Breaking the Law: An Empirical Investigation of the Efficacy of Okun's Law

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Abstract

This paper seeks to contribute to the empirical literature surrounding the composition, structure, and efficacy of Okun's Law. The paper begins with an extensive literature review on the formulation and evolution of Okun's Law and then proceeds to test the validity of the law during periods of abnormal productivity growth using National Accounts Data for Canada, France, Japan, the United States, and the United Kingdom. There has been much discussion of the "breaking" of Okun's Law during the current economic contraction, but much of this debate has not dealt with the causation of such "breaking". The paper concludes with a discussion of the efficacy of Okun's Law given the paper's econometric results.

I Introduction

This paper questions part of the canon of Macroeconomics during periods of abnormal productivity growth. The relevance of this paper stems from recent discussions of a looming jobless recovery in which output growth is not coupled with an equal recovery in the labor market and the composition of such asymmetrical recoveries. Arthur M. Okun was a renowned economist who was very influential even during his own period of academic work, and his single most important contribution to economics was one of simple, empirical observation. In 1962, Okun published *Potential GNP: Its Measurement and Significance* while at Yale University, and with it developed what has become one of the most practical innovations of Macroeconomics, Okun's Law (Okun, 1962).

Okun's Law (OL) is the term that has come to signify Okun's conclusion from his seminal 1962 paper. Okun found that a stable relationship between the rate of change of output growth, as measured by GNP, and the rate of change of unemployment held. He measured this relationship using quarterly data from the second quarter of 1948 to the fourth quarter of 1960 (Knotek, 2007). He concluded that this relationship was both inverse and proportional. More precisely, a three percent increase in output growth should result in a one percent decrease in the unemployment rate. The implications for such a discovery were obviously grand and extremely practical. Okun's intent seems to have been to clarify any arithmetic misconceptions that policy makers may have held with regards to the relationship between output and unemployment. He wrote:

> If programs to lower unemployment from 5.5 to 4 percent of the labor force are viewed as attempts to raise the economy's grade from 94.5 to 96, the case for them may not seem compelling. Focus on the (output) gap helps to remind policy makers of the large reward (in terms of extra output) associated with such an improvement (Okun, 1962).

Clearly, Okun's discovery, as well as many further advances in macroeconomics, has negated any of the naive conceptions of an economy that is governed by a perfect ratio of one-to-one between unemployment and output. This notion seems to have been the standard paradigm prior to Okun's original paper (Okun, 1962).

For the five decades since Okun's Law originated, the relationship has held very well for the United States economy as well as other developed economies. There have been revisions of Okun's Law that dealt with the actual proportion between output and unemployment, which has been estimated again and again by many economists in many distinct works. Even with these revisions, they are not very drastic in that Okun's original estimate of a proportional scalar of three has been revised to be between two and three (or four recently) depending on the model of estimation. Given the aforementioned robustness of Okun's Law, it is clear as to why it has been heralded as such a grand achievement. During the 1997 American Economics Association annual meeting, a discussion was held that was titled "Is there a Core of Practical Macroeconomics That We Should all Believe" Princeton economist Alan Blinder cited Okun's Law as one of these core principles, because of both its persistent accuracy in prediction and the fact that Okun's Law is a practical principle that occupies an academic field that is increasingly shifting towards obscure mathematical theory devoid of any immediate practical application. He stated:

> The other truly sturdy empirical regularity, Okun's Law, is even more atheoretical, if not indeed antitheoretical. This simple linear relationship between the percentage change in output and the absolute change in the unemployment rate presumably embodies productivity growth, labor-force participation, and production-function considerations. On the surface, it seems to contradict the concavity of the latter. Nonetheless, it closes the loop between real output growth and changes in unemployment with stunning reliability (Blinder, 1997).

Such a resounding endorsement reflects the prominence and importance of Okun's Law, though an endorsement alone, from any single prominent economist, cannot be seen as proof enough of the cogency of any empirical regularity. And it is that cogency, the accuracy and robustness of Okun's Law, that this paper seeks to investigate.

II Literature Review

When Okun's Law is tested using extended time series of economic data, the efficacy of the relationship of output and unemployment is very obvious. But, there are outliers present within the relationship as well. For the United States economy, the year 2003 represents such an outlier. Using the Bureau of Labor Statistics' measure of the unemployment rate and the Department of Commerce's figure for GDP for the third and fourth quarters of 2003, we see that unemployment decreased by roughly .5% while GDP increased by roughly 10.3%, suggesting that the proper proportional scalar for the United States economy with respect to Okun's Law is actually much higher (20.15 opposed to 3) than the scalar originally estimated by Okun. Moreover, it seems that for the majority of time following the 2001 recession, the United States economy has not been linked to the original Okun coefficient. There could be several explanations for this phenomenon. Some deal with the actual nature of Okun's Law, and other explanations contend either that the Law is actually not a law at all or that the Law can be used only when using extended periods of time. These explications are not easily derived nor easily dismissed, but this paper seeks to investigate whether there is yet another underlying source for the recent disentanglement of the United States economy from its historical Okun coefficient, productivity growth.

