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Okun's Law and Long Term Co-Integration Analysis for OECD Countries (1987-2012)

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Abstract

Even though, there are so many so long discussions on the relation between population increase and economic growth, today, general opinion tends to believe that there is a direct relation between population increase and economic growth. This opinion is supported by some empirical studies. Despite an economical growth caused by directly with population growth, it is known that there is a reverse relation between unemployment and growth known as Okun's Law. This relation, suggesting that every 1 point decrease in unemployment induces a 3 point increase in growth, is tested for many countries. In this study, this hypothesis of Okun is examined and it is found to be true for selected 23 countries, even with the difference in coefficients. At the same time, long term relation between growth and unemployment is tested with the use of time series analysis and long term relation is found for 14 countries. Additionally, tests done for all 34 OECD countries showed that reversed relation between unemployment and growth is valid and they are co-integrated in long run. In this study, countries are categorized according to growth rate as "low", "normal" and "high" and a consistent unemployment rate for countries with high growth rate could not be seen. In the case of countries with lowest growth rate, generalization that they have quite high unemployment rate can be made.

Keywords: Economic Growth, OECD Countries, Unemployment.
JEL Classification: O40, O57, J64.

1. Introduction

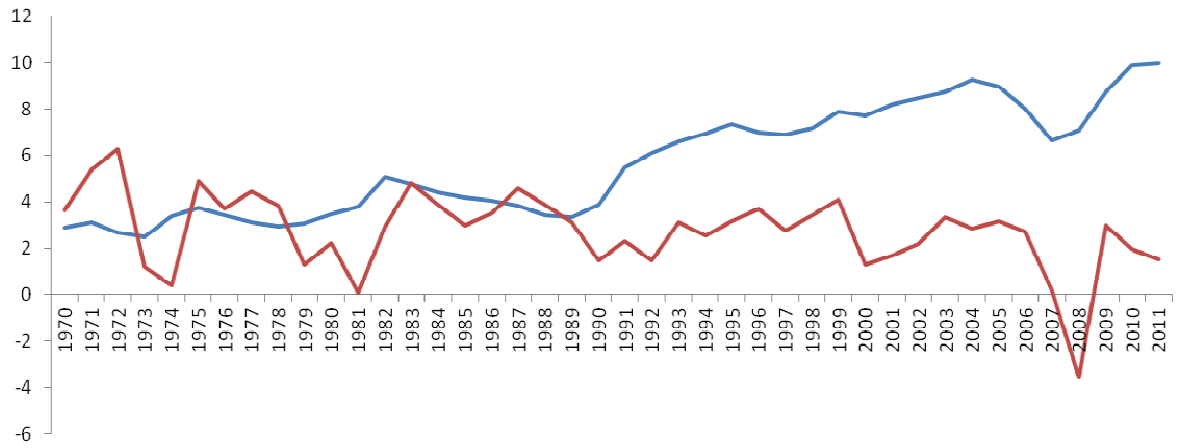
A. Okun (1962), to explain relation between unemployment and growth, stated that an increase in employment should induce an increase in the level of GDP and unemployment will cause GDP to decrease. This reverse relation GDP and unemployment is defined as Okun's Law. (Mankiw, 2009: 260-263; Plosser and Schwert, 1979; Lang and De Peretti, 2009; Teck, 2012). There are some special cases for Okun's Law. Increase of working hours of current employees may create increase in GDP if it does not cause increase in unemployment (Knotek 2007; Levine, 2013).

While average unemployment rate of the period 1970 to 2012 for OECD countries (OECD.StatExtract) was %5.586, it is found to be %8.430 when calculated for the period 2000 to 2012. GDP is increased %2.747 for the period 1970 to 2012, but for the period 2000 to 2012 it increased %1.871. Both data are given in the Graph-1.

GDP graph starting from 1970 also shows 1974, 1981 and 2008 crisis. Most influential crisis is 2008 crisis in the way of its effecting unemployment mostly.

Especially at the end of 80's, unemployment rates started to increase while GDP continuing its characteristic movements. Reason of this can be shown as; developments in the use of technology and directing to non-OECD countries with cheap facilities and labor force.

