INTERNATIONAL EFFICACY OF OKUN'S LAW

Matiur Rahman, McNeese State University
Muhammad Mustafa, South Carolina State University

ABSTRACT

This paper re-explores the validity of the Okun's Law using annual data over 1970-2013 across selected 19 developed countries. The pooled data on real GDP growth and unemployment rate are largely nonstationary as well as these two variables are found cointegrated. The estimates of panel vector error-correction model by dynamic OLS unveil a much weaker relationship than what was originally observed in Okun (1962) in the US context only. **JEL Classifications**: E60, E61

INTRODUCTION

Using US quarterly data from 1947:Q_2 to 1964:Q_4, Okun (1962) found an inverse statistical relationship between unemployment rate and real GDP growth. According to the finding of this seminal paper, 1 percent rise in unemployment rate is associated with approximately 3 percent decline in real GDP growth. This law involves two important macroeconomic variables. Okun assumed that unemployment rate can serve as a useful summary of the amount of labor being used in the economy. In reality, Okun's law is a statistical relationship rather than a structural feature of the economy. Like any statistical relationship, Okun's law is subject to revisions in a dynamic economy. As a rule of thumb, this law proves to be useful to policymakers and economists with some modifications. Okun's statistical relationship varies over time and over the business cycle. The alternative versions of Okun's law include the difference version, the gap version, the dynamic version and the production function version.

Each of the above versions is presented briefly in simple words as follows:

The difference version: Okun's first relationship captured how changes in the unemployment rate from one quarter to the next moved with quarterly growth in real output.

The gap version: While Okun's first relationship relied on readily accessible macroeconomic statistics, his second relationship connected the level of unemployment to the gap between potential output and actual output. Okun sought to identify how much the economy would produce "under conditions of full employment". In full employment, Okun considered what he believed to be an unemployment level low enough to produce as much as possible without generating too much inflationary pressure.

The dynamic version: One of Okun's observations suggested that both past and current output can impact the current level of unemployment. In the difference version of Okun's law, this implies that some relevant variables have been omitted from the right side of the equation. Partly based on this suggestion, many economists now use a *dynamic version* of Okun's law.

A common form for the dynamic version of Okun's law would have current and past real output growths, and past changes in the unemployment rate as variables on the right side of the equation. These variables would then explain the current change in the unemployment rate on the left side. This dynamic version of Okun's law bears some similarities to the original difference version of Okun's law. However, it is fundamentally distinct since it no longer only captures the contemporaneous correlation between changes in the unemployment rate and real output growth. The dynamic relationship is not as restrictive in terms of the timing of the connection between output growths and changes in unemployment.

Production-function version: Okun also noted another shortcoming in his proposed relationship. The unemployment rate is at best "a proxy variable for all the ways in which output is affected by idle resources". Idle resources can come from a number of sources. Economic theory suggests that a country's production of goods and services requires a combination of labor, capital, and technology. The unemployment rate is but one factor in determining the total amount of labor used as an input. Other factors include the population, the fraction of the population that is in the labor force, and the number of hours that employed workers are used. By accounting for all of these components along with the components of capital and technology, economists have a more complete picture of what affects output.

This approach has led to *Production-function version* of Okun's law, which typically combines a theoretical production function or a particular way in which labor, capital, and technology combine to produce output with the gap-based version of Okun's law. Doing so allows economists to assess all the economy's idle resources. Production-function versions of Okun's law have the benefit of an underlying theoretical structure.

The principal objective of this paper is to re-explore the validity of the dynamic version for Okun's law for 19 selected advanced economies (Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Netherland, New Zealand, Norway, Potugal, Spain, Sweden, UK and USA) by implementing Dynamic OLS (Stock and Watson, 1993) with annual data from 1970 through 2013.

The rest of the paper proceeds as follows: brief review of the related literature; empirical methodology; results; and conclusions with some policy implications.

BRIEF REVIEW OF THE RELATED LITERATURE

A vast amount of empirical research since Okun (1962) and Plosser and Schwert (1979) has focused on estimating the textbook specification of Okun's law as opposed to inverting the relationship originally stated by Okun. Depending on the data set, the period used for the estimation, and the estimation method, the estimate changes. For example, using the same data set, Attfiled and Silverstone (1997) find that the coefficient for the United States changes from 0.67 to 2.25 when accounting for a cointegrating relationship. Songer and Stiassny (2002) provide some evidence that the size of the coefficient can also vary by country.

