela; Kumar et al. 2012 for Australia; Upender and Sujan, 2008 for India; Wakeford, 2004 for South Africa). All these studies find that labor productivity statistically causes real wage movements.

On the other hand, Mendez and Hernandez (2014) show that the relationship is bi-directional in Colombia, while Marquetti (2004) and Yusof (2007) indicate that higher productivity leads to higher wages in the U.S. and Malaysian, respectively. Together with the studies for individual countries, it is relatively scarce for Turkey. Karaalp and Orhan (2007) indicate that real wages affect labor productivity in the long run while there is no statistical causality between them in the short run. Yıldırım (2015) analyzes the relationship between productivity, real wage, and inflation in the Turkish manufacturing industry and shows unidirectional causality from real wages to productivity. Pazarlıoğlu and Çevik (2007) examine the relationship between productivity, real wages, and unemployment over 1945-2005 and determine a bi-directional causality between real wage and productivity between 1969 and 2005.

This study provides the causality between real wage and productivity in the Turkish economy. The paper contributes to the literature by analyzing this causality at the sectoral level for the first time to our best knowledge. We employ a Granger causality analysis to observe the flow of causation. We confirm the orthodox approach that real wages are adjusted in response to a change in labor productivity. A similar relation also appears in the manufacturing sector and the electricity,

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gas, steam, and air conditioning supply sectors. Besides, there exists a bi-directional relationship in the mining and quarrying sector.

The structure of the paper is as follows: We introduce the data we used in the analysis in Section 2. In Section 3, we build our expectations about causality and observe the breaking points in the time series. We present our methodology in Section 4. We show our results and robustness checks in Sections 5 and 6, respectively. Then we conclude.

2. Data

This study uses the real unit wage index for Turkiye calculated and published by the Presidency of Strategy and Budget for the periods 2009Q1-2021Q3 (PSB, 2021). According to the definition given by the U.S. Bureau of Labor Statistics, the term labor productivity is a measure that collates the number of goods and services with the number of hours spent on the production of these outputs. In other words, it is the ratio of the volume of gross output and the volume of labor inputs, hours worked. The unit labor cost, which is a measure of price competitiveness, is defined as the ratio of the average cost of labor to output produced. Accordingly, the Presidency of Strategy and Budget identifies the unit wage index as the ratio of total labor cost per hour worked to labor productivity.

The Presidency of Strategy and Budget obtains hourly labor productivity as the ratio of industrial production index to hours worked index, which TURKSTAT calculates. Following this, the Presidency of Strategy and Budget calculates the nominal unit wage index as the ratio hourly labor cost index in the industry based on 2015, calculated by TURKSTAT, to hourly labor productivity. Accordingly, the reel unit wage index is calculated by Presidency of Strategy and Budget while dividing the nominal unit wage index by Consumer Price Index.

Figure 1. Seasonality of Real Unit Wage Index and Labor Productivity in Total Industry

Source: Data of Presidency of Strategy and Budget and authors' calculations

Figure 1[1] shows that the unadjusted series of real unit wage index and labor productivity include a seasonality. So, we decided to use the seasonally adjusted series in our analysis.

3. Conceptual Background

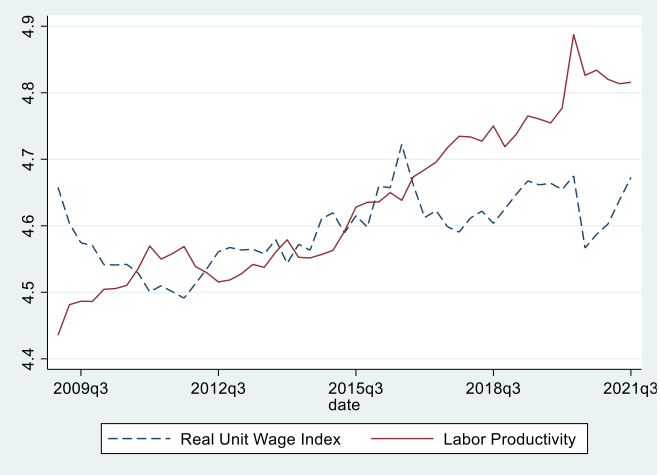
The relation over time of real unit wage index and labor productivity can be observed in Figure 2. Here the variables are expressed as a logarithm. Note that the trend of the variables seems to be the same within the period between 2009 and 2015.

The Minimum Wage Determination Commission has declared the minimum wage as monthly 1.647,00 TL put in place on 30.12.2015. This increase in the minimum wage broke the harmony of the relation between the real unit wage index and labor productivity. The level shift in the real unit wage index resulted in a gap between the growth of the series.

The chart below shows the relationship between the real unit wage index and labor productivity in total industry. As can be seen, the increase in the real unit wage index is delayed for one period. In other words, after an increase in productivity is observed, there is an increase in the real unit wage in the following period. Based on the observation from Figure 2, we expect to estimate a causal relation that labor productivity statistically causes real wage movements.

[1] The numbers seen between x and y axis of graphs (1, 2, 3 and 4) present the quarter periods of the year.

Figure 2. Real Unit Wage Index vs. Labor Productivity in Total Industry



Source: Data of Presidency of Strategy and Budget and authors' calculations

4. Methodolgy

Our model aims to analyze the relationship between the real unit wage index and labor productivity in the Turkish economy. To do so, we exploit from causality test: Granger test (1969). To perform this test, we need stationary variables to avoid spurious regression. Hence, we apply the Augmented Dickey-Fuller (ADF) Test and Phillips-Perron (P.P.) Test to test the null hypothesis that a unit root exists in a time series sample.

