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The dynamics of real wages and productivity in public and private sectors: an empirical investigation for 1963-2007 period in Turkey

Abstract

The aim of this paper is to investigate the long- and short-run dynamic relation between labor productivity and various sectoral real wages in Turkey for 1963-2007 period. In order to achieve these objectives, the study employs Engle-Granger cointegration analysis where Zivot and Andrews's endogenous unit root is employed in measuring degree of ordering and Granger-causality analysis where Quandt-Andrews structural break test is utilized in the regression. The study finds that in the long run, the labor productivity and wages do not move too much apart from each other. The Granger causality test shows that in public sector, the real wages seem to induce labor productivity while bidirectional causality is indicated in private sector.

Keywords: labor productivity, wages, public sector wage policy, time series analysis, structural break, macroeconomics.

JEL Classification: C22, E02, H00.

Introduction

There are various theoretical and empirical studies assessing the link between labor productivity and real wages. With regard to the long-run relation, the theoretical argument raised by Arthur L. Bowley (see Hicks, 1932, pp. 125-133) and also by Kaldor¹ (1965) seems to suggest that the share of wages in income remains constant in the long run. While the Bowley's Law and Kaldor's proposition seem to be intuitively logical and quite explicit, the findings in the empirical literature are not always with their prediction². An indirect approach examining the constant share proposition is the cointegration analysis where if there exists a cointegration relation between the real wages and the labor productivity, then this suggests they go hand in hand without diverging one another. Using cointegration analysis, for example, Marquetti (2004) investigated the link between aggregate level wages and productivity of the US economy for the period of 1869-1999 and found that these variables appear to move together in the long run. This finding is practically consistent with Kaldor's and Bowley's approach suggesting real wages and productivity share a same stochastic trend in the long run.

Once established the long-run equilibrium between real wages and labor productivity, the short-run dynamics or casual linkage between the variables would be pursued. If the productivity growth precedes the real wages, the picture is to some extent consistent with the neoclassical approach. On the other hand, in a systematic manner, if the wage increases (decreases) precede the productivity increases (decreases) of labor, then the

result is consistent with "biased technology change" hypothesis raised by Hicks (1932).

The objective of the paper is to investigate the dynamics of wages and the labor productivity for Turkey for the period of 1963-2007. The first objective is to investigate the long-run or equilibrium relationship between productivity and real wages in the long run. Related to the first objective, the other objective is to inquire the causality between these two variables. The short-term casual linkage is ascertained by Granger-causality test. In other words, the second objective is to investigate whether Turkish real wage and labor productivity pattern is consistent with Hicks' "biased technology change" hypothesis.

While this study shares some theoretical and methodological elements with Marquetti's (2004) study, there are at least two major differences. First, our study investigates Turkish labor market for 1963-2007 period (the former for the US for 1869-1999 period). Secondly, the study allows possibility of structural breaks both in unit root tests (i.e. employing Zivot and Andrews (1992) endogenous structural break unit root test) and in regression analysis (i.e. Quandt-Andrews Breakpoint test)³.

This novelty of this research has two strong foundations. To our best knowledge, the long-run relation between sectoral real wages and labor productivity under cointegration setting has not been examined for Turkey. In addition to this ingenuity, the causal short-run linkage with above mentioned methodological device has not been utilized.

The study is organized in the following way: The first section will narrate the theoretical and empirical studies over both long- and short-run relations and behaviors of real wages and labor productivity.

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¹ According to Kaldor's (1965) empirical work, the relative factor share of labor seems to be constant in the long run and he considered this regularity as one of the stylized facts of economic growth.

² See, for example, Atkinson (1983) and Kramer (2006).

³ Due to Quandt (1960) and Andrews (1993).

In the second section, the data and the methodology will be described and the analysis will be performed. In the same section, the study will interpret the results of the analysis. The study will be finished with brief summary and policy conclusions.