Studies have also addressed the possibility if structural breaks in the relationship between the unemployment rate and output growth. Knotek (2007) associates changes in Okun's coefficient with business cycles in the United States. The coefficient is, on average, smaller (in absolute value) in expansions than during recessions. Knotek also finds that the contemporaneous correlation has decreased over time, while the dynamic correlation; that is, the correlation with the lagged values of output growth measures, has increased. This asymmetric behavior of the Okun's coefficient over the business cycle is further reinforced by the findings of Beaton (2010) for both U.S. and Canada. Recent empirical phenomenon, such as, the Great Moderation (the period roughly between 1984 and 2007 described by low volatility on multiple time series in the data) and the financial crisis that followed may have altered the relationship between output and unemployment fluctuations. For example, Daly and Hobijn (2010) note that the Great Recession was marked by a persistent deviation from Okun's empirical relationship. They argue that in 2009, unemployment rose well in excess of what would be predicted by Okun's law. Daly and Hobijn (2010) attribute this deviation to an unusual rise in labor productivity.

Chamberlin (2011) has detailed the difference version in regression form and found that changes in unemployment rate and output growth have negative Okun's coefficient. Irfan (2010) provides the link between the natural log of real output and the natural log of unemployment rate.

Again, Chamberlin (2011) using the gap version explains that if output falls below potential, giving rise to a negative output, unemployment would be expected to increase and if actual output exceeds potential output, unemployment is expected to fall. Potential output is the equilibrium level of output where the economy can grow without experiencing inflationary or deflationary pressures. Burgen, Meyer, and Tasci (2012) analyzing data over 40 years find a "strong correlation between output growth and increase in unemployment rate when it is below potential, but disappears when output is growing above potential". Unemployment is present even when the economy is strong. Once unemployment reaches a certain level, it may not go below that level even if growth continues. Wen and Chen (2012) state that for "each 1- percentage-point increase (decrease) in the unemployment rate from its natural rate, total output, on average, will be lowered (raised) by nearly 2 percent relative to its long-run trend".

Okun's law is based on the fact that output and production depend on the labor involved, leading to a positive relationship of output to employment and thus negative relationship between output and unemployment. Chamberlin (2011) highlights that in past UK recessions, unemployment has continued to rise even as the economy returns to growth.

Burgen, Meyer and Tasci (2012) and Altig, Fitzgerald, and Rupert (1997) mention that the relationship of one variable affecting the other in a certain direction can alter over time. With positive unemployment causing a negative change in GDP, it can change directions under various market conditions. Altig, Fitzgerald, and Rupert (1997) also state that while this is original thought process, it does not always hold in the same direction and may change entirely, due mainly to productivity increases or decreases. This shows that there is not always a cut and dry exchange with Okun's law and the GDP or unemployment if affected by other variables.

Other studies not only include unemployment and GDP of countries, but other variables as well. These sources view Okun's law with slight modifications to see if

Okun's law holds under each circumstance. Owyang and Sekhposyan (2012) opine that Okun's law does not always hold over the short-run, in particular, when dealing with the recession and the recovery. Especially, after the recovery, periods of large growth in output does not correspond with the lessening of the unemployment rate.

Kitov and Kitov (2012) modify Okun's law to show the reflection of unemployment in GD per capita rather real GDP. They test this hypothesis in developed countries and find that Okun's law hold for the developed countries with GDP per capita. Neely (2010) focused on the Okun coefficient of countries and states that the United States, Canada and the United Kingdom have smaller Okun coefficients than most other industrialized nations. This is likely a result of these three countries having less regulation on labor markets, allowing companies to lay off workers easier when there is a slowdown in the economy.

EMPIRICAL METHODOLOGY

This section provides a brief summary of current econometric practices for time series analyses and the preferred method dynamic OLS (DOLS) used in this paper for estimation.

In brief, classical regression properties hold only for cases where variables are stationary (integrated of order 0). In contrast, when most economic variables are integrated of order 1 or higher, this assumption is not satisfied. Also, where error-correction mechanisms or long-run relationships exist, certain combinations of I(1) variables are likely to be I(0) and hence amenable to OLS estimation. In such cases, the variables are said to be cointegrated and OLS estimates of such cointegrated variables may not be superconsistent in the sense of collapsing to their true values more quickly than if the variables had been stationary. The first step is to determine the degree of integration of the individual time series under investigation. This may be done using standard Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests on series of regressions of original values, first differences in the series, second differences and so on where the null hypothesis to be tested is that the series is non-stationary. These tests are unreliable due to their supersensititvity to selection of lag lengths.