The extrication of what seemed to be the natural, proportional relationship between United States GDP and unemployment has been accompanied by a prolonged period of high productivity growth rates (productivity, in this usage, is measured as output per unit of hour worked). There of course could be other causes, either unobservable or observable, but the rapid rise of productivity growth is too visible of a possible causation to be ignored, and though Okun contends that fluctuations in productivity growth are captured within the Law, extreme fluctuations may not have been. Hence, the question which this paper seeks to examine is the stability of Okun's Law and its maintenance of the previously estimated proportional relationship between national output and the national unemployment rate during period of volatile productivity growth. The implications of a positive finding would have extensive ramifications for policymakers who assume that Okun's Law is part of the foundation of the macro economy, especially with regards to fiscal stimulus.

The previous literature regarding Okun's Law is extensive, including theoretical examinations, practical applications, and empirical observations. Perhaps the most comprehensive introduction to the mechanics and history of Okun's Law is Martin F. J. Prachowny's *Okun's Law: Theoretical Foundations and Revised Estimates* (Prachowny, 1993). Prachowny delves into the historical roots of the theoretical foundations of Okun's Law, which he describes as every bit as important as the Phillips curve in understanding the Aggregate Supply curve for any macro-economy (Prachowny, 1993). Prachowny proceeds to derive Okun's law in the standard expression of the difference version. Explicitly, the difference version of Okun's Law states that the difference between output and potential output as a percentage of potential output for a given economy is negatively proportional to the difference between the rate of unemployment and the natural rate of unemployment.

$$\frac{(Y^* - Y)}{Y^*} = \lambda(U - U^*)$$

The reason for terming this expression as the difference version of Okun's Law is that the term Okun's Law refers only to the relationship between output and unemployment and not the specific expression of that relationship, or a specific method of measurement of that relationship. The other versions of Okun's Law will be discussed in full in the following pages. Prachowny goes on to state this formulation assumes a great deal on the right side of the equation. He maintains that the output gap cannot simply be stated as strictly proportional to the unemployment rate because there are many other factors that can and do contribute to the output gap. The variables he uses are: C, the capital utilization rate; L, the natural log of the supply of labor; U, the unemployment rate; H, the number of hours worked per worker; and he denotes the potential or equilibrium of any variable by $*$. Using this notation he constructs the following relationship,

$$Y - Y^{*} = \alpha(C - C^{*}) + \beta\gamma(L - L^{*}) - \eta\gamma(U - U^{*}) + \beta\delta(H - H^{*})$$

He derives the above relationship of Okun's estimates of increased employment while allowing for an increase in productivity for all workers. The difference between the standard interpretation of Okun's original work and Prachowny's is that Prachowny believes that his right-hand variables, excluding the employment gap, affect output independently and hence the direct relationship between the output gap and the employment gap is much smaller than previously understood. He states:

> Okun's coefficient of three is derived from a complicated weighted sum of all other changes. For example, a one-point reduction in the unemployment rate together with a 3% reduction in hours worked would change output relative to its potential by 3%, even if $\beta\gamma$ and $\beta\delta$ were both 0.75. As long as unemployment changes and hours worked move together precisely in this assumed $1:3$ ratio, the distinction is not very important, but there is plenty of evidence that this is not the case (Prachowny, 1993).

His example demonstrates the seeming pitfalls with the simple formulation of the standard difference version of Okun's Law, and he further suggests that more empirical investigation be employed towards Okun's Law, especially with regards to hours worked and capital utilization rates. Prachowny's paper emphasizes the seeming incompleteness of OL and therefore its potential for mis-estimation or misinterpretation (Prachowny, 1993).

A very important but brief revision of Okun's Law was also made by Benjamin Friedman and Michael Wachter in their paper entitled *Unemployment: Okun's Law, Labor Force, and Productivity* (Friedman and Wachter, 1974). The authors use a revised form of the Phillips Curve model relating inflation and unemployment and coupling it with Okun's Law to derive a more sophisticated version of OL. The authors build upon the original model through the same method of decomposing the labor market side of the equation in to more parts so that the relationship is more explicit in its awareness of other factors that influence the relationship between output and employment.

The authors introduce two factors that they claim to be indispensable in evaluating the existence and robustness of OL. These factors are the inflation rate and the growth rate of real wages. Using this augmented form they explain the rapid rise in unemployment between 1969 and 1970 as the being composed of those three factors. The unemployment level rose from 3.4% to 5.9% during that time and they contend that eighty percent of this increase is a direct effect of output decline while the remaining fifth is due to a decline in real wages, a decline in firm profit levels and an increase in the inflation rate which actually counteracted (under a Phillips Curve framework) the increase in unemployment. This measurement is the empirical manifestation of their revision of Okuns Law, which estimates that the effect of real output on the unemployment rate has two parts; a direct employment effect, which has a negative influence on the unemployment rate, which operates rapidly, while an indirect effect in the opposite direction operates more slowly over time through the growth of capital stock and labor force (Friedman and Wachter, 1974). The authors' revision of OL informs the topic of investigation for this paper, that Okun's Law and the Okun coefficient is subject to other fluctuations than the simple relation stated previously in this paper. This conclusion allows for fluctuations in output to be determined by factors endogenous to the labor market.

Thus far the focus of this paper has been on the measurement and application of OL for the United States economy, but several economists have written on the applicability of OL on other developed economies. Imad Moosa, writing in the *Journal for Comparative Economics*, claims to have collected the most extensive record of OL for developed economies in his paper, *A Cross-Country Comparison in Okuns Coefficient* (Moosa, 1997). We cannot validate his claim, but it is a very informative piece of literature. The countries for which Moosa estimated the Okun Coefficient are the G7 Nations, namely Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Before delving into his findings for each country, it is important to note that Moosa believes, based on the then-existent literature, there to be an increase in the value of Okun's coefficient which was directly affected by the oil-price shocks of the 1970s.

