A New Framework for Output-Unemployment Relationship: Okun's Law Revisited

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Abstract

This paper provides a new and useful framework for developing various models to investigate the output-unemployment relationship. By using this framework, a simple but reasonable theoretical background to Okun's law is derived. This theoretical background, in turn, facilitates the decomposition of Okun's law coefficient into several quantifiable and interpretable components that incorporate main insights from Arthur Okun's original analysis. The empirical decomposition exercise indicates that Okun's law has an inherent tendency to vary substantially over time, especially, in response to the structural changes in legal, institutional and other related characteristics of labor and goods markets.

Keywords: output-unemployment relationship; Okun's law

JEL classification: E24, E32, C2

1. Introduction

Okun's law is generally considered as one of the cornerstones of macroeconomics. This is mainly attributed to its practical use, as a short-cut for the relationship between the change in unemployment and output growth, both in policy decisions and evaluations (see, for example, Krugman (2009) for the evaluation of the president Obama's stimulus package in the United States). Additionally, it is often treated as one of the crucial components of macroeconomic models that link output and labor markets (see, e.g., Blinder, 1997).[1]

Nevertheless, despite its popularity Okun's law has been criticized heavily on several grounds. The major criticism is that Okun's law is purely an empirical regularity, which lacks a theoretical framework. Even though a number of studies have attempted to provide theoretical foundations for Okun's law (Gordon, 1973, 1984; Prachowny, 1993),[2] so far there is no consensus that the existing studies fully capture the nature of Okun's law. To put it differently, these studies lack a clear analytical framework with an explicit account of the transmission channels suggested by Arthur Okun. Therefore, there is still need for an appropriate theoretical framework that incorporates main insights from Arthur Okun's original analysis (Okun, 1962).

The second criticism is related to the reliability of Okun's law. A number of empirical studies have shed doubt on the stability of Okun's relationship in many industrialized countries including the United States (e.g., Altig, Fitzgerald, and Rupert, 1997; Kaufman, 1988; Lee, 2000; Moosa, 1997; Sögner and Stiassny, 2002).[3] Furthermore, several studies

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[1] Furthermore, Okun's law also provides an alternative way to estimate and forecast potential output (see, e.g., US Congressional Budget Office, 2004).

[2] Gordon (1984), for instance, provided an analytical framework to Okun's law based on output identity. Prachowny (1993), on the other hand, has shown that Okun's relationship can be considered as a special case of a production function model. These two studies are widely acknowledged by other researchers; however, there are also other studies which attempt to provide some analytical framework to Okun's law (e.g., Sheehan and Zahn, 1980; Hamada and Kurosaka, 1984; Mairesse, 1984; Knoester, 1986; Sögner and Stiassny, 2002).

[3] A number of more recent studies argued that Okun's law collapsed in the United States during the recent economic recovery from the latest financial crisis (e.g., Ball and Koenig, 2009). Gordon (2010, p. 13) went further and stated that "Okun's Law is obsolete for the 1986-2009 interval … since there is no longer any procyclical responsiveness of output per hour". In contrast, by pointing to the international evidence on the

pointed to the role of institutional and related features of the labor market (e.g. employment practices of firms) and the goods market (e.g. the role of foreign competition) as potential reasons for the variation in Okun's coefficient across time and country[4] (see, for example, Kaufman (1988) and Lee (2000) for a review).

Another related issue to the above criticisms is that Okun's law is often treated as a *behavioral* rather than a *reduced-form* relation and this, in turn, leads to misinterpretation of the law. To put it differently, while Arthur Okun interpreted his relationship on a *mutatis mutandis* basis (Okun, 1962), many researchers and several textbooks have preferred to interpret it –albeit wrongly– on a *ceteris paribus* basis (Prachowny, 1993).[5] More specifically, Arthur Okun clearly stated that his relationship contains not only the direct effect of output growth on unemployment but it also incorporates the induced changes in the supply-side variables; namely, labor force, productivity and hours worked per worker. In other words, Arthur Okun was referring to a *reduced-form* relation –that contains both the direct and indirect effects– in his seminal study. All this raises the possibility that Okun's relation is highly sensitive to the structural changes in the economy –such as those in labor and goods markets. Therefore, significant changes in the structural relations representing the induced effects may possibly lead to a substantial variation in Okun's relation over time. Considering this point and the previously mentioned two criticisms lead us to the conclusion that there is a need for a more general framework which can incorporate the role of both demand-side and supply-side factors on unemployment.