A large number of methods are also available for testing whether a model has appropriate cointegration properties. Two of these methods are briefly stated. In the first place, residuals from OLS estimates of the baseline regression for long-run relationship can be used by detecting the presence of cointegration. Provided that the residuals are I(0), or stationary, the model can be considered to be cointegrated and a valid long-run relationship exists between the variables. In the DF and the ADF cointegration tests, the appropriate null hypothesis is that the residuals possess a unit root against the alternative hypothesis that the residuals are stationary. Where a cointegrating relationship cannot be found, no long-run relationship among the variables can be demonstrated due to spurious correlation that is very likely to yield misleading inferences.

The OLS approach, while simple to implement, is not without problems. Parameter estimated can be biased in small samples as well as in the presence of dynamic effects. This bias varies inversely with the size of the sample and the calculated R^2. Secondly, when the number of regressors exceeds two there can be more than one cointegrating relationship. So, it is difficult to give economic meaning to this finding.

Additionally, a problem caused by the likely endogeneity of the regressors would prevent OLS estimating the true values of the parameters. These difficulties associated with the OLS approach have led to the development of alternative procedures, the most well-known of which is that of (Johansen, 1991). Johansen developed a maximum likelihood procedure, which improves on OLS in various ways. Firstly, the existence of at most one cointegrating vector is not assumed a prori, but is tested for in the procedure. Next, the Johansen procedure takes the regressors to be endogenous and applies appropriate methods. Finally, a more powerful set of tests are provided which enable the number of cointegrating vectors to be identified and the effect of various restrictions to be evaluated. Implementing the method involves identifying the rank of the matrix in the following equation:

$$\Delta X_t = \delta + \sum_{i=1}^{K-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t$$

Where, X_t is a column vector of the m variables Γ, and Π represents coefficient matrices, Δ is a first-difference operator, k denotes the lag length and δ is constant.

This can be done using methods described in (Pesaran and Pesaran 1997). The rank r provides the number of cointegrating vectors, so that if the rank is 1 for example, a single stationary relationship exists which can be taken as the long-run relationship. The parameters of the cointegrating relationship itself and the adjustment coefficients of an error-correction model can be obtained by further decomposition of the matrix Π. The foregoing summary applies only to long time series data for variables not to panel data as a combination of both time series and cross-sectional observations. For implementation, all variables need to be of the same order of integration. Moreover, maximum eigen value and trace test statistics offer conflicting results in some instances.

The panel cointegration tests proposed by Pedroni (2004) are residual-based tests for the null of no cointegration in heterogeneous panels. Two classes of statistics are considered in the context of Pedroni test. The first type is based on pooling the residuals of the regression along the within-dimension of the panel, whereas the second type is based on pooling the residuals of the regression along the between-dimension of the panel. For the first type, the test statistics are the panel *v*-statistic, the panel ρ-statistic, the panel PP-statistic, and the panel ADF-statistic. These statistics are constructed by taking the ratio of the sum of the numerators and the sum of the denominators of the analogous conventional time-series statistics across the individual members of the panel. The tests for the second type include the group ρ-statistic, the group PP-statistic, and the group ADF-statistic. They are simply the group mean statistics of the conventional individual time series statistics. All statistics have been standardized by the means and variances so that they are asymptotically distributed *N(0,1)* under the null of no cointegration. As one-sided tests, large positive values of the panel ρ-statistic reject the null hypothesis of no cointegration. For the remaining statistics, large negative values reject the null hypothesis. Panel data set augments the sample size by inclusion of limited time series observations across a set of sample objects in presence of endogenous macroeconomic factors causing comovement among variables.

The Stock-Watson dynamic OLS (DOLS) approach is an alternative approach, which has certain advantages over both the OLS and the maximum likelihood procedures, as proposed by (Stock and Watson, 1993). Their method improves on OLS by coping with small sample and dynamic sources of bias. The Johansen method, being a full information technique, is exposed to the problem that parameter estimates in one equation are affected by any misspecification in other equations. The Stock-Watson method is, by contrast, a robust single equation approach which corrects for regressor endogeneity by the inclusion of leads or lags or both of first difference of the regressors, and for serially correlated errors by a GLS procedure. In addition, it has the same asymptotic optimality properties as the Johansen distribution.

