DOKUZ EYLÜL UNIVERSITY

FACULTY OF BUSINESS

DEPARTMENT OF ECONOMICS

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Avni Önder Hanedar

Elmas Yaldız

Özgül Bilici

Onur Akkaya

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Avni Önder Hanedar [a,*], Elmas Yaldız [b], Özgül Bilici [c], Onur Akkaya [d]

[a] Department of Economics, Faculty of Business, Dokuz Eylul University, Izmir 35190 Turkey
[b] Department of Economics, Faculty of Economics and Administrative Sciences, Izmir University of Economics, Izmir 35330, Turkey
[c] Department of Economics, Faculty of Economics and Administrative Sciences, Izmir University of Economics, Izmir 35330, Turkey
[d] Institute of Social Sciences , Dokuz Eylul University, Izmir 35190 Turkey

Abstract

The purpose of this research is to investigate whether the long-run relationship implied by profit maximization is valid for the Turkish manufacturing industry for the period of 1950-2001. During this period, the Turkish economy has experienced important policy changes, for example the implementation of liberalization policies after the 1980s. Thus, the possible effects of economic policy implementations over the profit maximization in the Turkish manufacturing sector will also be studied by using advanced time series techniques such as the Zivot and Andrews (1992) unit root test and the Gregory and Hansen (1996) co-integration test. The results of the study show that rationalization mechanism does not appear to work in Turkey.

Because most of the previous studies on this issue are concentrated in developed countries and also, there has been little research into the Turkish manufacturing sector, the contribution of this study is important.

Key words: Long Run Equilibrium, Co-integration, Elasticity of Substitution, Structural Breaks

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* Corresponding author. Tel.: +90-232-412 82 41,
E-mail address: onder.hanedar@deu.edu.tr

Introduction

Much economic theory is based on equilibrium and optimization concepts. These concepts are the most important issues for empirical testing of economic theory. These concepts are of great importance, particularly in neo-classic theory.

This study will investigate whether the long run equilibrium implied by profit maximization was valid for the Turkish manufacturing sector for the period 1950-2001. In this paper, profit maximization relationship will be constructed by using neo-classical labor theory. Therefore, the function to be estimated must include real wage and average labor productivity variables. Empirical analysis will be carried out applying co-integration techniques for real wage and average labor productivity. During this period, the Turkish economy underwent important structural changes, for example the implementation of liberalization policies after the 1980s. It is evident that the structure of the variables may have been affected by economic policy implementations in this period, which caused some structural changes. To understand the possible effects of economic policy implementations on the profit maximization in the Turkish manufacturing sector, the methodology of structural break will be employed. Because a break can change the order of integration of the series, the Zivot and Andrews (1992) unit root test and the Gregory and Hansen (1996) co-integration tests that take into account the break in the data are used.

The paper proceeds as follows: section one presents the derivation of the profit maximization model to be estimated in the empirical part. Section two includes a brief literature review of profit maximization. Section three sets out the econometric methodology used. The data and empirical results are presented in section four. The empirical analysis shows that the co-integrating relationship has failed between wage and productivity in Turkish manufacturing sector.

1. Quantitative Methodology

A production function, summarizing the process of conversion of factors into a particular commodity, can be classified in two groups: homothetic and non-homothetic. The main reason for this distinction is whether a constant elasticity substitution is along expansion path. However our interest is the first group. We can illustrate Cobb-Douglas, CES and VES type of production functions as an example of homothetic production functions. The Cobb-Douglas is a production function which has unit elasticity of substitution and factor income

shares are independent of relative factor prices. The CES (Constant Elasticity of Substitution) production function assumes that there are no variable returns and elasticity of substitution is constant through the production surface. The VES (Variable Elasticity of Substitution) production function has a variable elasticity of substitution along the expansion path. (Meyer and Burley; 1972, Kmenta; 1967 and Wolkovitz; 1969)

The Constant Elasticity of Substitution (CES) Production Functions dominates in applied studies, Therefore we will firstly outline the CES and then Profit Maximization procedure and outline how to go from a production function to a profit maximization relationship. It is illustrated by the following model,

$$Q = \gamma(\delta L^{-p}+(1-\delta)K^{-p})^{-\mu/p} \qquad (1)$$

In equation 1, L denotes labor, K indicates capital and Q is product. The μ parameter is a measure of the economies of scale, δ indicates the share of the production factor, while p determines the degree of substitution. (Heatfield and Wibe; 1987 and Doll and Orazem; 1984**)**