The purpose of this paper is to address these two criticisms[6] by providing a new framework that will allow us to derive various models to explore the relationship between

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banking crises, Knotek and Terry (2009) argued that factors related to such crises (e.g. unusually high uncertainty and credit-constraints faced by firms and households) may lead to a large and persistent increase in unemployment, which can exceed the prediction based on the plain form of Okun's law.

[4] Knoester (1986), Paldam (1987) and Kaufman (1988) provided the early evidence on cross-country differences in the Okun's coefficient.

[5] However, it must be noted that there are several textbooks which carefully explain the insights of Arthur Okun. See, for example, Blanchard (2006).

[6] There are also other problems and associated criticisms, particularly, regarding the issues related to the estimation of coefficients in Okun's law (e.g., Moosa, 1997). Furthermore, most of the recent research has drawn attention to the possibility of non-linearity and asymmetry in Okun's law (see, e.g., Silvapulle,

output growth and unemployment. This framework, in turn, enables us to provide a reasonable theoretical background to Okun's law and hence allows us to shed light on its instability.

This work differs from the existing studies in several ways. A novel feature of this paper is that it presents a new and useful framework for developing various models to explore the output-unemployment relation. In other words, Okun's law and its variants are merely a few possibilities among the pool of possible models. Another distinguishing feature is that, unlike the existing studies, this work provides a theoretical framework to the original difference version of the Okun's law and to its recent popular gap version, by tracing the transmission channels suggested by Arthur Okun.

The rest of the paper is organized as follows. Section 2 aims at providing the derivation of the new framework for the output-unemployment relationship by integrating the unemployment and output identities with a suitable macroeconomic equilibrium condition. Section 3, in turn, utilizes this framework to provide a reasonable theoretical background to the difference version of Okun's law. This section also investigates the sources of possible instability by decomposing the Okun's law coefficient for the sample of six countries[7] over the period 1960-2005. Finally, Section 4 concludes the paper.

2. A New Framework

In order to develop a new framework for the output-unemployment relation, this study initially utilizes the definition of unemployment rate (U): $U_t \equiv 1 - L_t/F_t$, where L is the number of people employed, F is the number of people in labor force and t represents time. A change in unemployment rate can be obtained by taking the first difference of this identity,

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Moosa, and Silvapulle (2004) for a review). Nevertheless, these issues are not taken up in this work since they are beyond the scope of this paper.

[7] The sample includes all the members of the G-7 except Germany; namely, the United States, Canada, the United Kingdom, France, Italy and Japan. It should be noted that Germany is excluded due to the data related problems arising from the unification of West and East Germany in 1990. This study also uses annual rather than quarterly data mainly because of the data unavailability and/or consistency problems associated with the quarterly data, especially for the 1960s.

$$\Delta U_t \equiv \frac{L_{t-1}}{F_{t-1}} - \frac{L_t}{F_t}\,, \tag{1}$$

where Δ is the difference operator.

Substituting the relations $L_t = (1+gL_t)L_{t-1}$ and $F_t = (1+gF_t)F_{t-1}$, where gX_t represents the proportionate change in variable X in time t, into Eq. (1) and rearranging terms yield the following

$$\Delta U_t \equiv N_{t-1}(1 - \frac{1+gL_t}{1+gF_t})\,, \tag{2}$$

where N is the employment rate ($N_t=L_t/F_t$).

The below equation can be obtained by approximating $[1-(1+gL_t)/(1+gF_t)]$ with $[\Delta f_t-\Delta l_t]$

$$\Delta U_t = N_{t-1}(\Delta f_t - \Delta l_t)\,, \tag{3}$$

where the lower case letters represent logarithms, e.g. $x = \ln(X)$, and Δx is the growth rate of X.