> Some differences have also been found when the estimation is carried out over different sample periods. For example, Weber (1995) found higher coefficient values in the post-1973 period. In fact, there seems to be a consensus view that the relationship changed in the aftermath of the two oil shocks of 1973 and 1979 (Moosa, 1997).

Table 1: Basic Statistics of Okun's Rolling Coefficients (Moosa, 1997)

Country	Maximum[a]	Minimum[a]	Mean	Coefficient of Variation
United States	-0.477	-0.432	-0.456	0.036
Japan	-0.112	-0.063	-0.083	0.192
Germany	-0.642	-0.213	-0.410	0.320
France	-0.409	-0.243	-0.217	0.167
UK	-0.414	-0.369	-0.392	0.031
Italy	-0.285	-0.113	-0.175	0.337
Canada	-0.588	-0.423	-0.488	0.066

[a] Absolute Value [*sic*]

This claim in and of itself would be quite the revision to OL if the author had delved deeper into the specifics of how much the coefficient has shifted, or to give details on his hypothesis as to why such a shift would have occurred. He does however say that labor market reform has intensified in recent years and this development could have caused the shift, but eventually concludes there to be no structural break for the G7 economies for their respective Okun coefficients during the 1970s. Moosa's estimation of OL uses a different form than that of the previously stated forms of OL. His estimator is of the following form,

$$U_t^c = \alpha + \beta U_{t-1}^c + \gamma Y_t^c + \epsilon_t$$

Here U^c is the cyclical employment gap, α is a constant term, Y^c is the logarithm of the cyclical output gap, and ϵ is a stochastic error term. Using this form of OL, a more dynamic version because it includes more than one time period into the model, we can basically divide the previously discussed Okun coefficient by a factor of ten to standardize our comparison. Hence, the United States economy would have an Okun coefficient, γ, roughly equal to .3 instead of three. The results for his estimation of the coefficient for the G7 economies is exhibited by the following table: The final interpretation of these results is that the Okun coefficients for at least these developed economies are actually higher than previously estimated for all countries, and there are significant differences between the responsiveness of output growth to employment growth and vice versa, depending on the country of interest. Moosa explains away most of this difference in responsiveness by referencing the different labor market restrictions and compositions between North American, European, and Japanese labor markets. He states:

> The first conclusion that can be drawn from the results presented in this paper is that employment is more responsive to economic growth in the United States and Canada than in Europe and JapanThis finding can be explained in terms of some institutional differences that determine the rigidity or flexibility of the labor market. More specifically, employment is more responsive to economic growth in the United States and Canada because of the lack of job security provisions and restrictions on layoffs. These provisions inhibit employers from reducing their workforce during recessions and hiring more workers during expansions (Moosa, 1997).

The immediate implications of this finding pertain mostly to the realm of policy making, more specifically, increasing output has a much more direct effect on decreasing unemployment in countries with less constrained and more fluid labor markets. This implies that any sort of fiscal policy that intends to induce a decrease in the employment gap by increasing output will not have the desired affect due to the preceding reasoning developed by Moosa. The direct implications for this paper from Moosa's work are a readily available coefficient in which to compare developed nations' Okun coefficient during periods of productivity growth fluctuation, but the immediate relationship between productivity growth and Okun's Law is not a topic that can be fully explicated by labor market rigidities unless those same rigidities have an immediate relationship with productivity and its rate of growth.

In order to have a comprehensive view of Okun's Law, its causes and implications, we must incorporate the skeptical view of OL as well. Perhaps the most widely circulated account of the skeptical take towards OL is Benjamin Bernanke and Andrew Abel's textbook, *Macroeconomics.* In the 2008 edition of the book, the authors present United States data from 1948 to 2007 and maintain that OL is very accurate in its predictions. They estimate the proportional scalar to be two and use the following formulations:

$$\frac{(Y^* - Y)}{Y^*} = 2(U - U^*)$$

$$\frac{\Delta Y}{Y^*} = 3 - 2\Delta U$$

The authors present OL as an observable phenomenon, but they also present it as a "rule of thumb" and not any underlying foundation of the macro-economy (Abel and Bernanke, 2008). In doing so they join Federal Reserve Bank of Kansas City economist Edward Knotek as a prominent skeptic of Okuns Law, but while Abel and Bernanke spend little time in their treatment of OL, Knotek investigates the issue at length in his article *How Useful is Okun's Law?*. Knotek maintains that OL is a simple statistical relationship and therefore its predictive effectiveness and theoretical importance are questionable. Knotek states, "In reality... Okun's Law is a statistical relationship rather than a structural feature of the economy. As with any statistical relationship, it may be subject to revisions in an ever-changing macro economy" (Knotek, 2007). Knotek states that his suspicion of the usefulness of Okun's Law stems from the fact that the relationship seems to have been drastically altered for the United States economy since 2003, this development is also a motivation for this paper.