Graph 1: GDP growth rate (Down) and unemployment (Up)



It is seen that unemployment rates show continues trend to increase. Difference between the two variables is (5.586-2.747) %2.839 in the period 1970 to 2012; (7.242-2.303) %4.939 in the period 1989 to 2012 and (8.430-1.871) %6.559 in the period 2000 to 2012. Total GDP for OECD was 3.1 trillion US Dollars in 1970; it has reached 46.1 trillion US Dollars at 2012. This shows that GDP increased 14.87 times.

Technically, Okun's Law suggest that %3 increase in GDP causes an %1 decrease in unemployment (Caraiani, 2010; Elshamy, 2013). Relation between unemployment and growth states the positive effects of power of trade associations and labor costs when unemployment rates are low and growth rates are high, besides, efficient trade union bargains in labor market may create negative effects on growth rate (Adjemian, Langor and Rojas 2010). In this study, unemployment and growth data of 23 OECD countries are used. Firstly, Okun Difference Equation (ODE) is used to calculate needed GDP increase to have constant unemployment rate. Then, with the use of time series analysis, long term relation of the two variables is studied.

2. Literature

First of all, for the different period and method, data sets may give different results. For example, while it is observed by Bankole and Fatai (2013) that hypothesis is invalid for Nigeria; Amossoma and Nwosa (2013) find that it is valid. Some studies had gathered results contrasting to Okun's Law and some of them are; Ting and Ling for Malaysia and Habees and Rumman (2012) for Arabian countries and Jordan showed that there is no absolute relation between unemployment and growth; Lal and others (2010), for some developing Asian countries, showed that Okun's Law is not applicable. Tillmann (2010) states that the relation started to get weak from 90's.

There exist studies showing partial validity of Okun's Law. Some findings are as follows: the relation is unstable for USA and Canada (Beaton, 2010); partially valid for Germany (Oberst and Oelgemöller, 2013); valid with low rate for Central and East Europe (CEE) countries (Hutengs and Stadtmann, 2013); strong validity for young population and weak validity for old population in Euro zone (Hutengs and Stadtmann, 2012); there are different coefficient for different countries and coefficients are time varying, while the relation is valid in the opposite way for Euro zone countries (Zanin and Marra, 2012). Using the Italy example, Busetta and Corco (2012) found results suggesting that there might be regional differences. In another study on regional differences, Kangasharju and others (2012) find similar results and pointed the decrease tendency of coefficients. In their study on

relation of unemployment in crisis periods and growth, for USA and EU, Cazes, Verick and Hussami (2011) (and Gordon, 2010a; 2010b; 2011) find that after global crisis, coefficients for USA, Canada and Spain showed sudden increases. In addition to this, these increases are quite sudden compared to crisis before 2000 and coefficients are lower for economies with high labor protection, like Germany.

However, many studies provide empirical proves strongly showing the relation Okun predicting between unemployment and growth. for example; Ball, Leigh and Loungani (2013) for USA and Moazzami and Dadgostar (2009) for 13 OECD countries (for OECD other study: Lee, 2000; Hopkin and Blyth 2012) find that in order to decrease unemployment %1, increase in GDP should be between %2.6-%4.7. Biggest coefficients in long term are calculated for Canada, Finland, Norway and USA and these countries experienced the effect of economic growth on employment the fastest. In their study for 15 OECD countries, Sögner and Stiassny (2000) find; there is constant Okun relation for Austria, Belgium, Canada, Italy and USA; There are deviations in Okun's Law for Sweden, Germany, Denmark, Finland, France, Great Britain, Japan, Netherlands, Norway and Switzerland. Herwartz and Niebuhr (2011) showed Okun relation for EU countries, whereas supporting the cause of the difference among the countries with the structural characteristics of countries. Besides, Huang and Lin (2008) for USA and Villaverde and Maza (2008) for Spain find empirical evidence for strong relations. Similar resultsare found in orther country studies (Bakas and Papapetrou, 2012; Ibragimov, Karimov and Permyakova, 2013; Giha, Leat and Renwick, 2012; Mosikari, 2013; Tingii and Lingii, 2011).