The relation contained in Eq. (3) is non-linear. However, it can be approximated with the following linear equation,

$$\Delta U_t = \varphi\ (\Delta f_t - \Delta l_t)\,, \tag{4}$$

where φ is assumed to be equal to the average value of the employment rate over the time period under consideration.[8]

[8] This assumption seems to be plausible since the employment rate *usually* moves in the vicinity of its expected value over time. Nevertheless, in order to provide an approximation for a change in unemployment rate, several researchers utilized the logarithmic transformation of the unemployment identity in their analyses, i.e. $\Delta U=\Delta f-\Delta l$. Sögner and Stiassny (2002), for example, utilized this approximation to relate the

Now, let's consider the following equation which provides the equilibrium condition in the goods market,

$$Y_t^d = Y_t^s , \quad (5)$$

where Y^d and Y^s represent the demand for and supply of aggregate output, respectively.

Eq. (5) can be rewritten in growth-form as follows

$$\Delta y_t^d = \Delta y_t^s . \quad (6)$$

The following equation decomposes output growth (Δy^s) into the growth rates of labor productivity (Δp), labor force (Δf), average hours worked per worker (Δh), and the employment rate (Δn).[9]

$$\Delta y_t^s = \Delta y_t^n + \Delta n_t , \quad (7)$$

where Δy^n represents the natural rate of growth, i.e. $\Delta y^n = \Delta p + \Delta f + \Delta h$.

Substituting Eq. (7) into (6) and rearranging terms yield

$$\Delta n_t = \Delta y_t^d - \Delta y_t^n . \quad (8)$$

By combining Eqs. (4) and (8), as well as utilizing the relation $\Delta n = \Delta l - \Delta f$, one obtains a useful equation that links labor and output markets:

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instability in Okun's law coefficient to the structural changes in labor supply and demand. Appendix A provides both visual and formal evidence confirming the superiority of a linear approximation in equation (4) against the logarithmic transformation.

[9] Eq. (7) is derived by taking the log-difference of the following identity: $Y^s \equiv P.F.H.N$, where P is labor productivity; $P = Y^s/(L.H)$, H is average hours worked per worker, and other variables are as defined earlier.

$$\Delta U_t = -\varphi(\Delta y_t^{\ d} - \Delta y_t^{\ n}) . \tag{9}$$

It is obvious from Eq. (9) that the change in unemployment rate is proportional to the difference between the growth rate of output demand and the natural rate of growth. This equation also implies that the unemployment rate decreases when output demand rises faster than the natural rate of growth and *vice versa*. Thus, the above equation provides a valid framework for the analysis of output-unemployment relation in the short-run. Eq. (9) is also consistent with the notion of medium-run (see, Blanchard, 2006). That is, output demand tends to grow at the natural rate of output over the medium-run and, as a result, the unemployment rate does not change [Putting $\Delta y^d = \Delta y^n$ in Eq. (9) implies that $\Delta U = 0$].

Eq. (9) can also be utilized to analyze the sources of the change in unemployment rate and, therefore, it can be rewritten as follows:

$$\Delta U_t = -\varphi \Delta y_t^{\ d} + \varphi \Delta p_t + \varphi \Delta h_t + \varphi \Delta f_t . \tag{10}$$

Ceteris paribus, an increase in growth rate of output demand leads to a fall in the unemployment rate. In contrast, *other things kept constant*, a rise in any one of the supply-side factors (P, H and F) has opposite effects on the unemployment rate. However, there is a serious problem with the clause “ceteris paribus” or “other things kept constant” since these supply-side variables are sensitive to the state of the business cycle. In other words, labor productivity, hours worked per worker and labor force change *pari pasu* with the change in output demand. Table 1 provides the correlation of the change in output demand (Δy^d) with rates of growth of labor productivity (Δp), average hours worked (Δh) and labor force (Δf) for the six countries. As is clear from the correlation coefficients in Table 1, the supply-side variables tend to have pro-cyclical relationships with output demand. Especially, there is a statistically significant positive association between the growth rates of labor productivity and output demand for all the six countries in the sample.