Knotek restates the fact that many economists have made substantial changes to the original equations that Okun developed in 1962, but that all of these variations and the original equation are collectively referred to as Okun's Law. In Okun's original paper he makes note of the fact that both past and current output can affect current levels of unemployment, but Okun himself never incorporated this insight to his models (Knotek, 2007). Due to Okun's aforementioned assertion Knotek employs what is known as the dynamic version of Okun's Law. This formulation does take into account the temporal affects of output fluctuations in order to formulate what Knotek believes to be a more robust estimator. The dynamic version is expressed by the following:

$$\Delta U_t = \beta_0 + \beta_1 G_t + \beta_2 G_{t-1} + \beta_3 G_{t-2} + \beta_4 \Delta U_{t-1} + \beta_5 \Delta U_{t-2} + \epsilon_t$$

In this model, U represents the unemployment rate, and G represents the real output growth. Using this version and data from the United States economy since 1946, Knotek finds that the quarterly movement in unemployment and output are very similar to that of Okun's original estimation, but that annual movements present a departure from that said estimation. A very important issue that the author addresses is that using long time series can often hide any variation within Okun's Law, and he shows that when estimated over much shorter time periods the relationship between unemployment and output growth is much more erratic than OL suggests. Knotek believes that much of this variation can be explained by the nature of the business cycle and the evolution of the relationship between output growth and unemployment, the advent of "jobless recoveries" (Knotek, 2007)..

When reflecting on the totality of the literature regarding Okun's Law, there seems to be two prominent features of the literature. First, there is a tremendous amount of deference paid to the law and its original formulation. Much of this deference can be attributed to the stunning accuracy of Okun's Law when using long time horizons and great amounts data. The second is that the Law is not impervious to revision and enhancement. Keeping this information in mind, we will now construct the framework for proceeding with this paper's topic of investigation.

III Methods

In order to fully investigate the affect of productivity growth on the stability of Okun's Law, we will use employment, productivity growth, and output data from five different member countries of the Organization for Economic Co-operation and Development (OECD). The reason we will only be using five countries is much of the literature deals only with the United States and data and estimates for other countries is sparse. Also, data in terms of quarters is not readily available for many countries, and hence choosing five countries is a result of practical data-gathering constraints.

We will use real (inflation adjusted) GDP as the measure of output, the national unemployment rate as the employment variable, and increases in output per hours worked as the measure of productivity growth, and all these figures will be reported on an annual basis. After gathering the data, we will conduct two estimates of Okun's Law, the original formulation stating a simple proportional relation, and the dynamic version. These countries are the United States, the United Kingdom, France, Japan, and Canada. The reason for these specific countries is the relative differences in labor market rigidities (each country has different levels of labor market restriction as reported by the European Central Bank) between each country and the prominence in labor market rigidities in explaining the differences in Okun coefficient estimates between countries (Berthou, 2008). The data will be provided from the Bureau of Labor Statistics and the Federal Reserve Bank of St. Louis, and from this data on the three above-mentioned variables, we will construct estimates of the Okun coefficient in order to find variations in the coefficient during periods of high productivity. The levels of high productivity growth will be determined on a country by country basis so as to standardize what is considered as high productivity growth for the specified country. After determining the periods of high productivity growth for each country, we will then produce estimates of the Okun coefficient for those specified time horizons and compare these coefficients with the normal coefficient for a country using a long time horizon. An issue that may prove to be problematic is whether or not the estimates' variation can be attributed to high productivity growth or whether the variation is a product of a short time horizon. To clarify this potentially indiscernible conflation, we will also use short time horizons with normal rates of productivity as a control group.

Our hypothesis is that there will be a statistically significant difference in the Okun coefficient during periods of high productivity growth as opposed to longer time horizons or periods of normal productivity growth in short time horizons. Also, we hypothesize that the difference between the method of the original Okun model and the dynamic version will be roughly equivalent. The implications of this research are both academic and practical. The academic implications will add to an already rich literature that involves a central tenet of macroeconomics and explores a previously ignored aspect of Okun's Law. The practical implications are for policy makers. If the relationship between output growth and unemployment reduction is highly erratic or highly unstable during periods of high productivity growth, then the remedy of fiscal stimulus during periods of economic contraction must be evaluated through this lens. And if this is not the case, then the argument for fiscal stimulus is strengthened by the discovery of a stable relationship between changes in output and unemployment. To conclude, this paper seeks to examine a long-established relation using new techniques.

In regards to the estimation of the regressions, the same procedure was used for all countries. Using time series data for 38 years, we run a dynamic estimate of the form previously stipulated using the Prais-Winsten procedure to correct for first-order auto-regressive serial correlation and White-robust standard errors to correct for heteroskedastic error terms. After the initial estimate without an independent variable relating to productivity rates or productivity growth rates, we include an independent binary variable representing productivity growth rates in the following way:

$$\{P_t > \mu \Longrightarrow P_d = 1, P_t < \mu \Longrightarrow P_d = 0\}$$

Where $\mathrm{P_t}$ represents the productivity growth rate, $\mathrm{P_d}$ the binary variable for productivity growth, and μ represents the mean productivity growth rate for the available data set. After estimating using Productivity as a binary variable, we estimate the dynamic model once more using Productivity growth rates as an independent variable. In addition to estimation using the preceding regression design, we have included an additional set of regressions using the exact same procedure, but instead of using GDP growth rates, we use Gross National Income (GNI) growth rates. The reasoning behind this additional estimation is that in the original formulation of Okun's Law, Okun used Gross National Product (GNP) as his measure of output growth and, disregarding the theoretical equivalence of GDP and GNI, GNP is more akin to GNI than GDP. Using this process, any relational difference between GNI and unemployment and GDP and unemployment may observed more rigorously.