A firm is considered as a production unit that transforms inputs into output and two factors are employed in the production process. L denotes the quantity of labor and K is the real stock of capital. Identity 2 illustrates this.

$$Q= f(K,L) \qquad (2)$$

According to the neo-classical formulation, the aim of a firm as a decision-making agent is to maximize profit. Therefore, the problem of a firm is to determine the amounts of K and L that maximizes profit. In order to get a useful model in the empirical analysis, the profit function would be considered as equation 3.

$$\pi = p f(L)-(wL + rK) \qquad (3)$$

The profit-maximization goal can easily be illustrated by taking the derivative of the profit function with respect to L. The first condition of profit maximization is the equality of the 4 to zero. In other words, we can move from the equation 3 to identity 5.

$$d\pi / dL=PQ_L-w=0 \qquad (4)$$

$$Q_L=w/P \qquad (5)$$

In identity 5, Q_L denotes marginal productivity of labor and w/p is real wage. The profit maximization will be realized at the level where the marginal productivity of labor is equal to real wage. Referring the production function in equation 2 as a CES Function, the first order condition for profit maximization can be defined as the 6th equation.

$$dQ/dL = ((1-\delta)A^{-p}(Q/L)^{p+1} \qquad (6)$$

If the equation 6 is integrated with 5, the decomposition becomes simply as equation 7,

$$w/p = (1-\delta)A^{-p}(Q/L)^{p+1} \qquad (7)$$

Consequently, taking natural logs of both of sides in the equation 7, we can derive an early form of the relationship, as equation 8,

$$Log\ (w/p) = log\ ((1-\delta)A^{-p}) + (p+1)Log(Q/L) \qquad (8)$$

and

$$Log\ (w/p) = a + v\ Log\ (Q/L)^{*} \qquad (9)$$

The empirical part of this paper is constructed by taking the last equation into account.

2. Literature Review

Since the mid-eighties, co-integration techniques have become increasingly popular, along with a remarkable amount of work in time series econometrics, and also in calculating labor demand function and measuring profit maximization. The validity of the profit maximization condition has usually been tested by using the Engle and Granger (1987) two-step method. Jenkinson (1986) and Mc Donald & Murphy (1992) have estimated the long run labor demand function and rationalization mechanism by using co-integration technique. Although Jenkinson's labor demand function failed to verify long run equilibrium, Mc Donald and Murphy verified it by employing variables of labor, capital, output, relative factor price and additionally output effect. Lianos and Fountas (1997) found some powerful proof regarding the long run profit maximization in the Greek manufacturing sector by using similar techniques. There are only a few studies on this subject in Turkey. Yamak and Küçükkale (1999) studied the period 1950-1993 and used the Johansen co-integration method to test the rationalization mechanism in the Turkish manufacturing sector. The empirical model in this research is based on two variables: real wage and average productivity. They concluded that there is a long run equilibrium relationship between real wage and average productivity. Taking into consideration the Lucas Critique, the validity of the studies mentioned above have been questioned, because they do not take into account the possible effects of structural breaks. Some other studies, like Boug (1999), have used techniques that consider the structural break.

[*] This equation is the reverse form of ACMS type CES function and v represents the $1/\sigma$. (σ) represent the elasticity of substitution, defined as a equation of percentage change in the factor proportion with factor prices is measured by using $1/(1+p)$ formulation. See. Arrow, K.T., H.B.Chenery, B.S.Minhas and R.M. Solow, "Capital-Labour Substitution and Economic Efficiency", American Economic Rewiev, p: 43, 1961, pp.225-250 and the derivation process of the model to be estimated was taken from Yamak and Küçükkale (1997).

With this critique in mind, this study provides an application of the Engle-Granger two-step co-integration methodology and also some advanced techniques with respect to structural breaks.

3. Econometric Methodology

Fundamentally, Granger (1986) identified that regression constructed with non-stationary time series on the other non-stationary series, generates a spurious regression. However, a regression did not yield spurious relationship in which two series were co-integrated. This situation is emphasized in latter work by Engle and Granger (1987). For the first condition of co-integration, we have to determine the integration level of series and the most common and useful way to determine the integration order of the series is unit root tests. Three different unit root tests are employed to test the unit root in this study: namely, the ADF (Dickey and Fuller) (1979), PP (Philips and Perron) (1988) and KPSS (Kwiatkowski, Phillips, Schmidt and Shin) (1992) unit root tests. The null hypothesis for the ADF and PP tests is that the series in question has a unit root, whereas the KPSS test has the null hypothesis of level or trend stationarity.

