Factors affecting labor productivity in the industrial sector in Algeria Standard study during the period (1980-2020)

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Abstract: The aim of this study is to highlight the factors affecting labor productivity in the industrial sector in Algeria during the period from 1980 to 2016 using johansen counteraction and error correction model. Thus, the study found the following main results: According to the Johansen test, all the variables of the study, namely, oil prices and wage rates, have a positive relationship with labor productivity in the industrial sector in Algeria in the long term, except the inflation index, which has a negative relation. Leads to excessive demand leading to higher prices. We conclude that the relationship between wage rate and productivity is determined only if the increase in productivity is higher than the rate of increase in wages to create surplus that allows the development and reduce the unemployment rate. In the short run, based on the VECM test, we conclude that the wage rate and inflation rate did not contribute to the explanation of labor productivity in Algeria during the study period, which maintained the same positive correlation.

Key words: labor productivity; industrial sector in Algeria; wage in industrial sector; time series analysis;

JEL Classification: **L6; M54; O14**.

ملخص : الهدف من هذه الدراسة هو تسليط الضوء على العوامل التي تؤثر على إنتاجية العمالة في القطاع الصناعي في الجزائر خلال الفترة من 1980 إلى 2016 باستخدام نموذج جوهانسن للرد وتصحيح الخطأ. حيث توصلت الدراسة حسب اختبار يوهانسن ، الى إن جميع متغيرات الدراسة سواءا أسعار النفط او معدلات الأجور، لها علاقة إيجابية بإنتاجية العمل في القطاع الصناعي في الجزائر على المدى الطويل، باستثناء مؤشر التضخم الذي له علاقة سلبية، كونه يؤدي إلى زيادة الطلب وبالتالي ارتفاع الأسعار. نستنتج أن العلاقة بين معدل الأجور والإنتاجية تتحدد فقط إذا كانت الزيادة في الإنتاجية أعلى من معدل الزيادة في الأجور لخلق فائض يسمح بالتنمية ويقلل من معدل البطالة، في حين المدى القصير بالاعتماد على اختبار ECM نستنتج عدم مساهمة كل من معدل الأجور والتضخم في تفسير إنتاجية العمل خلال فترة الدراسة على خلاف أسعار النفط الذي حافظ على نفس العلاقة الطردية السابقة.

الكلمات المفتاحية : إنتاجية العمل، القطاع الصناعي في الجزائر، الأجور في القطاع الصناعي، تحليل السلاسل الزمنية.

تصنيف JEL : **L6** ، **M54** ، **O14**.

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1.Introduction

As it is an important key to increase annual growth rate, competitiveness and goods comparative advantage, productivity has a lot of attention, especially in last past years, and in both its macro and partial terms it is one of the most important sources of global economic growth. For that, studying labor productivity has a great importance not only as a measure of labor force efficiency, but also as an economic progress, society well-being level indicator.

Therefore, labor productivity increasing can rise production and consumption, for that it is a primary goal of any economy.

For the importance role that industry plays in the national economy productivity can show (strength/weakness) in this important sector, and its role can appears clearly in increasing national income by increasing production regularly and at a lower cost .

It is difficult to give-up rentier sectors (oil sector), especially developing countries, today its facing the difficulty of moving from oil economy dependence to other economic sectors (industrial, agricultural, service), and Algeria is one of those countries whose economy related to oil sector and behave according to crude oil prices .

Algerian government looks for industrial development, for that it gives attention to set a national strategy to rise industrial competitiveness, which rise private industrial share in gross domestic product.

The problem in Algerian economic competitiveness is the weakness of its industrial production out of oil sector, which makes problem in exportation area. To get out of that we have to build a diverse economic base that helps us to be far from oil sector.

This work gives an idea about factors affecting labor productivity in Algerian industrial sector to give a future vision for the development of this sector that leads to maximize its investments.

For that, we can pose the following problem:

What are the most important factors affecting labor productivity in Algerian industrial sector during the period 1980-2020?