Finally, there are also studies whose findings are suggesting ratio relation other than the ratio relation suggested by Okun. Results of some of such studies are as follows; Boulton (2010), for 10 west Europe countries, showed that %4 increase in growth causes %1 decrease in unemployment; for Romania, Andrei, Vasile and Adrian (2009) find that %0.5 decrease in growth causes %1 increase in unemployment. In an analysis on developed countries, Kitov (2011; and Kitov and Kitov, 2012) calculated that the lowest coefficient is 0.4 belonging Australia and highest is 0.84 belonging USA. In their study, Huang and Yeh (2013) find that GDP and unemployment variable are co-integrated in long term. Also they find that these two variables are reversely and strongly related in both long and short term. In a survey study (for Wall Street economists, Mitchell and Pearce, 2009) on G7 countries with professional economists, Pierdzioch, Rülke and Stadtmann (2011) showed that reverse relation between growth and unemployment predicted by economists is agreed with Okun's Law.

3. Method and Data

The data belonging the period between 1987 and 2012 is taken from the OECD database. An analysis is done over data of each one of 23 OECD countries' data and total OECD data. First thing in the analysis is to calculate "Okun Coefficient" of countries with the regression relation Okun predicted. Growth rates are categorized as "low" (between %0-%2), "normal" (between %2-%4) and "high" (%4+). By doing this comparison between growth rate and Okun coefficient is done.

In the second step of analysis, the data time series and co-integration relation are tested. For this reason, firstly for each country; i) the growth and unemployment data are tested with unit root tests (Dickey and Fuller. 1979) ii) The two stepped Engle-Granger (1987) test is applied. Same process is done on sum of growth and unemployment data of 34 OECD countries. First condition, to decide whether series are co-integrated in long term or not, is to have stationary series at same level.

4. Empirical Results

Table-1 shows the results of equation 1 for each country. Regression constants are given in b_0. b_1GDP gives negatively expected coefficient of GDP variable in regressions, known as Okun coefficient. "Average unemployment" (Avg. UNE) and "Average Growth" (Avg. GRW) rates, calculated from the data set of the period 1987 to 2012, are also given in Table-1. According to this, the highest average unemployment rate is %15.46 belonging Spain and the lowest average unemployment rate is %3.25

belonging Luxembourg. While the highest average growth rate is for South Korea and %5.91, lowest is for Italy and %1.3.

According to Table-1 average unemployment rate for OECD countries is %6.87. Average of average growth rates for the countries with higher average unemployment than this average (UK, Turkey, Spain, Portugal, Italy, Ireland, Germany, France, Finland, Chile, Canada, Belgium, and Australia) is %3.5. So, the ratio between average unemployment and average growth is almost two (0.687/0.350=1.96). So it can be said that this reverse relation of unemployment and GDP is one-to-one for the countries with highest unemployment rate.

Average of average unemployment rates for the countries with lower average unemployment than OECD average (US, Sweden, Norway, New Zealand, Netherlands, Mexico, Luxembourg, South Korea, Japan and Denmark) is 4.80. Average of average growth rate for these countries is 2.76. Even though, this ratio is lower than OECD average, it is pretty close. Ratio between unemployment and GDP is lower (0.480/0.276=1.74) for economies with low unemployment rate. Then, findings suggest that average of growth rate is lower (2.76<3.50) for countries with lower unemployment rate than OECD average. Shortly, growth rate occurring when the unemployment is high is higher than growth rate occurring when the unemployment is low. High unemployment creates high growth, low unemployment creates low growth. This is the relation Okun claims.

Tablo 1: Okun' regressions: $u - u_{-1} = b_o + b_1(y)+e$ (difference model)