IV Results

i. Dynamic Estimates

Let[1] us first examine the regression results for the dynamic estimates using GDP growth rates as the output measure.

$$\Delta U_t = \beta_0 + \beta_1 G_t + \beta_2 G_{t-1} + \beta_3 G_{t-2} + \beta_4 \Delta U_{t-1} + \beta_5 \Delta U_{t-2} + P_d + \epsilon_t$$

$$\Delta U_t = \beta_0 + \beta_1 G_t + \beta_2 G_{t-1} + \beta_3 G_{t-2} + \beta_4 \Delta U_{t-1} + \beta_5 \Delta U_{t-2} + P_t + \epsilon_t$$

The first equation above represents the inclusion of a productivity dummy, $\mathrm{P_d}$, and the second, the inclusion of a productivity growth rate variable in level form at time $\mathrm{P_t}$. As we can see from Table 1 through Table 5, none of the national data sets examined showed any significance at the 1% level for the productivity dummy when using GDP growth rates for our output growth measure, and by in large, inclusion of the productivity dummy had no effect on the significance levels of the other independent variables. Similarly, none of the national data sets examined displayed significance at the 1% level for the productivity growth rate variable, with the exception of Japan. The nature of the Japanese exception can be traced back to Moosa's explanation for the discrepancies in cross-country Okun's Coefficients, namely the labor market rigidity of the Japanese economy (Moosa, 1997). Yet, such a simple explanation is inadequate due to the fact that the French economy has a more rigid labor market than that of Japan (Berthou, 2008), although we cannot discount any unobservable structural dissimilarities between the economies of Japan and France. The main result of the dynamic estimates using GDP growth rates is that the inclusion of an independent productivity variable, binary or level, does not change the composition of Okun's Law or its stability (or lack thereof). Our next estimate uses the same variables as the above, but with GNI growth rates as the output measure.

$$\Delta U_t = \beta_0 + \beta_1 g_t + \beta_2 g_{t-1} + \beta_3 g_{t-2} + \beta_4 \Delta U_{t-1} + \beta_5 \Delta U_{t-2} + P_d + \epsilon_t$$

$$\Delta U_t = \beta_0 + \beta_1 g_t + \beta_2 g_{t-1} + \beta_3 g_{t-2} + \beta_4 \Delta U_{t-1} + \beta_5 \Delta U_{t-2} + P_t + \epsilon_t$$

The above equations are of the same composition as the immediately preceding estimates, but whereas $\mathrm{G_t}$ represented GDP growth at time t, the variable $\mathrm{g_t}$ represents GNI growth at time t. The results from these regressions in Tables 6-10 exhibit a very different outcome for the inclusion of the productivity dummy, such that $\mathrm{P_d}$ is

[1] All of the regression results are presented at the end of this paper.

statistically significant at the 1% level with a negative coefficient for the economies of Canada, France, and Japan. But, the results for the significance of the level productivity variable, P_t, corresponds exactly to the previous estimate using GDP growth rates. Our interpretation of these results is that, at least for Canada, France, and Japan, above-average productivity growth does have a measurably negative impact on same-period unemployment rates even when controlling for GNI growth rates in the same period, the previous period, and a two-period lag. The discrepancy resulting from the use of different measures for output growth confirms our hypothesis, at least in the dynamic estimate's case, that differing measures of output growth do contribute to the stability of Okun's Law for some national economies. The results of the regressions for the United Kingdom and the United States do not display any significant reaction to either of the additional variables or to the use of GNI as opposed to GDP, reflecting the both the flexibility of their labor markets as noted by Berthou (Berthou, 2008), and the more correlated relationship of GDP and GNI for these two countries in relation to Canada, France, Japan.

ii. Difference Estimates

We now turn to the original formulation of Okun's Law, namely the difference estimate. This formulation is composed of the following equations using GDP growth rates, G, as the output measure:

$$\Delta U = \pi_0 + \pi_1 G + \pi_2 P + \epsilon$$

$$\Delta U = \pi_0 + \pi_1 G + \pi_2 P_d + \pi_3 P_d * G + \epsilon$$

The first equation acts as a control group in that it is just Okun's Law with a level productivity growth variable,P, included in order to discern any possible causality between unemployment and productivity growth, and not conflate any significance of productivity to natural temporal variations in unemployment. The main coefficient of interest is π_4, which measures the interaction effect of GDP growth, G, with a productivity dummy, P_d. In every single estimate (Tables 11-15), this interaction coefficient showed no significance at the 1% level, though the productivity dummy without the interaction showed varying degrees of significance when the interaction term was not included. Our conclusion from this result is that the original formulation of Okun's Law, using GDP growth rates as the output measure, implicitly controls for abnormal productivity growth rates. This conclusion is basically a confirmation of Okun's original work, and leaves us only with one more regression using GNI growth rates, g, to find the root of the recent instability of Okun's Law.

$$\Delta U = \pi_0 + \pi_1 g + \pi_2 P + \epsilon$$

$$\Delta U = \pi_0 + \pi_1 g + \pi_2 P_d + \pi_3 P_d * g + \epsilon$$

As with the dynamic estimate, the above formulation is exactly as the previous difference estimate but with GNI growth rates. The results of this estimation, in terms of the significance of the interaction, are exactly as they were using GDP growth rates. As we can see from the final set of tables, Tables 16-10, no country showed significance at the 1% level in the interaction term. These results are examined more closely in the following section.