From here, the study hypothesis can be formulated as follows:

- There is a direct positive, statically significant relationship between wage rate and labor productivity in Algerian industrial sector during the period 1980-2020.
- There is a direct positive, statically significant relationship between oil prices and labor productivity in Algerian industrial sector during the period 1980-2020

In order to answer this problem the work will be addressed through the following topics:

- What is productivity and labor productivity;
- Measures of global and partial productivity;
- Reality of Algerian industrial sector;
- A standard study of the factors affecting labor productivity in Algerian industrial sector.

Previous studies:

- (M.H., 2005)« Factors Affecting the Productivity of Workers in the Industrial Sector » This study aims to determine the methods of measuring and the most important factors affecting the productivity of workers in the industrial sector in Gaza. The study concluded the following most important results: It has been proven that there is a relationship between the productivity of workers in the woodworking industry and the application of the incentive system in the facility and the existence of labor rights paid For workers, the impact of Israeli practices on the facility, and the amount of capital established .
- (A. H. , F., & A. N., 2010) "Measuring and analyzing the impact of labor and capital productivity on manufacturing industries in Iraq and some Arab countries for the period (1990-2000)." This study aims to determine the impact of labor and capital productivity on manufacturing industries in Iraq during the period from 1990 to 2000 using the joint integration model. The study concluded that: The productivity criterion in general and the productivity of labor and capital in particular are among the general indicators in the economy, as the relationship between them determines the productive technological pattern and the subject of their similarity and homogeneity in the production process increases the interdependence productive.
- (El Amri & Hmidat , 2013)"Factors affecting worker productivity and wages in the Jordanian manufacturing sector." This study seeks to shed light on the manufacturing sector in Jordan and to identify the factors affecting the productivity of workers and wages in this sector during the time period 1985-2009 using the error correction model (VECM). Investment in the manufacturing sector, while the relationship between average productivity and the balances of credit facilities granted to manufacturing industries was inverse.
- (Elharazin & Erraai, 2016) entitled "Factors affecting labor productivity and wages in the Palestinian manufacturing sector during the period 1994-2012." This study aims to identify the most important factors affecting labor productivity and wages in this sector. The study reached the t results the following results: There is a direct relationship between the average productivity and the average worker's share of investment in the manufacturing industry, and an inverse relationship between the average productivity and the balances of credit facilities granted to the manufacturing industries. As for the labor component, it was directly related to the compensation of workers in the Palestinian manufacturing sector.

2.Theoretical framework of the study

The theoretical framework of the study is represented by highlighting the nature of productivity and labor productivity, and from the study of measures of total and partial productivity, up to the reality of the Algerian industrial sector.

2.1.The concept of productivity

Before addressing labor productivity, we first are acquainted with Productivity, which generally refers to the ratio of output to input. Input includes working hours or its cost, production costs, machinery and equipment costs, while outputs include sales, income and market share. Although the concept of productivity may vary according to the type of activity, however, it always remains on the relationship between the value and quantity of resources used in production, and productivity is often expressed by the following equation:

Productivity = Output / Input

High productivity means achieving more output with the same amount of resources. There are a number of factors that control productivity improvement, including equipment, technology used in production, raw materials, location, people, prevailing systems, working methods, and administrative methods. Identifying these factors is useful in setting priorities for change in order to improve productivity and identifying factors those that are easier to deal with and those that require stronger management support. (M.H., 2005, p. 04)

2.2.The concept of labor productivity

First definition: Labor productivity is the relationship between the results obtained (production) and the quantity of the labor factor used in it.