Country	b_o	b_1(GDP)	Avg. UNE	Avg. GRW	b_o / b_1
Australia	1,139776	-0,391112	6.919	3.301	2,91419
Belgium	0,495702	-0,295806	8.096	1.986	1,67576
Canada	0,841631	-0,375152	8.173	2.484	2,24343
Chile	1,379607	0,275437	8.23	5.698	5,00879
Denmark	0,605353	-0,360756	5.988	1.358	1,67801
Finland	0,879881	-0,355040	9.13	2.138	2,47825
France	0,583921	-0,307495	9.423	1.805	1,89896
Germany	0,284049	-0,151278	7.857	1.833	1,87766
Ireland	1,595931	-0,342655	10.2	4.871	4,65754
Italy	0,281676	-0,216006	9.153	1.18	1,30401
Japan	0,220478	-0,103351	3.803	1.651	2,13329
Korea	1,118544	-0,192760	3.369	5.911	5,80278
Luxembourg	0,328280	-0,054827	3.257	4.085	5,98756
Mexico	0,644013	-0,208315	3.78	2.84	3,09153
Netherlands	0,487941	-0,231328	4.769	2.268	2,10930
New Zealand	1,050341	-0,374662	6.407	2.4	2,80343
Norway	0,237443	-0,129464	4.134	2.337	1,83404
Portugal	1,034295	-0,341197	6.969	2.179	3,03137
Spain	2,512723	-0,921603	15.469	2.559	2,72647
Sweden	0,954893	-0,340653	6.488	2.169	2,80312
Turkey	0,638043	-0,157970	8.526	4.224	4,03901
United Kingdom	0,564312	-0,290173	7.061	2.363	1,94474
United States	1,255776	-0,449484	6.026	2.656	2,79381
OECD - Total	0,716469	-0,274117	6.873	2.438	2,61373

Calculated b_o / b_1 coefficients are "Okun coefficient" and indicate the needed economic growth rate to prevent unemployment rate growing. Countries with highest unemployment, Chile (8.23), Ireland (10.2) and Turkey (4.03), needs growth rate higher than %4 to prevent unemployment rate to increase more than current rate. Countries with high calculated Okun coefficient, South Korea (5.80) and Luxembourg (5.98) need growth rate more than %5.

Lowest Okun coefficient is calculated for these countries; Italy (1.30), Belgium (1.67), Denmark (1.67), Norway (1.83), Germany (1.87), France (1.89) and UK (1.94). These countries have two basic common points: i) average unemployment is higher than OECD average (except Denmark and Norway) and ii) average growth rate is lower than OECD average.

The second part of our analysis is time series analysis and to do this, firstly, Dickey-Fuller unit root test is applied to unemployment and growth data of each country. Findings are given in Table-2. "ADF" column of Table-2 shows ADF statistics of variables for "level" values. Values in parenthesis show the critical value for %5 meaning value of applied test. When ADF<Critical Value, It is concluded that series is not stationary, meaning it includes unit root. In this case, ADF test is redone by taking the first difference of series. ADF test statistics and critical values are calculated taking first difference and given in ADF (-1).

Unemployment variable for all 23 countries includes unit root in its meaning level. For Italy and Portugal, unemployment variable becomes stationary [I(2)] by taking second difference. Unemployment variable for other 21 countries becomes stationary [I(1)] by taking first difference. For Denmark, Finland, Germany, Italy, Japan, Mexico, Sweden and Turkey, growth variable is stationary in its level value [I(0)]. Growth variable for other 15 countries is stationary [I(1)] when the first difference is taken.

In this case, since for Italy and Portugal unemployment variable is I(2) and for Denmark, Finland, Germany, Italy, Japan, Mexico, Sweden and Turkey growth rate is I(0), they will not be subjected to co-integration analysis. Unemployment and growth relation for other 14 countries is suitable for co-integration analysis.