V Discussion

The recent instability of Okunss Law has led many to believe that there has been a structural change in the American economy, and that abnormally high levels of productivity growth have had unforeseen consequences for the traditional relation between output growth and unemployment. The empirical research conducted for this paper signifies that any deviation from the established correspondence between GDP and unemployment is not a product of high productivity rates. The lack of a recovery in the labor market during a robust recovery in output has caused much confusion, and the specter of prolonged slack in the labor market has caused many to reevaluate the merits of countercyclical fiscal measures. Clearly, a deep systematic evolution in the macro-economy cannot be adequately countered with any type of fiscal measure, but the political ramifications of mass unemployment also seems to be untenable. In this paper, we examined the efficacy of an established empirical regularity in order to investigate the causes of its recent volatility. Our results simply eliminated one possible cause, we have not reached a satisfactory conclusion. The cause of recent, unusual macroeconomic fluctuations is likely a byproduct of the evolution of modern, advanced economies. Robert Gordon has postulated that Okun's Law has been "turned on its head" since 1986, and that productivity has ceased to be procyclical (Gordon, 2010). Such a conclusion leaves us to wonder about the future of the business cycle, the ramifications of prolonged unemployment, and the future composition of the macro-economy as a whole.

VI Endnotes

A main concern of the author has been the lack of quarterly data for the estimations in this paper. A great deal of the variations in the variables are lost by using annual data, and has therefore limited the extent to which we can observe the stability or instability of Okun's Law. Any further research should utilize quarterly data in order to more fully explore the composition and variation of Okunss Law, and in order to not fall prey to the same limitations as the author.[2]

[2]The following tables use STATA variable names instead of the notation previously presented. All of the variables are easily identifiable, but note that *pProduct* is our dummy variable for productivity growth and *dProduct* is the level productivity growth rate term.

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Table 1

Canada

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
GDPg	-0.391***	-0.428***	-0.495***
	(0.073)	(0.081)	(0.091)
L.GDPg	0.296**	0.267**	0.196*
	(0.119)	(0.120)	(0.104)
L2.GDPg	0.000	0.070	0.178
	(0.094)	(0.115)	(0.112)
L.gUnemp	0.950***	0.828***	0.593***
	(0.161)	(0.179)	(0.167)
L2.gUnemp	-0.238	-0.105	0.091
	(0.160)	(0.197)	(0.191)
pProduct		0.264	
		(0.222)	
dProduct			0.155**
			(0.075)
Constant	0.247	0.114	0.023
	(0.208)	(0.264)	(0.245)
Observations	34	34	34
R-squared	0.838	0.835	0.831

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2

France

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
GDPg	-0.221***	-0.202***	-0.198***
	(0.055)	(0.055)	(0.046)
L.GDPg	0.000	0.008	-0.000
	(0.074)	(0.074)	(0.072)
L2.GDPg	0.164**	0.125	0.133
	(0.072)	(0.105)	(0.094)
L.gUnemp	0.805***	0.838***	0.841***
	(0.196)	(0.205)	(0.204)
L2.gUnemp	0.012	-0.064	-0.084
	(0.204)	(0.231)	(0.234)
pProduct		-0.123	
		(0.192)	
dProduct			-0.047
			(0.067)
Constant	0.102	0.205	0.254
	(0.211)	(0.307)	(0.376)
Observations	34	34	34
R-squared	0.735	0.743	0.746

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3

Japan

	(1)	(2)	(3)
VARIABLES	Dynamic Estimate	Dynamic Estimate (Productivity Dummy)	Dynamic Estimate (Productivity)
GDPg	-0.093***	-0.079***	-0.063**
	(0.024)	(0.023)	(0.028)
L.GDPg	0.016	0.015	-0.009
	(0.027)	(0.025)	(0.027)
L2.GDPg	0.066***	0.049***	0.047***
	(0.012)	(0.009)	(0.009)
L.gUnemp	0.740***	0.664***	0.608***
	(0.168)	(0.153)	(0.150)
L2.gUnemp	0.086	0.101	0.078
	(0.140)	(0.135)	(0.124)
pProduct		-0.158**	
		(0.058)	
dProduct			-0.041***
			(0.015)
Constant	0.029	0.114**	0.187***
	(0.057)	(0.050)	(0.060)
Observations	34	34	34
R-squared	0.744	0.812	0.823

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4

U.K.

	(1)	(2)	(3)
VARIABLES	Dynamic Estimate	Dynamic Estimate (Productivity Dummy)	Dynamic Estimate (Productivity)
GDPg	-0.325***	-0.316***	-0.335***
	(0.040)	(0.045)	(0.045)
L.GDPg	-0.206***	-0.168***	-0.175***
	(0.047)	(0.054)	(0.050)
L2.GDPg	-0.100**	-0.049	-0.043
	(0.046)	(0.055)	(0.052)
L.gUnemp	-0.039	0.146	0.096
	(0.167)	(0.188)	(0.171)
L2.gUnemp	0.081	0.100	0.156
	(0.135)	(0.137)	(0.123)
pProduct		0.114	
		(0.170)	
dProduct			0.063*
			(0.031)
Constant	1.488***	1.199***	1.153***
	(0.241)	(0.217)	(0.218)
Observations	35	35	35
R-squared	0.751	0.817	0.824

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5

U.S.A.