Because the Turkish economy has undergone important structural changes, we have to analyze the effects of structural breaks on integration and co-integration. Structural breaks may potentially cause a change in the regression parameters of the model. A structural break can change mean value, trend value, or both. The conventional unit root tests erroneously fail to reject the null of unit root for the series in case of a structural break. Perron (1989) first analyzed the impact of structural breaks on the performance of unit root tests. He showed that standard unit root tests, like the augmented Dickey-Fuller (ADF) test, have dramatically less power when the underlying process undergoes a structural break. Zivot and Andrews (1992) criticized Perron's assumption of an exogenous date of structural break and they permitted the date of the structural break to be endogenously determined within the model. Because policy implementations in the Turkish economy may affect the variables used in the study. We thus considered the contribution of Zivot-Andrews to the unit root methodology.

Therefore, the following testing equation is used;

$$y_t = \mu + \beta t + \delta y_{t-1} + \gamma DU_t + \theta DT_t + \sum_{i=1}^{k} \eta_i \Delta y_{t-i} + \varepsilon_t \qquad (10)$$

In this methodology, *TB* (the time of break) is chosen at the point that minimizes the one-sided *t*-statistic of δ =1 in equation 10. *DU* and *DT* are dummy variables that respectively capture a break in mean and slope occurring at TB. As TB is the break date, and

DU = 1 if t > TB, and zero otherwise, DT is equal to (t-TB), if (t>TB) and zero otherwise. The null is rejected if the coefficient is statistically significant.

To determine the long run relationship between Lwr and Lqr, the Engle-Granger co-integration method will be employed. The Engle-Granger test has two steps: First is estimation of the co-integrating regression (in equation 11) that specifies the long-run equilibrium between variables.

$$Lwr_t = c + a\ Lqr_t + e_t \qquad (11)$$

In the second step, e_t is tested for stationarity. If e_t is stationary, the null hypothesis of no co-integrating relationship between Lwr and Lqr is rejected.

The conventional approach of co-integration assumes that co-integration vectors are time invariant. Gregory and Hansen (1996) is an extension of the Engle-Granger test where a unit root test is applied to the residual error from an OLS regression of a co-integrating equation that directly incorporates with the structural break. For this reason, the alternative hypothesis is that residuals do not contain a unit root and hence there is co-integration with a single unknown break, since the null hypothesis of the Gregory-Hansen tests is similar to the Engle-Granger method. To test for co-integration in the presence of an unknown structural break, we used the co-integration tests suggested by Gregory and Hansen (1996). There are three types of structural breaks in the Gregory-Hansen approach, a shift in intercept (12), in trend (13), and in both of these (14) in the co-integrating vector. Gregory and Hansen (1996) considered three models allowing structural change in the co-integrating relationship. These models are as follows;

Model 1: Level shift (C)

$$y_{1t}=\mu_1+\mu_2.\phi_{t\tau}+\alpha^T.y_{2t}+e_t, \qquad t=1,2,.....,n \qquad (12)$$

y_t and x_t, in the context of our analysis, are the Lwr and Lqr respectively. The dummy variable $\phi_{t\tau}=1$ *if* $t>[n\tau]$ and 0 otherwise, where the unknown parameter $\tau\in(0,1)$ denotes the (relative) timing of the change point, and [ ] denotes integer part.

Model 2: Level shift with trend (C/S)

$$y_{1t}=\mu_1+\mu_2.\phi_{t\tau}+\beta t+\alpha^T.y_{2t}+e_t, \qquad t=1,2,.....,n \qquad (13)$$

Model 3: Regime shift (C/T)

$$y_{1t}=\mu_1+\mu_2.\phi_{t\tau}+\alpha_1{}^T.y_{2t}+\alpha_2{}^T y_{2t}\phi_{t\tau}+e_t, \qquad t=1,2,.....,n \qquad (14)$$

For each τ, the above models are estimated by OLS, yielding the residuals e_t. From these residuals, the ADF test statistics and the Phillips' (1987) test statistics $Z_\alpha(\tau), Z_t(\tau)$ are estimated.

The breaking point is where the minimum ADF, $Z_\alpha(\tau)$ or $Z_t(\tau)$ statistics are acquired. Next, the null hypothesis of no co-integration is tested by using the smallest values of these statistics in the possible presence of breaks.