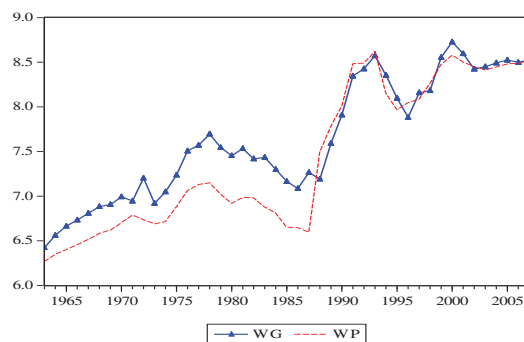
1. Theoretical framework and literature review

According to the Bowley’s Law, in the long run, the share of labor in national income is reasonably stable¹. In parallel to Bowley’s Law, Kaldor (1961) showed that the aggregate share of gross domestic product that goes to labor had displayed relatively stable and constant pattern in the long term and this phenomenon has been considered as one of the stylized facts of economic growth (Kramer, 2006). Although the share of labor had displayed relatively stable pattern prior to 1970s for many developed nations, several empirical studies have failed to show the similar pattern within the last 20-30 years. In particular, although the US labor market tends to follow pattern consistent with Kaldor’s stylized fact, the studies found that developed nations including nations in continental Europe show a clear downward trend within the last 20-30 years (Kramer, 2006, pp. 147-150)².

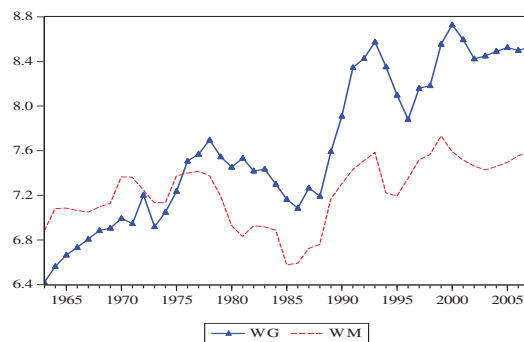
Theoretically, when real wages are suppressed (or not increase as much as productivity), the firms are expected to invest in labor-intensive technological production methods implying reduction in average labor productivity. In other words, reduction in real wages is expected to induce attenuation of productivity. From the reverse angle, when real wages increase, profit maximizing firms will lean towards labor-saving technological methods and thus the average productivity of labor will be expected to increase. This hypothesis is known as “biased technological change” and it then accentuates the fact that the change in wages proceeds change in productivity. Hicks’s observation (1932, pp. 124-5) that ‘a change in the relative share of factors of production is itself a spur to innovation and inventions of a particular type-directed at economizing the use of a factor which has become relatively expensive’ is perhaps the best-known expression of biased technical change (Marquetti, 2004, p. 433).

If real wages in Turkey follow a path consistent with Kaldor’s stylized fact or with Bowley’s Law, the real wages and productivity would display equilibrium relationship in the long run or they do not move too much apart from each other. In econometric sense, these series are expected to be cointegrated.

The development in Turkish wages is depicted on Figure 1. The wage structure among sectors in Turkey displays significant differences over the period of 1963-2007. The average growth rate in real wages for public workers and public officers has been around 6.5% and 1.2%, respectively. In the same period, the average growth rate of real wages for employees in private sector has been around 7.4%. The growth rate of real productivity per worker has been around 3.8%³. The development of real wages for public workers (WG) and private workers (WP) sector displays quite similar pattern throughout the period. Although both wages appear to be affected similarly by economic shocks, the wage gap between two wages disappeared after the mid 1980s. The visual inspection shows another important development for public officials’ wages. Although the real wages of public officials were significantly higher than that of public workers (and also that of private sector workers) prior to late 1970s, the wage advantage of being public officials disappeared in 1980s and the gap has been widened since. Consistent with the graphs, the liberal economic reforms initiated in 1980 and are still in progress harmed the relative welfare of public employees.



A. Public worker and private sector



B. Public worker and public officials

Notes: WG – public worker wages; WP – private sector wages; and WM – public official wages.

Fig. 1. Development in real wages

¹ See for detail, for example, Carter (2007).

² See, for instance, Blanchard (2006). The detailed explanation can be found in Carter (2007).

³ In order to calculate average growth rates, we employ a regression: $\log(X_t) = \beta_0 + \beta_1 \log(t) + u_t$, where X is the variable under investigation and t is the time trend and \log is the natural logarithm of the series.

2. Methodology, model and data

This empirical research employs annual data on wages for government workers (WG), government officials (WM), private sector workers (WP) and average labor productivity (VA) for Turkey over the 1963 to 2007 period. All the data were obtained from Turkish Statistical Institute (TSI, 2007), State Planning Organization (SPO, 2007) and Central Bank of Turkey¹ (CBRT) data delivery system. Since the data were collected from various sources, we synchronize the data by using their approximate growth rate as the harmonization variable. All the data were deflated by using GNP deflator, 1963=100. In order to acquire stationary variance in the data, all the series are transformed to logarithmic form and denoted by respective lower case letters.