<Table 1>

Even though the above correlation analysis provides us with useful information on the strength of linear association between the demand-side and supply-side variables, it does not present any information about the structural or causal relations between those variables. However, considering the fact that Eqs. (9) and (10) are derived from the identities and the macroeconomic equilibrium condition, these equations could be used as a framework to link output and labor markets. In other words, by formulating various assumptions about the behavior of both the demand-side and supply-side variables in Eq. (10) one can develop different models to explain the output-unemployment relation. The following section aims to develop such a model, which can provide a reasonable theoretical background to the difference version of Okun's law.[10]

3. Okun's Law: The Difference Version

3.1. Theoretical Framework

The following specification –which is Okun's first specification (Okun, 1962, p. 99)– is frequently used to estimate Okun's relation,

$$\Delta U_t = \alpha_0 + \alpha_1 \Delta y_t^{\ d}, \qquad (11)$$

where ΔU is the change in unemployment rate, Δy^d is the growth rate of real GDP, and α_1 represents the Okun's law coefficient (OLC).[11]

Eq. (11) implies that the change in unemployment rate is solely determined by the growth rate of output demand. However, as mentioned before, Okun himself carefully explained the role of the induced effects of labor productivity, average hours worked and labor force on the output-unemployment relation and he emphasized that Okun's law coefficient

[10] Appendix C extends the analysis by considering the gap version of Okun's law.

[11] The main problem with the Okun's law is the lack of a common specification. In some specifications (e.g., Lee, 2000), the change in unemployment rate appears as an explanatory variable and the growth rate of output is treated as a dependent variable. Accordingly, the respective slope term is interpreted as OLC. However, it should be noted that the lack of a common specification is mainly related to the different uses and interpretations of Okun's law (see, e.g., Hagemann and Seiter, 1999).

contains the combined effect of all variables (Okun, 1962). More specifically, Okun's analysis suggests that the supply-side factors –F, P and H– vary endogenously with the level of output demand and hence with the state of business cycle. According to George L. Perry, "the beauty of the [Okun's] Law is its recognition of these endogenous things" (Perry, 2000, p. 21). Additionally, it should be also noted that Okun's law was formulated in the heydays of Keynesian economics; therefore, the focus of this relationship is on Keynesian unemployment (Knoester, 1986). As a result, while examining Okun's law, one should also keep in mind the *traditional* Keynesian assumption that output supply is primarily driven by output demand in the short-run. This seems to be the basic idea and hence the implicit assumption behind Okun's emphasis on the indirect or induced effects.

Arthur Okun asserted several reasons as to why F, P and H would have pro-cyclical relationships with the movement of output (Okun, 1962, pp. 102-104).[12] In other words, he suggested a number of transmission channels through which a change in output demand influences the productivity, hours worked, and labor force over the business cycle. For instance, as output demand decreases (increases), labor productivity may decline (rise) due to labor hoarding.[13] To put it differently, during downturns, firms tend to adjust employment less relative to the change in output in order to abstain from the firing costs (e.g. severance payments) as well as hiring costs (e.g. recruitment and training) when the state of business cycle begins to change. Arthur Okun also points to other factors –such as technological, legal and moral factors– as possible causes of labor hoarding and hence a decline in productivity during recessions (Okun, 1962, pp. 103-104).[14] Similarly, average hours of work may decrease as a result of a fall in demand for output and *vice versa*. In part, this is also related to labor hoarding but it may also include other factors like the change in part-time work. Moreover, during recessions (expansions)

[12] Also see Gordon (1973, pp. 137-8).

[13] The notion of the pro-cyclical behavior of productivity was also noted by Hultgren (1960) and Oi (1962), who formally argued that this pro-cyclicality can be due to the *quasi-fixed* nature of labor.

[14] According to Arthur Okun, another possible reason for the pro-cyclical change in labor productivity is sectoral shifts in employment and output (Okun, 1962, p. 104). Furthermore, Fay and Medoff (1985, p. 653) found that "[n]ot all of the labor in excess of regular production requirements should be classified as hoarded, since some of it was performing worthwhile other work. … [Therefore] the form, as well as the total amount, of hoarding is important, since not all forms of hoarding provide a reserve of redundant labor for the subsequent recovery."

some unemployed people may stop (start) looking for jobs and this leads to a fall (rise) in the level of labor force –which is known as the discouraged (encouraged) worker effect. However, Arthur Okun also noted that there might be an opposite –additional worker– effect of a recession on labor force: "the loss of a job by the breadwinner of a family might increase the labor force by leading his wife and teen-age children to seek work" (Okun, 1962, p. 102). Thus, the net effect of a recession on labor force depends on the strength of the two opposite effects. Nevertheless, by pointing to the evidence available to that date, Arthur Okun seems to be convinced that the former effect is stronger than the latter.