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
GDPg	-0.403***	-0.389***	-0.398***
	(0.033)	(0.033)	(0.032)
L.GDPg	-0.111	-0.279***	-0.113
	(0.082)	(0.093)	(0.088)
L2.GDPg	0.181**	0.097	0.184**
	(0.084)	(0.077)	(0.084)
L.gUnemp	0.078	-0.292*	0.089
	(0.142)	(0.166)	(0.149)
L2.gUnemp	0.241	0.138	0.246
	(0.161)	(0.143)	(0.160)
pProduct		-0.211	
		(0.167)	
dProduct			-0.021
			(0.026)
Constant	0.987***	1.771***	1.024***
	(0.299)	(0.425)	(0.321)
Observations	34	34	34
R-squared	0.872	0.873	0.876

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6

Canada

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
gGNI	-0.066**	-0.076***	-0.071***
	(0.025)	(0.022)	(0.022)
L.gGNI	0.068**	0.073**	0.073***
	(0.025)	(0.026)	(0.026)
L2.gGNI	0.007	0.005	0.001
	(0.015)	(0.016)	(0.016)
L.gUnemp	0.752***	0.870***	0.835***
	(0.077)	(0.086)	(0.090)
L2.gUnemp	-0.439***	-0.409***	-0.354***
	(0.103)	(0.084)	(0.094)
pProduct		-0.647***	
		(0.230)	
dProduct			-0.147**
			(0.063)
Constant	-0.104	0.227	0.212
	(0.161)	(0.169)	(0.194)
Observations	34	34	34
R-squared	0.634	0.763	0.716

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7

France

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
gGNI	-0.003	-0.007	-0.010
	(0.010)	(0.008)	(0.008)
L.gGNI	0.008	0.002	0.003
	(0.008)	(0.008)	(0.008)
L2.gGNI	-0.003	-0.004	-0.006
	(0.008)	(0.007)	(0.007)
L.gUnemp	0.911***	1.046***	1.094***
	(0.138)	(0.143)	(0.135)
L2.gUnemp	-0.332*	-0.429**	-0.552***
	(0.188)	(0.181)	(0.159)
pProduct		-0.511***	
		(0.147)	
dProduct			-0.180**
			(0.068)
Constant	0.036	0.366**	0.601**
	(0.141)	(0.138)	(0.233)
Observations	34	34	34
R-squared	0.523	0.704	0.702

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8

Japan

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
gGNI	0.002	-0.002	-0.000
	(0.002)	(0.003)	(0.003)
L.gGNI	-0.003	-0.004**	-0.003
	(0.003)	(0.002)	(0.002)
L2.gGNI	-0.005	-0.000	-0.002
	(0.004)	(0.003)	(0.004)
L.gUnemp	-0.197	0.483***	0.583***
	(0.155)	(0.148)	(0.146)
L2.gUnemp	-0.335**	0.006	-0.084
	(0.127)	(0.152)	(0.132)
pProduct		-0.308***	
		(0.080)	
dProduct			-0.070***
			(0.016)
Constant	0.128	0.226***	0.275***
	(0.183)	(0.080)	(0.080)
Observations	34	34	34
R-squared	0.239	0.591	0.661

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9

U.K.

VARIABLES	(1) Dynamic Estimate	(2) Dynamic Estimate (Productivity Dummy)	(3) Dynamic Estimate (Productivity)
gGNI	-0.017	-0.018	-0.017
	(0.011)	(0.010)	(0.011)
L.gGNI	0.020	0.025*	0.024
	(0.015)	(0.014)	(0.015)
L2.gGNI	-0.010	-0.010	-0.009
	(0.016)	(0.017)	(0.017)
L.gUnemp	0.483**	0.678***	0.709***
	(0.184)	(0.177)	(0.196)
L2.gUnemp	-0.303	-0.333	-0.336
	(0.180)	(0.217)	(0.228)
pProduct		-0.363	
		(0.274)	
dProduct			-0.088
			(0.063)
Constant	0.122	0.234	0.242
	(0.276)	(0.273)	(0.240)
Observations	35	34	34
R-squared	0.335	0.436	0.447

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10

U.S.A.

	(1)	(2)	(3)
VARIABLES	Dynamic Estimate	Dynamic Estimate (Productivity Dummy)	Dynamic Estimate (Productivity)
gGNI	-0.270***	-0.264***	-0.270***
	(0.049)	(0.050)	(0.049)
L.gGNI	0.290***	0.268***	0.297***
	(0.069)	(0.076)	(0.071)
L2.gGNI	-0.009	-0.006	-0.006
	(0.090)	(0.092)	(0.090)
L.gUnemp	0.810***	0.790***	0.807***
	(0.218)	(0.227)	(0.220)
L2.gUnemp	-0.349**	-0.347**	-0.348**
	(0.165)	(0.166)	(0.167)
pProduct		-0.145	
		(0.203)	
dProduct			0.018
			(0.040)
Constant	-0.122	0.028	-0.238
	(0.232)	(0.314)	(0.344)
Observations	34	34	34
R-squared	0.716	0.719	0.717

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11

Canada

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
GDPg	-0.343***	-0.378***	-0.447***	-0.390***
	(0.051)	(0.056)	(0.066)	(0.059)
pProduct		0.328	-0.410	
		(0.228)	(0.461)	
GDPg_pProduct			0.212*	
			(0.116)	
dProduct				0.085
				(0.057)
Constant	1.024***	0.989***	1.146***	1.015***
	(0.188)	(0.186)	(0.200)	(0.185)
Observations	37	37	37	37
R-squared	0.562	0.587	0.625	0.589