As a methodological device, the study employs Engle and Granger (1987) residual-based cointegration testing procedure. When a model deals with only two endogenous variables, the Engle-Granger methodology is a suitable tool (Hatanaka, 1996, p. 210) in attempting to pursue the objective. If the cointegration between the variables exists, then either unidirectional or bi-directional Granger-causality must exist in at least the $I(0)$ variables (Engle and Granger, 1987).

The *Engle-Granger* cointegration approach is a three-step procedure. The first step entails the application of the unit root tests on each series employed in the model. In Engle-Granger and other cointegration approaches (e.g., Johansen and Juselius), it is necessary for series to have a common integration order. A stochastic process is said to be integrated of order p , abbreviated as $I(p)$, if it needs to be differenced p times in order to achieve stationarity. This study uses both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to determine the order of integration.

As it was observed from Figure 1, all real wage series seem to display some structural break(s). When a series possesses structural break(s), the conventional unit root tests would find results that can produce unreliable results. In order to solve this, we employ Zivot and Andrews (1992) unit root test (ZA test thereof), which involves three different regressions (Model A, Model B and Model C). In Model A, a dummy variable is included into the regression such that the intercept can shift at certain point in time. Model B allows for one-time change in slope of trend function, and Model C combines both Model A and Model B (i.e. allows both change

in slope and change in intercept). ZA model uses the following regression for Model C:

$$\Delta y_t = \mu + \beta[t] + \alpha[y_{t-1}] + \theta[DU_t] + \gamma[DT_t] + \sum_{j=1}^k c_j[\Delta y_{t-j}] + e_t, \quad (1)$$

where DU_t is a dummy variable for a mean shift occurring at each possible break-date (T_B) while DT_t is corresponding trend shift variable. Model A includes only DU_t while Model B includes only DT_t . The possible values for dummy variables can be formally summarized as:

$$DU_t = \begin{cases} 1: \dots \text{if } : t > T_B \\ 0: \dots \text{otherwise} \end{cases}, \quad (2)$$

$$DT_t = \begin{cases} t - T_B : \dots \text{if } : t > T_B \\ 0: \dots \text{otherwise} \end{cases}. \quad (3)$$

The corresponding null hypothesis for each model would be: $H_0: c=0$. The null hypothesis states that the series contains a unit root with a drift that excludes any structural break. The alternative hypothesis states that $c < 0$ or the series is a trend-stationary process with a one-time break occurring at an unknown point in time.

Once the order of integration requirement is fulfilled the second step of cointegration approach is to estimate the regression equation:

$$Y_t = \beta_0 + \beta_1 X_t + \lambda KUK_t + e_t, \quad (4)$$

where Y_t is the dependent variable (assume real wages), X_t is a regressor (assume average labor productivity), KUK_t , t and e_t are structural break dummy, time trend and residuals, respectively. As it will be explained below, we will run 6 regressions. In three of these six regressions, a particular real wage will be a dependent variable (and average labor productivity will be the regressor) and in the other three equations average labor productivity will be a dependent variable and the respective real wage variable will be used as a regressor.

The structural breaking point is detected by employing Quandt-Andrews Breakpoint test. The objective of this test is to identify one or more unknown structural breakpoints for a specified equation. In order to detect structural break (if any), the above regression is run for each model without structural break dummy and Chow Breakpoint Test is performed at every observation between two times t_1 and t_2 . If there are k periods between t_1 and t_2 , the regression is run for k times (by including structural break dummy for respective year) and the null hypothesis of no breakpoints between t_1 and t_2 is tested by

¹ <http://evds.tcmb.gov.tr/yeni/cbt-uk.html>

employing some standard statistic tests such as Maximum LR F-statistics and Maximum Wald F-statistics. After detecting the structural break (if any) at time T_B , the dummy variable takes value 1 for T_B and years after and takes value 0 for years preceding T_B .

After break-point analysis is concluded, the above regression (equation (4)) is run and the estimated residuals are tested for unit-root. If the estimated series for the residuals is found to be stationary, then it is said the productivity and individual wage series do not move too much apart from each other or these series are cointegrated.

Conditional upon the outcomes of the first two steps, the final step in Engle-Granger procedure is to perform Granger causality test augmented with appropriate error-correction term derived from the long-run cointegration relationship in equation (4). As Granger (1988) stated, the existence of Cointegration implies the existence of Granger causality at least in one direction.