Arthur Okun's main objective was empirical, so he never attempted to provide formal representations of the above transmission channels. These channels, however, can be formulated in terms of behavioral relationships as follows[15]

$$\Delta p_t = \gamma_1 + \delta_1 \Delta y_t^{\ d}, \qquad (12)$$

$$\Delta h_t = \gamma_2 + \delta_2 \Delta y_t^{\ d}, \qquad (13)$$

$$\Delta f_t = \gamma_3 + \delta_3 \Delta y_t^{\ d}, \qquad (14)$$

where δ_1, δ_2, δ_3 represent the effect of a one percentage point change in output growth on Δp, Δh, Δf, respectively; γ_1, γ_2, γ_3 represent the growth rate of P, H and F, respectively, independent of the growth rate of output demand.

For the sake of convenience, Eqs. (12)-(14) can be contained in a single equation as follows

$$\Delta y_t^{\ n} = \gamma + \delta \ \Delta y_t^{\ d}, \qquad (15)$$

where $\gamma = \gamma_1 + \gamma_2 + \gamma_3$ and $\delta = \delta_1 + \delta_2 + \delta_3$. It should be noted that γ represents the growth rate of natural output which is independent of the growth rate of output demand and δ represents the responsiveness of Δy^n to Δy^d.

[15] However, it must be noted that Okun himself attempted to estimate an equation corresponding to the structural relation as in Eq. (13) (Okun, 1962, p. 103).

It is worth emphasizing that the above structural equations reflect the traditional Keynesian view that variations in output supply are primarily driven by exogenous changes in aggregate demand in the short-run.[16] In other words, Δy^d is treated as exogenous in this setup.

The simple model developed so far –for the difference version of Okun's law– contains two equations; namely, Eqs. (9) and (15).[17] While Eq. (9) is a relation that links labor and output markets, Eq. (15) is a behavioral relationship which represents the above mentioned transmission channels through which a change in output demand influences the supply-side variables and hence the output supply. Therefore, combining Eq. (9) with (15) yields the reduced-form equation for the Okun's law relation as follows

$$\Delta U_t = \varphi\gamma + (-\varphi + \varphi\delta)\Delta y_t^{\ d}, \qquad (16)$$

where $-\varphi+\varphi\delta$ is the reduced-form of OLC and $\varphi\gamma$ corresponds to the intercept term in Eq. (11).

As is clear from the above equation, OLC contains a number of structural parameters which represent the previously mentioned features of macroeconomic adjustment process over the business cycle. More specifically, it is obvious from Eq. (16) that Okun's coefficient does not only represent the direct –employment creation– effect ($-\varphi$) of the growth rate of output on unemployment but also contains the indirect effect ($\varphi\delta$) of Δy^d on ΔU. While the former effect is favorable –reduces unemployment– the latter is unfavorable. Clearly, the magnitude of OLC depends on the relative sizes of the two opposing effects; namely, the direct and the indirect effects. The size of the indirect effect is, in turn, determined by the magnitudes of the three effects: the productivity effect ($\varphi\delta_1$), hours worked effect ($\varphi\delta_2$) and labor force effect ($\varphi\delta_3$).[18]

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[16] However, Blanchard and Quah (1989) noted that the response of unemployment to the output growth substantially differs depending on whether a disturbance is from a demand-side or supply-side.

[17] Alternatively, this model is represented by Eq. (10) and Eqs. (12)-(14).

[18] Thus, this decomposition analysis *formally* confirms that the Okun's relationship represents the combined effect of a number of variables and, as a result, it should be interpreted on a *mutatis mutandis* basis.

Considering the simple structure of the model (e.g. Δy^d is treated as exogenous), the structural parameters –δ_1, δ_2 and δ_3– can be estimated by applying ordinary least squares (OLS) to the stochastic versions of the structural relations. Given that φ is equal to the average value of employment rate, then OLC can be easily decomposed into the direct effect and the indirect effect.