Second definition: The labor productivity measure is one of the commonly used partial productivity measures. Labor productivity is measured by finding the relationship between the final products (outputs) and the labor component as one of the inputs. It is calculated in the following way:

Labor productivity = Quantity of products produced / Number of hours worked

Third definition: Labor productivity represents the ratio between the quantity produced of a commodity and the labor used to produce this quantity, or it is the quantity produced from a unit of time. (Gherbi, 2008, p. 66)

Because of difficulties encountered in the methods of measuring total productivity, researchers are interested in measuring labor productivity, which represents the relationship between production and work:

- Labor productivity = total production / number of workers
- Labor productivity (one hour labor productivity) = total production / number of hours worked
- Labor productivity (productivity dinar wage) = value of total production / total wages

Accordingly, we can deduce two basic concepts of productivity: The average productivity of labor, which is meant by the productivity of the labor unit. The labor units are measured either by the number of workers, then the average labor productivity reflects what one worker produces, or by the number of working hours, so the average productivity becomes an expression of the one-hour productivity, and accordingly it is calculated as follows:

Average labor productivity = total production / number of labor units.

Marginal productivity is the amount of change in total production because of changing units of labor by one unit, that is, marginal productivity is the productivity of the last unit of labor, whether it is a worker or an hour of work.

Marginal Productivity of Labor = Change in the volume of production / Change in the amount of work used. (S. A., 2010, p. 204)

Measures of total productivity

Productivity measures the ratio of outputs to inputs of goods that were produced during a certain period of time. Productivity is often expressed by the following equation: Productivity = Output / Input The measurement of productivity in itself does not give any significance unless it was compared to previous years. Productivity measurements try to be efficient in the physical use of resources, which stimulates and evaluates through the production of higher products with less inputs, which leads to improving quality by focusing on physical measurements. (El Amri & Hmidat , 2013, p. 83)

Measures of partial productivity

Most studies are based on the study of partial productivity, such as labor productivity, capital productivity, and machinery productivity, and each one of them is affected by different factors. Taking just one of these studies can never give the right idea about global productivity For example, rates of capital productivity won't move as labor productivity ones.

The elements of inputs and outputs are diverse and the methods of their measurement differ. Some of them accept quantitative measurement in units of weight, length, or area…etc , and others need to measure the productivity of the total elements of inputs or outputs in general units of measurement such as values, prices, time and standard units of work, and others, so it is necessary to use specific units of measurement that are appropriate for each case to measure partial productivity and calculate its indicators. Therefore, the most important of these measures are:

- ✓ Labor productivity = output / work
- ✓ Productivity of materials = output on materials
- ✓ Capital Productivity = Output / Investments

Perhaps what distinguishes the idea of partial productivity is the simplicity and ease in calculating and understanding, and one of its flaws is misinformation, as it measures the efficiency of one of the factors of production, and this is often not right. Labour productivity rates can rise because of using newer machines, which give greater productivity, so when using this criterion, the changes that occur in the rest of the production factors should be taken into consideration. (The Arab Industrial Developpment and Mining , 2004)

2.3.The reality of the Algerian industrial sector

Industry can be the main pillar in the national economy as the main driver for the rest of the national economic sectors . it plays a great role in activating development and pushing it forward in developing countries in general and Algeria in particular for several reasons :

- Industrial sector growth treats unemployment problems, as it can provide employment opportunities , as the majority of developing countries suffer from the problem of unemployment.
- Industrial sector development can lead to diversification of sources of production, income and exports in developing countries, which increase GDP and exports, and consequently , the dependence on the export of raw materials decreases.

- The growth of industrial sector contributes to productivity level raising, because industrial sector is one of the most capable sectors in applying the use of modern technology, and this, rises productivity . also dividing work and specialization in industrial sector are greater .
- The industrial sector contributes in providing foreign exchange resources and treating deficit payments balance problems in developing countries through the manufacture of goods that replace imports, and goods for export abroad .
- Industry is the sector that drives the national production, and industrialization is the wheel through which the generalization of activities and employment in all economic sectors, especially services and agriculture sectors. (Shaobi & Ben Gana, 2014, pp. 13-14)