Table 1 shows the unit root test that we apply for the real unit wage index and labor productivity series and the first differences. Note that the probabilities are greater than 0.05, meaning that we accept the presence of a unit root as these series are not stationary at level. However, when we take the first differences, the test results indicate that both time series are stationary variables at first differences. Also, note that at the sectoral level, we show that both the real unit wage index and labor productivity series are $I(1)$. The unit-root test results for the sectors are presented in Appendix A1-A3.

Table 1. Unit root tests (Total Industry)

Variables	Augmented Dickey-Fuller Test	Prob.	Phillips-Perron Test	Prob.
Log(LP)	-0.883	0.793	-0.786	0.823
Log(UWI)	-2.019	0.278	-2.126	0.234
D.Log(LP)	-8.652	0.000	-8.875	0.000
D.Log(UWI)	-7.953	0.000	-7.973	0.000

Notes: L.P.: Labor productivity, UWI: Unit wage index, D.Log: First difference. ADF and P.P. sans lag and without trend nor intercept

Suppose that the following simple Autoregressive Distributed Lag (ADL) model holds:

$$Y_t = \alpha + \gamma Y_{t-1} + \beta_1 X_{t-1} + \varepsilon_t \quad (1)$$

The coefficient of β_1 is a measure of the effect past values of X. If $\beta_1 = 0$, we can say that X does not Granger cause Y. In general, we could assume that (X, Y) relation is described by an ADL(p, q) model (**unrestricted model**):

$$Y_t = \alpha + \delta t + \gamma_1 Y_{t-1} + \cdots + \gamma_p Y_{t-p} + \beta_1 X_{t-1} + \cdots + \beta_q X_{t-q} + \varepsilon_t \quad (2)$$

Here, we can say that X does not Granger cause Y if all $\beta_i = 0$. The **restricted** version of this model can be written as:

$$Y_t = \alpha + \delta t + \gamma_1 Y_{t-1} + \cdots + \gamma_p Y_{t-p} + \varepsilon_t \quad (3)$$

If all $\beta_i = 0$, the unrestricted and restricted models are more or less the same. The F-statistics that is used for the causality test:

$$F = \frac{(SSR_R - SSR_{UR})/q}{SSR_{UR}/(T - q - p - 2)} \sim F(q, T - q - p - 2) \quad (4)$$

5. Results

Table 2 presents the Granger causality test for the total industry. We conduct the analysis at levels and differences, with different lags. The probabilities obtained by the causality test do not vary as the number of lags change. The results indicate that at levels, labor productivity Granger cause real unit wage. There is more unlikely to reject the null hypothesis that real unit wage does not Granger cause labor productivity.

Table 2. Granger causality tests (Total Industry)

H_0	Number of lags	F-statistic	Prob.
Log(LP) does not Granger-cause Log(UWI)	2	14.302	0.001
Log(UWI) does not Granger-cause Log(LP)	2	9.302	0.010
Log(LP) does not Granger-cause Log(UWI)	3	17.033	0.001
Log(UWI) does not Granger-cause Log(LP)	3	12.516	0.006
D.Log(LP) does not Granger-cause D.Log(UWI)	2	16.461	0.000
D.Log(UWI) does not Granger-cause D.Log(LP)	2	0.258	0.879
D.Log(LP) does not Granger-cause D.Log(UWI)	3	17.421	0.001
D.Log(UWI) does not Granger-cause D.Log(LP)	3	0.375	0.945

Also, note that both variables are not stationary; Wooldridge (2015) asserts that the coefficients are biased. We include variables at differences in the model instead of levels to overcome this issue. We have somehow the same

conclusion. Although we accept the null hypothesis that real unit wage does not Granger cause labor productivity, the test results indicate that labor productivity Granger cause real unit wage.

We replicate the same analysis at the sectoral level. The results are presented in Appendix Tables A4-A6. The manufacturing sector results are essentially the same as the results for the total industry. We most likely reject both null hypotheses for the mining and quarrying sector, meaning a bi-directional causality exists between labor productivity and the real unit wage index. The results differ between levels and differences for the electricity, gas, steam, and air conditioning supply sector. We can also say that the flow of causation stems from labor productivity to real wages at the 5% level of significance.

6. Robutness

We can apply the cointegration tests between labor productivity and the real unit wage index to see how robust the estimates are. To determine whether labor productivity and real unit wage index are cointegrated, we perform Engle and Granger (1987) test, which analyzes the residuals' stationarity.

We consider labor productivity as a dependent variable and the real unit wage index as an explanatory variable. At different numbers of lags, we calculate the ADF test statistics. The results indicate no long-term relationship between labor productivity and the real unit wage index. We obtain the same results for the different sectors (Tables A7-A9). Thus, we do not need to follow the error correction models.

Table 3. Cointegration tests between real unit wage index and labor productivity (Total Industry)

Dependent Variable	Regressor	Coefficients		Number of Lags	ADF Test	Prob.
		Constant	*Beta*			*Constant*
Log(LP)	Log(UWI)	-0.990	1.224	1	-2.230	0.195
Log(LP)	Log(UWI)	-0.990	1.224	2	-2.172	0.216
Log(LP)	Log(UWI)	-0.990	1.224	3	-2.293	0.174
Log(LP)	Log(UWI)	-0.990	1.224	4	-1.629	0.468

7. Concluding Remarks

This paper analyzes the causal relationship between labor productivity and the real unit wage index. We have estimated that in total industry labor productivity Granger causes real unit wage. The results confirm the orthodox approach that real wages are adjusted in response to a change in labor productivity.

The paper has also provided the estimates at the sectoral level. We have shown that the flow of causation stems from labor productivity to real wages in the manufacturing sector. We have found a bi-directional causal relationship between labor productivity and the real unit wage index in the mining and quarrying sector. For the electricity, gas, steam, and air conditioning supply sector, we have also found a decrease in labor productivity forces a decrease in the real wage.

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