Tablo 2: ADF Unit root tests for UNE and GRW

Ülke	UNE		GRW		Notes
	ADF	ADF(-1)	ADF	ADF(-1)	
Australia	-0,908449 (-1,955020)	-3,248560 (-1,955681)	-1,538109 (-1,955020)	-5,681636 (-1,955681)	
Belgium	0,142256 (-1,958088)	-4,130355 (-1,958088)	-2,321835 (-2,660720)*	-5,797556 (-1,956406)	GRW is Meaningful at I(0) for 1%
Canada	-0,611939 (-1,955020)	-3,474439 (-1,955681)	-2,005565 (-2,660720)*	-5,675185 (-1,955681)	GRW is Meaningful at I(0) for 1%
Chile	-1,134512 (-1,955020)	-4,425504 (-1,955681)	-1,447020 (-1,955020)	-6,924916 (-1,955681)	
Denmark	0,169550 (-1,955020)	-3,404381 (-1,955681)	-2,720146 (-1,955020)		GRW is Stationary at I(0)
Finland	-0,846320 (-1,955681)	-2,142956 (-1,955681)	-2,700622 (-1,955020)		GRW is Stationary at I(0)
France	0,088157 (-1,955020)	-3,494173 (-1,955681)	-2,061675 (-2,660720)*	-5,277750 (-1,956406)	
Germany	-0,223752 (-1,956406)	-3,216671 (-1,956406)	-2,778381 (-1,955020)		GRW is Stationary at I(0)
Ireland	-0,815741 (-1,955681)	-2,349557 (-1,955681)	-1,313100 (-1,955202)	-4,846012 (-1,955681)	
Italy	0,237083 (-1,955681)	-1,575031 (-1,955681	-2,850082 (-1,955020)		UNE I(2) Stationary; GRW is Stationary at I(0)
Japan	0,166641 (-1,955681)	-3,119968 (-1,955681)	-2,970024 (-1,955020)		GRW is Stationary at I(0)
Korea	-0,600884 (-1,955020)	-4,379657 (-1,955681)	-1,830450 (-1,958088)	-6,599361 (-1,956406)	
Luxembourg	0,828045 (-1,955020)	-3,377125 (-1,955681)	-1,890258 (-1,955020)	-6,537240 (-1,955681)	
Mexico	-0,195295 (-1,955020)	-4,191578 (-1,955681)	-3,064823 (-1,955020)		GRW is Stationary at I(0)
Netherlands	-0,392488 (-1,957204)	-3,827521 (-1,957204)	-1,699881 (-1,955020)	-4,472764 (-1,959071)	
New Zealand	-0,627356 (-1,956406)	-2,918821 (-1,955681)	-1,709697 (-1,955020)	-7,825929 (-1,955681)	
Norway	-0,854987 (-1,956406)	-3,576689 (-1,956406)	-1,176697 (-1,955020)	-5,551168 (1,955681)	

Tablo 2: ADF Unit root tests for UNE and GRW – Continued

Portugal	1,619556 (-1,956681)	-1,284031 (-1,955681)	-2,036313 (-2,660720)*	-4,317693 (-1,956406)	UNE is Stationary at I(0); GRW is Meaningful at I(0) for 1%
Spain	0,174815 (-1,955681)	-1,955758 (-1,955681)	-1,767823 (-1,955020)	-4,735233 (-1,955681)	
Sweden	-0,291357 (-1,955681)	-3,413449 (-1,956408)	-2,828183 (-1,955020)		GRW is Stationary at I(0)
Turkey	-0,301171 (-1,955020)	-4,336725 (-1,955681)	-3,716088 (-1,955020)		GRW is Stationary at I(0)
United Kingdom	-0,270641 (-1,955681)	-3,224373 (-1,955681)	-2,119882 (-1,955020)	-5,024712 (-1,956406)	
United States	0,275519 (-1,956406)	-3,844323 (-1,956406)	-1,541823 (-1,955020)	-6,018883 (-1,955681)	
OECD - Total	0,616892 (-1,956406)	-4,191554 (-1,956406)	-1,859498 (-1,955020)	-6,710746 (-1,955681)	

Results of applied test for 14 countries having stationary variables at the same level, which is prerequisite for Engle-Granger co-integration test, and all of OECD are given in Table-3.

Engle-Granger co-integration test examining long term integration relation between variables. For this purpose, firstly, regression models between unemployment (independent) and growth (dependent) for each country are created. Calculated coefficients, standard error and t-statistics for regression models are given in Table-3. Being stationary in their level of U model error term is prerequisite for two variables to be co-integrated in long term. ADF unit-root test is applied to created error term series and calculated ADF test statistics are given in "u ADF" and critical value for %5 meaning level of these values are presented in "%5 level" column. When these two columns are examined, it is seen that error terms are stationary [I(0)] at their level value. In this case, it can be concluded that unemployment and growth variables are co-integrated in long term for each country.