The process of industrialization and economic development go hand in hand. Thus, industry plays a vital role in advancing and developing the national economy. In Algeria industry until the beginning of the nineties was mainly represented in the public sector, as it represented 80% of the total institutions, the private sector, it was represented only by a small percentage of the total institutions. However, the reforms that Algeria undertook in the framework of industrial restructuring allowed the rehabilitation of private enterprises, and recognition of the important role that they can play in economic and social development, thus changing the structure of the national economy with the decline in the status of the public sector and the emergence of the private sector in all branches of economic activities. The quality of industries is not the same with the one in the past, especially at the beginning of the nineties, which distinguished by manufacturing industries. Today, the Algerian industry is characterized by the dominance of light industries, in particular the agricultural and food industries, the metal and steel industry, the mechanical and electronic industries.

3. The standard study of the labour productivity affecting factors, in the industrial sector in Algeria during the period 1980-2020

The standard study can be presented by presenting the method and methodology of the study, then studying the stability test of the study variables, that is, the unit root test, and finally, the interpretation and discussion of the results of the study.

3.1. Stability test of study variables (unit root test)

As a first stage, we test the stability of time series, which is a condition of co-integration. Unit roots tests are the most important method for determining the stability of time series, knowing the statistical properties and knowing the characteristics of the time series under study in terms of their degree of integration. The (PP) test and (ADF) test were used, and the following table illustrates this:

Table (1): Results of the Advanced Dickey Fuller Test (ADF)

variable	difference	ADF				
		Calculated value	Critical value at 1%	Critical value at 5%	Critical value at 10%	Decision
PT	PT	0.24	-2.63	-1.95	-1.61	Not refuse Ho
	D(PT)	-6.84	-2.63	-1.95	-1.61	Refuse Ho
WAGE	WAGE	2.65	-2.63	-1.95	-1.61	Not refuse Ho
	D(WAGE)	-1.48	-2.63	-1.95	-1.61	Refuse Ho
OIL	OIL	-0.62	-2.63	-1.95	-1.61	Not refuse Ho
	D(OIL)	-5.85	-2.63	-1.95	-1.61	Refuse Ho
INF	INF	-1.27	-2.63	-1.95	-1.61	Not refuse Ho
	D(INF)	-5.59	-2.63	-1.95	-1.61	Refuse Ho

Source: Prepared by the researcher based on Eviews 10

Table (2): Results of the Philips Perron Test (PP)

variable	Difference	Pp				
		Calculated value	Critical value at 1%	Critical value at 5%	Critical value at 10%	Decision
PT	PT	0.72	-2.63	-1.95	-1.61	Not refuse Ho
	D(PT)	-7.03	-2.63	-1.95	-1.61	Refuse Ho
WAGE	WAGE	6.3	-2.63	-1.95	-1.61	Not refuse Ho
	D(WAGE)	-1.84	-2.63	-1.95	-1.61	Refuse Ho
OIL	OIL	-0.62	-2.63	-1.95	-1.61	Not refuse Ho
	D(OIL)	-5.85	-2.63	-1.95	-1.61	Refuse Ho
INF	INF	-1.27	-2.63	-1.95	-1.61	Not refuse Ho
	D(INF)	-5.58	-2.63	-1.95	-1.61	Refuse Ho

Source: Prepared by the researcher based on Eviews 10

It is clear from the (ADF) test and the (PP) test that it is not possible to reject the null hypothesis that the variables have a unit root, but this hypothesis can be rejected with respect to the first differences. Which means that the variables are integral of the order (1) and that their first difference is of the order (0) , the conclusion is that all the series are non-static and of the order (1) and then the co-integration test can be performed using the JOHANSEN method.

3.2. Estimation of the model at the long term

The model can be estimated in the long run by relying on the co-integration methodology using the JOHANSEN method or by using the ordinary least squares methodology

3.2.1 Co-integration methodology using the JOHANSEN method

Co-integration methodology using the JOHANSEN method we will rely on the co-integration test according to the JOHANSEN test methodology in the framework of the VAR model because this methodology is considered as a special case of the autoregressive vector model. This method is considered better than the first method (ENGLE GRANGER) because it allows determining the mutual effect between the variables under study, and it is assumed that they are not present in the first methodology (the ENGLE GRANGER method - two-stage). In addition, more stable, especially in the case of time series that suffer from the problem of non-stability in the level.