The formulation of a Granger-causality test involves:

$$\Delta W_t = c_1 + \pi_1 EC_{t-1} + \sum_{j=1}^p \alpha_j \Delta W_{t-j} + \sum_{j=1}^p \beta_j \Delta VA_{t-j} + h_t, \quad (5)$$

$$\Delta VA_t = c_2 + \pi_2 EC_{t-1} + \sum_{j=1}^p \eta_j \Delta W_{t-j} + \sum_{j=1}^p \kappa_j \Delta VA_{t-j} + v_t, \quad (6)$$

where Δ is the difference operator; EC_{t-1} is the error correction term derived from the long-run cointegration relationship; h_t and v_t are zero-mean, serially uncorrelated random error terms. In traditional Granger-causality analysis, EC_{t-1} term is not included into the system.

According to Granger (1988), independent variables “cause” dependent variable either if the error correction term carries a significant coefficient (i.e. λ_1 and λ_2 are significantly different from zero) or the first difference independent variables are jointly significant (i.e. some of the β_i and/or κ_i are not equal to zero). In equations (5) and (6), λ_1 and λ_2 show the adjustments of wages and productivity to their respective long-run equilibrium (if exists). The short-run causality or Granger-causality test is based on a standard F-test statistics to test jointly the significance of the coefficients of the explanatory variable(s) in

their first differences. In particular, based on equation (5), the productivity increases “Granger-causing” the wage increases provided that some β_i is statistically different from zero. In parallel to this, the wage increases are said to Granger-cause productivity increases if some κ_i is not equal to zero.

The number of lags to perform test is selected according to Akaike information criterion (AIC).

3. Empirical results

The first step of Engle-Granger approach is to determine the degree of integration of the series. For this purpose, the study employs both conventional unit-root tests and endogenous structural-break unit root test. This study utilizes ADF and PP tests as conventional unit root in examining the degree of integration for the variables. We include a drift parameter into the conventional unit-root regressions and the results of the tests are given in Table 1. The lag length in these tests is determined by Akaike information criterion (AIC). The results indicate clearly that the null hypothesis can not be rejected for the levels of all the series since McKinnon's critical values at the 1%, 5% and 10% levels of significance are less than their ADF and PP values. After each series is differenced once, the unit-root tests are performed over these new series. After differencing, all the series become stationary at 1% significance level. Consequently, the conventional unit root tests conclude all the order of integration properties of series is compatible with cointegration analysis, i.e. they are I(1).

In order to avoid undesirable consequences generated by the structural breaks, we further apply Zivot-Andrews (ZA) endogenous breaking point unit root test. Since all the variables in the study involve systematic upward trend, we follow Ben-David and Papell (1997) and employ Model C of ZA unit root test. The results for ZA unit root test are shown in Table 2. As the table shows the results of ZA test are consistent with those of the conventional tests. The null hypothesis ($H_0: \alpha=0$) of unit root for all series failed to be rejected at 5% significance level. We concluded that the structural breaks in the series are not strong enough to create conflict with the results of conventional unit root tests.

Table 1. Unit root tests (without structural break)

Variable	LEVEL		Variable	FIRST DIFFERENCE	
	ADF test	Phillips-Perron test		ADF test	Phillips-Perron test
WG	-0.86 (5)	-1.37 (3)	Δ WG	-4.46 (4)	-5.19 (1)
WP	-1.09 (1)	-0.93 (0)	Δ WP	-4.82 (1)	-4.80 (1)
WM	-2.02 (1)	-1.85 (0)	Δ WM	-5.00 (0)	-4.86 (0)
VA	-0.37 (2)	-0.32 (0)	Δ VA	-8.51 (0)	-8.52 (0)

Notes: Both tests include a constant (a drift term). The lag selection is based on AIC criteria. The number in parentheses shows the lag number. The critical MacKinnon t-values for ADF test at 1%, 5% and 10% significance levels, respectively are -3.60, -2.94 and -2.61.