Stock and Watson (1993) show that DOLS is more favorable, particularly in small samples, compared to a number of alternative estimators of long-run parameters, including those proposed by Engle and Granger (1987), Johansen (1988) and Phillips and Hansen (1990). Furthermore, Short-run elasticity counterparts are also derived via robust dynamic error-correction models (ECMs).

For panel data, the estimating base equation is specified as follows:

$$Y_{it} = \alpha_0 + \alpha_1 X_{it} + e_{it} \,;\, \alpha_1 > 0,\ \alpha_2 < 0 \ldots\ldots \quad (1)$$

Where, Unemployment rate, X = Real GDP growth, e = Error term, t = 1,2,…., T and i = 1,2, …, N. Thus, total number of observation in the panel data set is N*T.

Prior to testing for panel cointegration, four panel unit root tests LLC (Levin, Lin and Chu, 2002),Breitung (2000), IPS (Im, Pesaran and Shin, 2003) and Hadri (1999) are implemented.

Following Pedroni (2000), the following model for cointegration between the variables is estimated by DOLS;

$$Y_{it} = \alpha_i + \beta_i X_{it} + \gamma_t D_{it} + \mu_{it} \ldots\ldots.. \quad (2)$$

Y_{it} is dependent variable with pooled data.
X_{it} is explanatory variable with pooled data.
a_i captures possible country-specific fixed effects and β_i allows for heterogeneous cointegrating vector. γ_t captures time-dependent common shocks of common time dummies (D_{it}).

The DOLS procedure which basically involves regressing any I(1) variables on the other I(1) variables, any I(0) variables and leads or lags of the first differences of any I(1) variables. However, since an investigation of the short-run dynamics are also of interest in the analysis, the panel VECM formulation is described as follows in facilitating inferences regarding the long-run and the short-run dynamics;

$$\Delta Y_{it} = \sum_{j=1}^{k} \emptyset_{ij}\, \Delta y_{t-j} + \sum_{j=0}^{m} n_j\, \Delta x_{i-j} + EC_{it-1} + \epsilon_t \ldots\ldots \quad (3)$$

Intuitively, when the variables are cointegrated, then in the short term, deviations from this long-term equilibrium will feed back on the changes in the dependent variable in order to force the movement towards the long-term equilibrium. If the dependent variable is driven directly by this long-term equilibrium error, then it is responding to this feedback. If not, it is responding only to short-term shocks to the stochastic environment. The significance tests of the ‘differenced’ explanatory variables give an indication of the ‘short-term’ effects, whereas the ‘long-term’ causal relationship is implied through the significance or otherwise of the‘t’ test(s) of the lagged error-correction term(s), which contains the long-term information since it is derived from the long-term cointegrating relationship(s). The coefficient of the lagged error-correction term, however, is a short term adjustment coefficient and represents the proportion by which the long-term disequilibrium (or imbalance) in the dependent variable is being corrected in each short period. Non-significance or elimination of any of the 'lagged error-correction terms' affects the implied long-term relationship and may be a violation of theory. The non-significance of any of the 'difference' variables which reflects only a short-term relationship, however, does not involve such violations because theory typically has nothing to say about short-term relationships (Masih and Masih, 1995a; 1995b; 1996b).

Data from 1970 through 2013 are collected for all nineteen selected developed countries from various annual volumes of International Financial Statistics of the IMF.

RESULTS

This paper does not invoke conventional cointegration procedure and error-correction model estimation due to possible pitfalls as stated earlier. Instead, it applies panel cointegration methodology for 19 selected developed countries, as stated earlier, to obtain robust estimates. The panel unit root tests results are reported as follow.

As observed above, LLC, Breitung and IPS tests confirm nonstationarity of real GDP growth at 1% level of significance. But Hadri test shows, otherwise. Breitung and Hadri tests confirm nonstationarity of unemployment rate at 5% and 1% levels of significance, respectively. In this case, LLC and IPS tests suggest, otherwise. Thus, the evidences on nonstationarity appear to be mixed. On first-differencing, stationarity is restored in both variables, as evidenced in the lower segment of Table 1.

As revealed in Table 2, all panel statistics except panel v-statistic and group statistics confirm cointegration between the variables of interest with constant trend at less than 5% level of significance. In contrast, the evidences are to the contrary for the variables with constant plus trend.