Table (3): Johansen's Concurrent Integration Test

Assumptions of the number of integration vectors	*intrinsic value*	*Impact statistic*	*Critical value*	*probability*
Nothing	*0.86*	*161.23*	*47.85*	*0.0000*
At m ost 1	*0.83*	*102.08*	*29.79*	*0.0000*
At most 2	*0.79*	*49.11*	*15.49*	*0.0000*
At most 3	*0.11*	*3.39*	*3.84*	*0.0655*
Assumptions of the number of integration vectors	*intrinsic value*	*Impact statistic*	*Critical value*	*probability*
Nothing	*0.86*	*59.14*	*27.58*	*0.0000*
At most 1	*0.83*	*52.96*	*21.13*	*0.0000*
At most 2	*0.79*	*45.72*	*14.26*	*0.0000*
At most 3	*0.11*	*3.39*	*3.84*	*0.0655*

Source: Prepared by the researcher based on Eviews 10

Table (03) shows the results of the impact test for the null hypothesis, which says that the number of co-integration equations is less than or equal to R. The calculated maximum probability value is greater than the tabular value in the first two rows. Therefore, we reject the null hypothesis and say that there is co- integration between the variables, and since the null hypothesis was accepted In the third row, we say that there is a co-integration relationship between the variables, where the null hypothesis was accepted in the third row, the number of co-integration equations equals 3 = R. And the other choice, which is the choice of the maximum characteristic values, which tests the null hypothesis that the number of co-integration vectors is R, compared to the alternative hypothesis that it is equal to 1 + R also supports and strengthens the previous result. Hence, 3 = R, which means that

there is a long-term equilibrium relationship between economic growth and the independent variables.

3.2.1 Model estimation using ordinary least squares method

After we verify the existence of long-term co-integration relationships between the variables of the study model, we move to the second plan by estimating the study model using this modern method and the appropriate method for the nature of the results, data and model variables. The estimate came as follows as shown in Table (04):

Table (4): Estimation of Long-Term Parameters Using Ordinary Least Squares Method

dépendent variable PT			
explanatory variable	*Parameters*	*T - stat*	*Prob*
C	*-20.77*	*-8.59*	*0.0000*
WAGE	*1.93*	*8.93*	*0.0000*
OIL	*0.01*	*3.55*	*0.0013*
INF	*-0.02*	*-2.89*	*0.0070*
R^2= 0.90		*AJD R^2=0.89*	

Source: Prepared by the researcher based on Eviews 10

Table (04) shows the regression results to explain the labor productivity variable using the following economic variables:

- Wage rates in the industrial sector (WAGE);
- Oil prices (OIL);
- Inflation rates (INF).

The following equation shows the final form of the model after substitution for the estimated coefficients :

$$PT = -20.77 + 1.93\,WAGE + 0.01\,OIL - 0.02\,INF + e_t \quad \textbf{(1)}$$

We note from the above table that all the model variables are significant at the level of 1%, and the estimates were in line with the economic theory, where the adjusted coefficient of determination was 0.89, and this means that the independent variables explain 89% of the change in the dependent variable, i.e., labor productivity. The remaining 11% indicates the influence of other variables that were not included in the model.

3.3. Estimating the model in the short term using ECM

The main objective of estimating the model in the short term using ECM is to detect the quiescence of the residual series using the KPSS unit wall test in addition to the ECM test.