To sum up, it is clear from the above analysis that OLC can be decomposed into several quantifiable and interpretable components. To the extent that these components or effects vary across countries and over time, this analytical framework may help to investigate the sources of cross-section variation and possible intertemporal instability through decomposing the Okun's law coefficient. The following sub-section, therefore, provides an empirical application which illustrates the usefulness of this approach.

3.2. A Decomposition Exercise

This sub-section presents an empirical application of the above decomposition of OLC for the sample of six countries over the period 1961-2005. Table 2 shows the estimates of the OLC and its decomposition for both the overall period and the two sub-periods (Pre-1980 vs. Post-1980).[19] The first column in Table 2 presents the OLS estimates of OLC (α_1) as contained in Eq. (11).[20] The second column provides the values for OLC derived from the decomposition exercise (denoted as α_1') as the net effect of direct and indirect effects. Comparing the estimates in each of the two columns indicates that the estimated and the derived OLC (α_1 and α_1', respectively) are identical for overall period in all countries but only slightly different in some sub-samples in the three countries (the United States, Canada and the United Kingdom) probably due to the small sample size. This comparison, in fact, confirms the validity of the above decomposition framework.

[19] To shed some light on the instability of OLC, this decomposition exercise is also performed for the two sub-periods. For the sake of cross-country comparison, 1980 is chosen as the uniform "break" point for all countries. Nevertheless, it must also be noted that the qualitative nature of the results in this section also holds for different sub-periods (e.g. Pre-1973 vs. Post-1973).

[20] It should be noted that these estimates are not directly comparable with the estimates of the previous empirical studies mainly because of the differences in model specification (i.e. the lack of a common specification for the Okun's law) and the sample period. However, the qualitative nature of empirical results is broadly in line with previous studies.

<Table 2>

A number of remarkable results emerge from this empirical exercise. First, Okun's law coefficient varies substantially across countries over the whole sample period. This result is in line with the literature suggesting that the response of unemployment to output growth is low (high) in those countries having high (low) job security provisions (e.g., Bertola, 1990; Di Tella and MacCulloch, 2005).[21] For instance, the lowest response of unemployment to output growth is found for Japan (-0.03), which is mainly due to the strong commitment of Japanese firms to job security. In contrast, US firms have weak commitment to job security as a consequence of the less restrictive nature of the legal, social and institutional features of the US labor market on hiring and firing. Thus, Okun's coefficient is the highest in absolute value for the United States (-0.40) over the period 1961-2005. Canadian and the UK's labor markets are similar to that of the US and, therefore, they also have larger OLC in absolute value. Similarly, the values of Okun's coefficient for the other European countries –Italy and France– are in between the values for Japan and the United States since these European countries have more restrictions on hiring and firing compared to the United States. However, Italy has relatively more restrictions and therefore has a lower OLC in absolute value among the three European countries.

As is evident from Table 2, cross-country variations in the Okun's coefficient are mainly due to the differences in the *indirect* effect. To shed more light on these results, the third and fourth columns in Table 2 present the decomposition of OLC for the six countries. As can be seen from these two columns while the magnitudes of the direct effect ($-\varphi$) are similar among the six countries, the magnitudes of the indirect effect ($\varphi\delta$) differ substantially between these countries. In fact, in line with the above observations, the indirect effect is the highest for Japan and the lowest for the United States and the magnitudes of the indirect effect for the remaining countries are in between the values for the United States and Japan. As is clear from the last three columns in Table 2, the productivity effect seems to be the main source of indirect effect responsible for the cross-country variation in OLC.

[21] Also see Kugler (2004) for a brief review of the related literature.

This decomposition exercise also provides some explanation to close to zero OLC for Japan and Italy, for the overall period. For instance, the productivity effect is the highest (0.93) for Italy and this is consistent with high job security provisions in Italy. Similarly, Japan has a very high productivity effect which is mainly due to the employment practices of Japanese firms (e.g. prevalence of lifetime employment opportunities). Thus, higher productivity –and indirect– effects of Japan and Italy generate close to zero OLC for these countries.