On the evidence of cointegration, the panel error-correction model is subsequently estimated with lags. The results are reported as follows;

$$
\begin{aligned}
\Delta UNR_{it} = {} & \underset{(2.3383)}{0.0432} + \underset{(1.7331)}{0.0806}\Delta UNR_{it-1} + \underset{(5.7960)}{0.3119}\Delta UNR_{it-2} - \underset{(-6.8332)}{0.1356}\Delta RGDP_{it-1} \\
& \underset{(-0.8713)}{-0.0128}\Delta RGDP_{it-2} - \underset{(-9.6538)}{0.1209}EC_{it-1} \ldots\ldots(2)'
\end{aligned}
$$

Associated t-values are reported in parenthesis. $R^2 = 0.4717$, $F = 96.003$, $AIC = 1.0520$

The estimated coefficient of the error-correction term (EC_{it-1}) is negative, as expected, and statistically highly significant in terms of the associated t-value. This is a strong affirmation of convergence toward long-run equilibrium and unidirectional causal flows to the current change in unemployment rate from the changes in the lagged independent variables with panel data. The coefficient shows that 1% increase in real GDP growth in the long-run reduces unemployment rate by 0.12%. The sum of the coefficients of lagged changes in real GDP growth rate is negative disclosing that real GDP growth rates unleash short-run net negative influence on the current change in unemployment rate. The associated t-value of the first lagged coefficient is overly significant. There are also short-run net negative feedback effects between the lagged real GDP growth and unemployment rate.

CONCLUSIONS AND SOME POLICY IMPLICATIONS

To recapitulate, the evidences on the nonstationarity of real GDP growth are mixed. These variables are cointegrated with constant trend. The estimates of the panel vector error-correction model disclose that the long-run negative effect of real GDP growth on unemployment rate is much weaker than what Okun (1962) found for the USA. The weaker statistical dynamic relationship is presumably due to omissions of some variables that influence labor markets of the selected 19 developed countries considered together. However, country-by-country analysis could shed additional light in this regard. In the short-run, the net interactive feedback effect between the variables is negative, as expected. Okun (1962) focused only on the USA. The economic structures and labor market conditions among these developed countries are asymmetric. Moreover, their macroeconomic policies differ. So, their mixture is likely to yield weaker results.

In closing, a policy of promoting real GDP growth to dent on unemployment is not as effective in recent decades since 1970 as compared to earlier decades of 1940s, 1950s and 1960s due to structural transformations of labor markets across these selected countries due to ongoing overall globalization, technological advances, increasing international mobility of both labor and capital, etc. Consequently, weakening of the trade-off relationship between real GDP growth and unemployment rate is eroding the importance of the Okun's Law as a useful policy tool. Strong economic growth does not necessarily translate into robust job growth due to sector-specificity of workers, differing labor laws, upward wage rigidities, etc.

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TABLE 1: PANEL UNIT ROOT TESTS

METHOD				
Variables in Level	**LLC**	**Breitung**	**IPS**	**Hadri**
Real GDP Growth	13.0128*	-12.4777*	11.6412*	0.4735
Unemployment Rate	1.2389	-1.7533**	0.5813	10.7085*
METHOD				
Variables in First Difference	**LLC**	**Breitung**	**IPS**	**Hadri**
ΔReal GDP Growth	19.5451	-19.8976	21.7461	28.5942
ΔUnemployment Rate	14.4300	-11.9995	9.3083	-0.6460

*Indicates significance at 1% level. ** indicates significance at 5% level

TABLE 2: PEDRONI RESIDUAL BASED CO-INTEGRATION TESTS

Test	Constant Trend	Constant + Trend
Panel v-Statistic	-1.9561 (0.9748)	-3.7831 (0.9999)
Panel rho- Statistic	-6.9411 (0.0000)	2.7269 (0.9968)
Panel PP- Statistic	-4.6818 (0.0000)	1.8057 (0.9645)
Panel ADF- Statistic	-3.5141 (0.0002)	1.8171 (0.8824)
Group rho-Statistic	-3.8587 (0.0001)	3.9741 (1.0000)
Group PP-Statistic	-4.9411 (0.0000)	3.1166 (0.9991)
Group ADF- Statistic	-3.3219 (0.0004)	2.4450 (0.9928)

Note: P-values are reported in parenthesis.