Table 2. The results for Zivot-Andrews unit root (structural break) test

	WG	<i>t-stat</i>	WM	<i>t-stat</i>	WP	<i>t-stat</i>	VA	<i>t-stat</i>
Year	1990		1979		1988		1979	
k	2		1		1		1	
μ	-23.25	-5.31	-19.34	-1.19	2.51	4.92	-33.75	-2.26
β	0.01	3.01	0.01	1.35	0.01	0.67	0.02	2.31
α	-0.51	-4.86	-0.38	-4.09	-0.37	-4.97	-0.48	-2.79
θ	0.27	2.44	-0.26	-2.81	0.38	4.38	-0.07	-1.97
γ	0.01	0.75	0.01	0.63	0.01	1.32	-0.01	-0.87

Notes: The critical values for Zivot and Andrews (1992) tests are -5.57, 5.30 and -5.08 at 1%, 2.5% and 5% levels of significance, respectively. The critical values are derived from Ben-David and Papell (1994).

Since each series is demonstrated to be I(1), we can move to the second step of the Engle-Granger cointegration method by exercising the regression (shown by equation (4)) analysis. In order to determine the value of structural dummy (KUK_t) in equation (4), the study utilizes Quandt-Andrews Breakpoint test. The results of Quandt-Andrews Breakpoint test are shown in Table 3. The null hypothesis of “no structural breaks” is rejected for each regression at 1% significance level. The information about break-year is given in the third column. When structural break occurs at say year T_B , the KUK_t takes 0 prior to T_B and 1 at and after year T_B .

Engle-Granger cointegration results for the average product of labor paired with three different types of wages are shown in Table 4. The estimated error series for each regression is tested for unit-root by using ADF test. In the table, ADF1 denotes unit root equation which does not include neither a constant nor a trend. ADF2 denotes unit root regression

which includes a drift but not a trend. The results show that the hypothesis examining the cointegrating relations between average productivity and the respective real wage levels failed to be rejected at the 5% level for all the regressions for ADF1. The result of ADF2 is in line with ADF1 except for the relation between the real productivity and private sector wages (for REG# 6). The first major finding of this research which is parallel to findings of Marquetti’s (2004) study over the US economy is about the existence of the long-term equilibrium relation between labor productivity and real wages. This result supports both Bowley’s Law and the hypothesis of Kaldor’s (1961) stylized fact. The close examination of wage equations (regressions 1, 3 and 5) shows that elasticity of wages with respect to labor productivity is around 1 suggesting there is a one-to-one relationship between the growth of labor productivity and real wages.

Table 3. The results for Quandt-Andrews breakpoint test

Regression #	Model	Break-year	Max. Wald stat	P-value
REG1	$wg_t = \beta_0 + \beta_1 va_t + e_{1t}$	1991	14.33	0.015
REG2	$va_t = \beta_0 + \beta_1 wg_t + e_{2t}$	1984	23.31	0.000
REG3	$wm_t = \beta_0 + \beta_1 va_t + e_{3t}$	1980	19.76	0.000

Table 3 (cont.). The results for Quandt-Andrews breakpoint test

Regression #	Model	Break-year	Max. Wald stat	P-value
REG4	$VA_t = \beta_0 + \beta_1 WM_t + e_{4t}$	1980	88.67	0.000
REG5	$WP_t = \beta_0 + \beta_1 VA_t + e_{5t}$	1990	46.87	0.000
REG6	$VA_t = \beta_0 + \beta_1 WP_t + e_{6t}$	1984	33.24	0.000

Notes: H₀: No-break points for the regression at 15% trimmed model or at 1970-2000 trimmed data.

Table 4. Test results for Engle-Granger cointegration

REG #	Model	REGRESSION			ADF-TEST	
		β_0	β_1	λ (KUK _t)	ADF1 No constant, no trend	ADF2 Constant, no trend
1	wg= f(va _t , KUK _{1t})	0.96 (1.07)	1.09 (6.95)	0.56 (4.82)	-4.06*** [2]	-4.01*** [2]
2	va _t = f(wg _t , KUK _{2t})	3.17 (12.45)	0.34 (9.58)	0.28 (5.82)	-3.18*** [2]	-3.08** [2]
3	wm _t = f(va _t , KUK _{3t})	1.52 (2.13)	1.02 (7.94)	-0.55 (-5.87)	-3.69*** [2]	-3.64*** [2]
4	va _t = f(wm _t , KUK _{4t})	1.33 (2.47)	0.59 (7.95)	0.56 (12.94)	-3.67** [3]	-3.58** [3]
5	wp _t = f(va _t , KUK _{5t})	1.92 (2.34)	0.85 (5.91)	1.03 (9.78)	-3.91*** [0]	-3.87*** [0]
6	va _t = f(wp _t , KUK _{6t})	3.74 (9.41)	0.27 (7.21)	0.29 (4.83)	-2.04** [0]	-1.77 [0]

Notes: The number in parentheses shows *t*-statistics. The lag selection is based on AIC criteria and the lag is given within the brackets: []. The critical MacKinnon *t* values for ADF test at 1% (***) , 5% (**) and 10% (*) significance levels for the ADF1 (i.e. no-constant and no-trend model) are -2.62, -1.94 and -1.61, and for the ADF2 (i.e. constant and no trend model) are -3.59, -2.93 and 2.60, respectively.