4. Empirical Results

4.1. Data

The data set used for the empirical analysis in this paper consists of annual observations extending from 1950 to 2001 on real wage (Lwr) and average labor productivity (Lqr) in the Turkish manufacturing sector. The real wage was measured by total payment to employee in the manufacturing sector divided by total employee, and average labor productivity was measured by total value added in manufacturing sector divided by total employee. Because the Turkish Economy had inflationary years, both Lwr and Lqr are deflated by the producer price index. All variables are expressed in TL. Data were obtained from Turkish Statistical Institute (TUIK).

4.2. Unit Root and Co-integration without Break

The first step of co-integration analysis is to test for the unit roots of the series, for which different tests are described in the literature. We employed ADF, PP and KPSS tests to check the non-stationarity assumption. Table 1 reports the results of various unit root tests developed by ADF (Dickey and Fuller) (1979), by PP (Phillips and Perron) (1988) and KPSS (Kwiatkowski, Phillips, Schmidt and Shin) (1992). The results are consistent with Real Wage (Lwr) and Average Labor Productivity (Lqr) being integrated of order one, I(1). This situation indicates a Difference Stationary Process (DSP). The KPSS and the results of other tests are in conflict, because the KPSS test says that integration level of series is I(0). Different unit root test results are likely to indicate us signs of structural break.

Table.1 Unit Root Tests Results

	Lwr		Lqr	
	Trend	No Trend	Trend	No Trend
ADF	-3.461*(1)	-1.644*(1)	-2.957*(1)	-0.768*(0)
PP	-2.221*(0)	-1.376*(2)	-2.514*(4)	0.753*(10)
KPSS	0.071*(5)	0.944(5)	0.065*(4)	0.912(5)

Note: * denotes unit root at 5% significance level; numbers in parenthesis are optimum number of lags determined according to AIC; critical values are based on MacKinnon (1991). For PP and KPSS tests, numbers in parenthesis are the truncation lag determined according to Bartlett Kernel.

Granger (1981) and Engle & Granger (1987) demonstrated that if a vector of time series is co-integrated, the long-run parameters can be estimated directly without specifying the dynamics because, in statistical terms, the estimated long-run parameter estimates converge to

their true values more quickly than those operating on stationary variables. The tests procedure depends on whether the disturbances are stationary or not.

In brief, our variables satisfy the first condition of the Engle-Granger co-integration method, (they are integrated of the same order). The estimation results of the long run Engle-Granger model are given in the Table 2. Having established that two series under examination are the I(1) process, the Engle-Granger two stage procedure is postulated. According to the Engle-Granger co-integration test result, showed in table 2, there is no co-integration vector between Lqr and Lwr, which means that the profit maximization does not seem to be valid for the Turkish manufacturing sector in studied period.*

Table. 2. Co-integration Tests Results

$Lwr_t = \beta_1 + \beta_2 Lqr_t$	
β_1	β_2
1.348*	0.724*
R-Squared = 0.9094	CRDW=0.3969

ECM (Error Correction Mechanism) $\Delta Lwr_t = \alpha_0 + \alpha_1 u(-1) + \alpha_2 \Delta Lqr_t + lagged\Delta Lwr_t$		
α_1	α_2	k
-0.164**	0.468	1

ADF
-3.0287 (1)**

Note: * denote the rejection of the null hypothesis and ** denote the non-rejection of the null hypothesis at 5% level respectively. Critical value are based on MacKinnon (1991) and at 5% significance level are -3.4966; models include constant and no trend; k is the lag length used in the test for each series and number of lags are determined according to the AIC and given in parenthesis.

4.3. The Structural Break, Unit Root and Co-integration

Perron (1989) admitted the possibility of structural breaks in the series and suggested that the conventional unit root test could fail to reject the unit root hypothesis of non-stationarity even for series known to be trend stationary with structural break. Zivot and Andrews (1992) criticized Perron's assumption of an exogenous date of the structural breaks and permitted the date of the structural break to be endogenously determined within the model.

Standard ADF tests have revealed the real wage and average labor productivity series in Turkey to be I(1). This paper also questions this result by using Zivot-Andrews unit root test permitting one endogenously determined break .Table 3 summarizes the result of the Zivot-Andrews test in the presence of structural break allowing for a change in the intercept and trend.