3.3.1 KPSS test

Table (5): KPSS Series Residual Static Test

level	*Residual series*	*Critical value at 1%*	*Critical value at 5%*	*Critical value at 10%*
KPSS	*0.08*	*0.73*	*0.46*	*0.34*

Source: Prepared by the researcher based on Eviews 10

We note from the table that we reject the unit root hypothesis using The (KPSS) test at the level of significance of 1%, 5% and 10%, that is, the residual series is static at the level, which indicates the existence of a long-term relationship between the variables and from which the error correction model (ECM) can be used.

3.3.2 ECM Error Correction Model Test

Since there is a simultaneous integration between the variables, we pass to the ECM model, which is considered the most suitable for estimating the relationship between them. We can estimate an error-correcting model according to the following steps:

The first step: estimating long-term relationships using the ordinary least squares method:

$$PT = -20.77 + 1.93\,WAGE + 0.01\,OIL - 0.02\,INF + e_t(ECM) \quad \text{.....(2)}$$

The second step: estimating the relationships of the (short term) by the method of ordinary least squares :

$$\Delta PT_t = \alpha_1 WAGE_t + \alpha_2 OIL_t + \alpha_3 INF_t + \alpha_4 e_{t-1} + U_t(\alpha_4 < 0) \quad \text{.....(3)}$$

Using Eviews 10 we find :

Table (6): ECM estimation results

dépendent variable D(PT)			
explanatory variable	*Parameters*	*T - stat*	*Prob*
C	*-0.04*	*-0.35*	*0.7265*
D(WAGE)	*1.87*	*0.83*	*0.4113*
D(OIL)	*0.02*	*4.43*	*0.0001*
D(INF)	*-0.009*	*-0.78*	*0.4379*
ECM	*-0.44*	*-2.80*	*0.0090*
R^2= 0.51	*F=7.52*	*DW=2.18*	

Source: Prepared by the researcher based on Eviews 10

It is noted from the table that the correction limit coefficient is negative -0.44 and is significant, and therefore the error correction is validated.

This means that the behavior of the dependent variable represented in labor productivity takes one period until it reaches a position of equilibrium in the long term, as it appears from the results that 44% of the deviation of Labor productivity from the equilibrium level in the long run will be corrected every year, and we note the contribution

of oil prices to the interpretation of labor productivity in the short term, similar to wages and inflation rates.

3.4. Discussion the results of the study

Through the table (04), it is noted that there is a direct relationship between wages in the industrial sector and the labor productivity , as the increase in wages by one point will lead to a rise in labor productivity by about 0.39 points, and this is consistent with the economic theory as higher wages leads to an increase in what is It is provided by the individual in the production process, and this in turn is reflected positively on the level of production and therefore labor productivity rates.

However, the relationship between wage and productivity is specific where the rate of increase in productivity is higher than the rate of increase in wages to form a surplus that allows to advance the wheel of development and reduce unemployment rates. As for the variable oil prices, we note the existence of a direct relationship, as the increase in oil prices by one unit leads to a rise in labor productivity by 0.01 units.

With regard to inflation, the results of the estimation showed a significant negative impact of this variable, as the regression coefficient amounted to -0.02 and this is consistent with the economic theory, as high levels of inflation lead to an increase in wage levels, which is in agreement with the quantitative theory, meaning that inflation is mainly due to Excessive money supply leads to excessive demand and thus prices rise, meaning that inflation arises if the amount of money in circulation increases, in addition to rising wages that are not commensurate with the increase in labor productivity leads to higher prices and thus higher rates of inflation, in other words high inflation is the result of On the rise in prices that leads to higher wages, either under pressure from the unions, or for the government to increase wages on its own to keep pace with the rise in prices.

4.Conclusion

It Contains the main resultsThe aim of the study is to highlight the most important factors affecting labor productivity in the industrial sector in Algeria during the period 1980-2020 using a standard technique represented in the ECM error correction model. The study reached the following most important results: According to Johansen's long-term simultaneous integration test, we conclude that all variables were statistically significant acceptable at the level of significance 1% and that all independent variables represented in oil prices and wages have a direct relationship with labor productivity in the industrial sector in Algeria.