Tablo 3: Engle-Granger cointegration test

Country	Coefficient	Std. Error	t-Stat.	ADF for u	5% Level	Integrated
Australia	0,125173	0,118623	1,055213	-3,231832	-1,955681	I(0)
Belgium	-0,006537	0,077958	-0,083850	-3,813356	-1,958088	I(0)
Canada	-0,140804	0,073700	-1,910512	-4,058520	-1,956406	I(0)
Chile	-0,157108	0,062189	-2,526298	-4,217602	-1,955681	I(0)
France	-0,068150	0,079465	-0,857608	-3,306543	-1,955671	I(0)
Ireland	-0,195960	0,100940	-1,941340	-2,335131	-1,955681	I(0)
Korea	-0,097530	0,039706	-2,456297	-4,998089	-1,956406	I(0)
Luxembourg	-0,037914	0,025535	-1,484799	-3,522490	-1,955681	I(0)
Netherlands	0,006223	0,075230	0,082718	-3,794921	-1,957204	I(0)
New Zealand	-0,025766	0,094766	-0,271893	-2,913987	-1,955681	I(0)
Norway	0,009446	0,065829	0,143499	-3,641056	-1,956406	I(0)
Spain	-0,625511	0,237883	-2,629487	-1,986534	-1,955681	I(0)
United Kingdom	-0,046496	0,077638	-0,598886	-3,004877	-1,955681	I(0)
United States	-0,150388	0,102529	-1,466780	-4,256037	-1,956406	I(0)
OECD - Total	-0,092221	0,054069	-1,705604	-4,653530	-1,956406	I(0)

Taking first difference, because series are not stationary while examining the long term co-integration relation, creates short term information losses. Removing these losses, Error Correction Models are created to show existence of short term relation and results are presented in Table-4.

By using, for each country, unemployment (dependent), growth (independent) variables and 1 lagged error term series in Error Correction Models, VAR models are obtained and obtained coefficients, error term coefficients (u(-1) coefficients), t statistics and probability values for %5 meaning level are given in Table-4.

Tablo 4: Error Correction Models

Country	Coefficient	u (-1) Coefficient	t-Stat.	%5 Prob.	Notes
Australia	-0,071853	-0,568314	0,226474	0,0204	%56 of losses is removed after 1 period
Belgium	-0,571773	-0,571773	2,637700	0,0154	%57 of losses is removed after 1 period
Canada	-2,296605	-0,718622	3,137732	0,0050	%71 of losses is removed after 1 period
Chile	-0,177540	0,164910	0,682898	0,5021	Losses con not be removed
France	-0,246964	-0,680557	2,465309	0,0224	%68 of losses is removed after 1 period
Ireland	-0,280638	-0,662728	0,174254	0,0010	%66 of losses is removed after 1 period
Korea	-0,131000	0,315185	1,236727	0,2298	Losses con not be removed
Luxembourg	-0,032472	0,315044	1,552124	0,1356	Losses con not be removed
Netherlands	-0,090831	-0,698149	3,642073	0,0015	%69 of losses is removed after 1 period
New Zealand	-0,093035	-0,526498	2,955737	0,0075	%52 of losses is removed after 1 period
Norway	-0,066788	-0,553571	2,629159	0,0157	%55 of losses is removed after 1 period
Spain	-0,861976	-0,750691	4,553393	0,0002	%75 of losses is removed after 1 period
United Kingdom	-0,224679	-0,823409	4,693064	0,0001	%82 of losses is removed after 1 period
United States	-0,277950	-0,564665	2,567682	0,0179	%56 of losses is removed after 1 period
OECD - Total	-0,186823	-0,600909	2,514537	0,0201	%60 of losses is removed after 1 period

According to Table-4, Error Correction Model does not work for Chile, South Korea and Luxembourg. Model did work for other 12 countries and by removing data losses caused by long term, short term relation is showed. According to this, for these countries a ratio, given in "Notes" column, of data loss for any period can be removed in the following period.

5. Conclusion

Okun Law indicates reverse relation between unemployment and growth. This means that increase in unemployment causes decrease in GDP. Result of calculation related to OECD countries showed that Okun Law is valid for 23 countries. Growth performance of countries, especially with high employment rate, is quite low. Countries, especially with high Okun coefficient need, at least, this much economic growth to keep unemployment at current rate.

Long term co-integration is valid for 14 of 23 OECD countries and variables are long term related. Similar results of Huang and Yeh (2013) for long term relation are found. Finally, the finding of Tillmann (2010) that reverse relation between unemployment and growth in long term is getting weak is supported. For 34 OECD countries average unemployment is calculated as 6.87 and average growth as 2.43. These results show that long term relation of unemployment and growth data are suggesting validity of Okun's Law.

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