* Because u (error term obtained from long run equation) was employed for stationarity, it was seen that u has unit root when α is % 5 or we said that u was I(1). To test for co-integration, Error-correction model was fitted to the model under study too. As a proof of no co-integration, we can see that the parameter of u (-1) in Error Correction Model was not significance.

Table.3 Zivot-Andrews Endogenous Break Test Results

	Lwr	*Lqr*
TB	1981	1980
δ	-0.4288 (-4.0262)	-0.5028 (-4.3188)
θ	-0.1355 (-3.1380)	0.3321 (4.1038)
γ	1.0042 (1.8909)	-1.6478 (-2.4306)
β	-0.0091 (-0.5104)	0.0214 (1.0024)
k	0	1

Note: Critical values at 1%, 5% and 10% significance level are –5.57, -5.08 and –4.82 respectively (Zivot ve Andrews, 1992). k is the lag length used in the test for each series and selected criteria based on AIC. t statistics of the related coefficients are given in parenthesis.

Especially, in our case, the model of Zivot and Andrews (1992) was projected over the period 1950-2001. The appropriate dummy (DU, DT) was employed each time. The results presented in table 3, reporting the minimum t statistics and their corresponding break times. Considering structural breaks in all series, the two variables are found to be I(1) or real wage and the average labor productivity series are difference stationary with one endogenous break. In other words, the results from the Zivot-Andrews test confirm the results of the other tests that all series are I(1). According to Table 3, break points seem to coincide with 1980 for Average Labor Productivity. This was the year that social rights and wages began to decline to a large extent after the Military Coup. Break points seem to coincide with 1981 for real wage. This was the year that real wages began to decline after the liberalization program with which the break point coincides. The main empirical result of this model is that we find general evidence for structural breaks, particularly a trend break, causing downward-sloping real wages and upward-sloping average labor productivity during and after the1980s.

Secondly, we investigated long run relationship with break. The power of the Engle-Granger test substantially decreased when there was a break in the co-integrating relationship. To overcome this problem, Gregory and Hansen (1996) extended the Engle-Granger test to allow for breaks in either just the intercept or both the intercept and trend of the co-integrating relationship at an unknown time. As stated by Gregory and Hansen (1996), their testing procedure is of special value when the null hypothesis of no co-integration is not rejected by the conventional tests. As it is seen in Table 2, the Engle-Granger test result signals that there is no a co-movement between variables. Because of the possibility of structural break in error term, it is necessary to use the Gregory-Hansen test to examine the effects of break on long run relationship.

Tablo.4. Gregory-Hansen Structural Break Test Results

Model	ADF	TB	Z_t^*	TB	Z_α^*	TB	k
C	-4.994*	1983	-3.722	1983	-24.383	1983	2
C/T	-5.481*	1983	-3.800	1983	-25.798	1983	2
C/S	-5.050*	1983	-3.724	1983	-24.332	1983	2

Note: Critical values for ADF and Z^*_t at 5% significance level is -5.72, and for $Z_{a\,is}$ -68,43 respectively (Gregory and Hansen, 1996). * imply that the non rejection of the null hypothesis in the possible presence of breaks at 5% respectively.

The results of the Gregory-Hansen test are presented in Table 4. According to these analyses, the standard and conventional co-integration approaches indicate the same results. All models support that the no co-integration is present with a break point at 1983. Consequently, there seems to be no long run relationship between real wage and average labor productivity considering the structural breaks.

Conclusion

This study aims to investigate whether the long-run equilibrium implied by profit maximization is valid for the Turkish manufacturing industry covering the period 1950-2001. In this period the Turkish economy experienced important policy changes. In the studied period, Turkey faced with increasing labor productivity and decreasing real wages, for this reason, a rupture occurred between wage and productivity in Turkish manufacturing sector. Other studies on this issue are concentrated in developed countries and there has been little research on the Turkish manufacturing sector. This study shows how policy implementations and the 1980s as a period affect the long run relationship and parameters.

When the rationalization mechanism was tested by the Engle-Granger method, no co-movement was found between real wage and average labor productivity variables. The Gregory and Hansen (1996) indicated that when a shift in parameters takes place, the Engle-Granger test may fail. So the structural break in the co-integration equation is important in terms of rationalization. In addition to the Engle-Granger, the Gregory-Hansen test rejected the co-integrating relationship, that is, no evidence is found in the empirical analyses supporting the link between real wage and average labor productivity. The conducted empirical analyses show that the co-integrating relationship between real wage and productivity in Turkish manufacturing sector failed, can be said as the main result of this study,

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