- There is a direct relationship between wages and labor productivity in the industrial sector, as higher wages lead to an increase in what the individual offers in the production process, and this in turn is reflected positively on the level of production and thus labor productivity rates;
- As for inflation, it has shown an inverse relationship with labor productivity in the industrial sector. This can be explained by the fact that when inflation rises, it is caused by high prices, which leads to higher wages, either under pressure from unions or for the government to increase wages on its own to keep pace with the rise in prices.
- The oil price index maintained the same direct relationship with labor productivity in the industrial sector in Algeria during the period 1980-2020 and has an acceptable

statistical significance at a morale level of 1%. As for wages and the inflation rate, it showed the absence of statistical significance in the short term

- We also note from the results that 44% of the deviation of labor productivity from the equilibrium level in the long run will be corrected every year;
- Finally, we note the contribution of oil prices to the interpretation of labor productivity in the short term, in contrast to wages and inflation rates, which did not show an impact on labor productivity in the short term.

The results showed in agreement with the hypotheses of the study that the wage rate expressed in the wages of the industrial sector has a positive impact on the productivity of work in the industrial sector and the positive impact of oil prices in Algeria during the period 1980-2020 in the long term, and this is consistent with the economic theory

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Appendices

Appendix (I): concurrent integration test JOHANSEN

Date: 01/04/19 Time: 23:06
Sample (adjusted): 1985 2018
Included observations: 34 after adjustments
Trend assumption: Linear deterministic trend
Series: PT WAGE OIL INF
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.869904	161.2322	47.85613	0.0000
At most 1 *	0.839021	102.0871	29.79707	0.0000
At most 2 *	0.793363	49.11912	15.49471	0.0000
At most 3	0.110390	3.392185	3.841466	0.0655

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.869904	59.14507	27.58434	0.0000
At most 1 *	0.839021	52.96801	21.13162	0.0000
At most 2 *	0.793363	45.72694	14.26460	0.0000
At most 3	0.110390	3.392185	3.841466	0.0655

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix (II): Estimation by OLS

Dependent Variable: PT
Method: Least Squares
Date: 01/04/19 Time: 23:05

Sample (adjusted): 1980 2018
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-20.77764	2.417509	-8.594649	0.0000
WAGE	1.939387	0.217026	8.936185	0.0000
OIL	0.012948	0.003639	3.558097	0.0013
INF	-0.029637	0.010231	-2.896736	0.0070

R-squared	0.907932	Mean dependent var	1.662093
Adjusted R-squared	0.898725	S.D. dependent var	1.475914
S.E. of regression	0.469692	Akaike info criterion	1.436651
Sum squared resid	6.618313	Schwarz criterion	1.616223
Log likelihood	-20.42307	Hannan-Quinn criter.	1.497890
F-statistic	98.61480	Durbin-Watson stat	0.943981
Prob(F-statistic)	0.000000		

Appendix (III): Residual series static test using KPSS

Null Hypothesis: ET is stationary
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.080512
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix (IV): Residual series static test using KPSS

Dependent Variable: DPT
Method: Least Squares
Date: 01/04/19 Time: 23:14
Sample (adjusted): 1981 2018
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.046357	0.131224	-0.353263	0.7265
DWAGE	1.874683	2.247537	0.834105	0.4113
DOIL	0.024963	0.005628	4.435377	0.0001
DINF	-0.009899	0.012579	-0.786910	0.4379
ECM(-1)	-0.441126	0.157029	-2.809209	0.0090

R-squared	0.518192	Mean dependent var	0.098656
Adjusted R-squared	0.449363	S.D. dependent var	0.505246
S.E. of regression	0.374918	Akaike info criterion	1.014507
Sum squared resid	3.935771	Schwarz criterion	1.241250
Log likelihood	-11.73936	Hannan-Quinn criter.	1.090799
F-statistic	7.528615	Durbin-Watson stat	2.187512
Prob(F-statistic)	0.000300		