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12

France

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
GDPg	-0.196***	-0.185***	-0.120	-0.184***
	(0.066)	(0.067)	(0.077)	(0.067)
pProduct		-0.214	0.339	
		(0.181)	(0.395)	
GDPg_pProduct			-0.227	
			(0.145)	
dProduct				-0.063
				(0.061)
Constant	0.585***	0.656***	0.518**	0.701***
	(0.179)	(0.187)	(0.204)	(0.211)
Observations	37	37	37	37
R-squared	0.201	0.232	0.285	0.225

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13

Japan

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
GDPg	-0.052***	-0.033*	-0.044*	-0.040**
	(0.017)	(0.017)	(0.025)	(0.016)
pProduct		-0.226***	-0.286**	
		(0.080)	(0.126)	
GDPg_pProduct			0.021	
			(0.034)	
dProduct				-0.055***
				(0.018)
Constant	0.218***	0.270***	0.292***	0.328***
	(0.062)	(0.060)	(0.070)	(0.067)
Observations	37	37	37	37
R-squared	0.209	0.359	0.367	0.381

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14

U.K.

VARIABLES	(1) Difference Estimate	(2) Difference (Productivity Dummy)	(3) Difference (Productivity Interaction)	(4) Difference
GDPg	-0.309*** (0.057)	-0.315*** (0.059)	-0.296*** (0.079)	-0.326*** (0.059)
pProduct		0.112 (0.230)	0.219 (0.374)	
GDPg_pProduct			-0.044 (0.120)	
dProduct				0.069 (0.062)
Constant	0.770*** (0.174)	0.731*** (0.194)	0.693*** (0.221)	0.651*** (0.204)
Observations	37	37	37	37
R-squared	0.458	0.462	0.464	0.477

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15

U.S.A.

VARIABLES	(1) Difference Estimate	(2) Difference (Productivity Dummy)	(3) Difference (Productivity Interaction)	(4) Difference
GDPg	-0.406*** (0.039)	-0.404*** (0.041)	-0.408*** (0.043)	-0.408*** (0.040)
pProduct		-0.064 (0.167)	-0.275 (0.555)	
GDPg_pProduct			0.062 (0.155)	
dProduct				0.009 (0.036)
Constant	1.222*** (0.142)	1.236*** (0.149)	1.249*** (0.154)	1.203*** (0.162)
Observations	37	37	37	37
R-squared	0.752	0.753	0.754	0.752

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16

Canada

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
gGNI	-0.038	-0.041*	-0.070**	-0.040*
	(0.023)	(0.022)	(0.031)	(0.022)
pProduct		-0.410	-0.851*	
		(0.302)	(0.450)	
gGNI_pProduct			0.058	
			(0.044)	
dProduct				-0.118
				(0.070)
Constant	0.265	0.471*	0.709**	0.488*
	(0.230)	(0.273)	(0.326)	(0.260)
Observations	37	37	37	37
R-squared	0.073	0.121	0.165	0.144

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 17

France

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
gGNI	-0.002	-0.006	-0.016	-0.008
	(0.008)	(0.009)	(0.010)	(0.009)
pProduct		-0.338	-0.571**	
		(0.208)	(0.235)	
gGNI_pProduct			0.036*	
			(0.019)	
dProduct				-0.122
				(0.073)
Constant	0.141	0.336*	0.452**	0.477**
	(0.123)	(0.170)	(0.175)	(0.234)
Observations	37	37	37	37
R-squared	0.001	0.073	0.165	0.077

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 18

Japan

	(1)	(2)	(3)	(4)
VARIABLES	Difference Estimate	Difference (Productivity Dummy)	Difference (Productivity Interaction)	Difference
gGNI	-0.000	-0.002	-0.002	-0.001
	(0.003)	(0.003)	(0.004)	(0.003)
pProduct		-0.294***	-0.291***	
		(0.078)	(0.096)	
gGNI_pProduct			-0.000	
			(0.006)	
dProduct				-0.067***
				(0.019)
Constant	0.077	0.226***	0.224***	0.261***
	(0.055)	(0.061)	(0.068)	(0.071)
Observations	37	37	37	37
R-squared	0.000	0.295	0.295	0.268

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19

U.K.

VARIABLES	(1) Difference (Productivity Dummy)	(2) Difference (Productivity Interaction)	(3) Difference
gGNI	-0.026*	-0.013	-0.025*
	(0.014)	(0.018)	(0.014)
pProduct	-0.254	0.020	
	(0.296)	(0.381)	
gGNI_pProduct		-0.033	
		(0.029)	
dProduct			-0.043
			(0.080)
Constant	0.393	0.260	0.359
	(0.253)	(0.279)	(0.280)
Observations	37	37	37
R-squared	0.096	0.130	0.084

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 20

U.S.A.

VARIABLES	(1) Difference Estimate	(2) Difference (Productivity Dummy)	(3) Difference (Productivity Interaction)	(4) Difference
gGNI	-0.120**	-0.155***	-0.142**	-0.152***
	(0.050)	(0.050)	(0.053)	(0.053)
pProduct		-0.653**	0.371	
		(0.304)	(1.186)	
gGNI_pProduct			-0.168	
			(0.189)	
dProduct				-0.112
				(0.068)
Constant	0.862**	1.342***	1.239***	1.374***
	(0.388)	(0.432)	(0.448)	(0.490)
Observations	37	37	37	37
R-squared	0.141	0.244	0.262	0.205

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1