Table 5 reports the results of Granger-causality test applied on the 3 sets of model associated with 6 null hypotheses. Although we employ AIC as a lag selection criterion, the table displays solutions based on three different lags including 2, 3 and 4. The first null hypothesis stating “H₀: va→wg: the labor productivity does not Granger-cause public sector real wages” is rejected. On the other hand, we failed to reject the second null hypothesis stating “H₀: wg→va: the real wages for public sector workers do not Granger cause the labor productivity”. Similar to the results

for public sector workers, the Granger-causality test for public officials suggests that, the real wages tend to induce labor productivity. In sum, there is a unidirectional causality running from labor productivity to real wages in the public sector. On the other hand, in the private sector, the causality seems to run bidirectional, i.e. both from real wages to labor productivity and from labor productivity to real wages. Both wages and productivity in the private sector are inducing each other. The result for private sector does not seem to support Hicks’ argument.

Table 5. Granger causality test results

H ₀ :	LAG								
	lag=2			lag=3			lag=4		
	F-value	p-val	AIC	F-value	p-val	AIC	F-value	p-val	AIC
① H ₀ :va→wg	1.92	0.17	-0.82	3.53	0.07	-0.78	2.92	0.09	-0.66
② H ₀ :wg→va	4.82**	0.04	-3.04	5.32**	0.03	-2.99	4.27**	0.05	-2.87
③ H ₀ :va→wm	1.31	0.23	-1.06	1.14	0.29	-0.95	1.27	0.28	-0.84
④ H ₀ :wm→va	3.93*	0.05	-3.08	4.19*	0.05	-3.11	4.42**	0.04	-3.04
⑤ H ₀ :va→wp	4.87**	0.03	-1.26	5.21**	0.02	-1.35	6.92**	0.01	-1.31
⑥ H ₀ :wp→va	0.37	0.54	-2.94	11.64***	0.00	-3.15	12.09***	0.00	-3.07

Notes: Null hypothesis: H₀: →Y: X does not Granger cause Y. p-val: probability of rejecting H₀.

There can be various interpretations for these results that can be consistent with economic intuition.

Hicks’ (1932) “biased technology change” argument is one of the arguments that can be

raised for public sector. The adoption of Hicks' argument implies that when the increase in real wages is enormous, the administrators, politicians or government officials push politicians to adopt technological change in order to have more capital intensive production methods in public sector. This argument seems to be sensible when employer's main motivation does not involve production of public goods. That is, although Hicks' argument is fairly consistent with profit seeking private firms, at his point; we believe that, Hicks' argument does not seem to be based on a steady foundation for Turkish public sector wages.

Keynesian approach would be the other candidate in explaining this outcome. The Keynesian construct would require plugging of aggregate demand into the nexus between the real-wage and productivity. The story basically suggests that increase in public real wages would induce aggregate demand which leads private firms to increase their capacity-utilization which in turn will lead to more output level with a given amount of employment. Therefore, increase (decrease) in real wages of public workers and officials might create extra demands which push production and thus increase output per worker.

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Conclusion

If there exists meaningful equilibrium relation between wages and productivity in the long run, the indirect conclusion would be generated which suggests that the share of wage earners from the national income remains stable. In this study, this hypothesis also known as Bowley's Law is tested for Turkish labor market over the period of 1963-2007. The result suggests that the real wages (for public and private sector) and average labor productivity show such an equilibrium relation. In other words, although these wages may diverge from their long-term path due to short-term shocks, they have a tendency to return back to their common stochastic path with the average labor productivity.

After establishing long-term equilibrium link between the labor productivity and real wages, the study focuses on causal links between two. The Granger-causality analysis shows that there is a unidirectional causality running from labor productivity to real wages in the public sector while the causality runs both ways for the private sector. The interesting conclusion for this study is that the behavior of public sector wages in the short run is consistent with Hicks' (1932) "biased technology change" hypothesis.