Another remarkable result is that there are intertemporal variations in the Okun's law coefficient. As is clear from Table 2, these variations are again mainly due to the differences in the *indirect* effect.[22] More specifically, as is seen from the last three columns in Table 2, the instability of Okun's coefficient is primarily arising from the shifts in the parameters of the relationships between the supply-side variables and output demand. These relationships, in turn, may be related to the institutional, legal and other features of the labor market, e.g. employment practices of the firms. For instance, OLC in absolute value increased for all countries from 1961-1979 to 1980-2005 but the magnitude of the change is substantial for the European countries (especially for the United Kingdom and France) and Japan. Most of the firms in these countries probably lowered the level of job security as a consequence of an increase in global competition as well as deregulation in labor markets since the early 1980s.[23] This can be seen from the considerable fall in the magnitudes of the productivity effects in the fifth column of Table 2.[24] Although this finding is only suggestive it is broadly in line with those studies that highlight the role of

[22] As is seen from Table 2, OLC has remained fairly stable for the United States. However, while the indirect effect has stayed quite stable, its composition has not remained constant between the two sub-periods.

[23] The early 1980s marks the shift in economic policies toward more liberal policies, such as trade liberalization, privatization and deregulation, and their international promotion by influential politicians like Margaret Thatcher in the United Kingdom and Ronald Reagan in the United States. As a consequence of world-wide applications of such policies and the substantial change in information and communication technologies, global competition among firms has intensified. These developments, in turn, led to similar and important structural changes both in goods and labor markets in all the countries in our sample. Of course, the effects of these changes differ across countries and over time, especially, due to the timing and/or intensity of the policy-led developments.

[24] In some countries, this fall is partially offset by hours effect and/or labor force effect.

intertemporal differences in legal, institutional and other related characteristics of labor markets –as well as goods markets– as potential causes of the instability of Okun's law (e.g., Kaufman, 1988; Lee, 2000).

4. Concluding Remarks

This paper makes several contributions to our understanding of output-unemployment relationship. The first and perhaps the most important one is that this study develops a new and useful framework from which one can derive various models to investigate the output-unemployment link. Additionally, by using this framework, this paper also provides a simple but reasonable theoretical background to the original difference version of the Okun's law and to its recent popular gap version.

This theoretical background, in turn, facilitates the decomposition of Okun's law coefficient into several quantifiable and interpretable effects that incorporate main insights from Arthur Okun's original analysis. More specifically, it is shown that Okun's coefficient is a *reduced-form* coefficient which contains a number of structural parameters that represent the features of macroeconomic adjustment process regarding the output-unemployment relation over the business cycle. Furthermore, findings from the empirical decomposition exercise indicate that the instability of Okun's coefficient is primarily resulting from the intertemporal shifts in the parameters of the structural relationships between the supply-side variables and output demand which are, most likely, related to the changes in legal, institutional and other related characteristics of labor and goods markets. Consequently, these structural changes seem to significantly affect the size of the Okun's coefficient over time and hence seriously undermine the reliability of Okun's law.

All these results imply that Okun's law has an inherent tendency to vary substantially over time, especially, in response to the structural changes in the economy. Therefore, in order to understand Okun's law better, one needs to understand the nature and the factors behind the Okun's coefficient. Fortunately, the presence of a reasonable theoretical framework, such as the one provided in this study, can help researchers to identify the impact of structural changes on Okun's law coefficient. This, in turn, will enable them to conduct better policy analyses and evaluations. Moreover, a detailed analysis of the causes of those structural changes and their propagation through the economy would further improve our understanding of the evolution of the Okun's coefficient.

Even though this study attempts to provide a theoretical background to the symmetric and static versions of the Okun's law, dynamic and/or asymmetric versions can also be derived from the suggested framework. Furthermore, by utilizing this framework different models outside the scope of Okun's law can be easily developed. These are left for future research.

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Appendix A. The Validity of Linear Approximation in Eq. (4)

This appendix provides both visual and formal evidence to examine the validity of the assumption in Eq. (4) –φ is equal to the average value of employment rate– against the implicit assumption in the logarithmic transformation (φ=1).

Fig. A.1 presents the visual evidence by providing the scatterplots of ΔU against Δf-Δl for the six countries over the period 1961-2005. While the solid lines represent the linear approximation in Eq. (4), the dashed (red) lines represent the logarithmic transformation. As is clear from Fig. A.1, the former approximation is better than the latter approximation.

<Fig. A.1>

In order to formally justify the validity of linear approximation in Eq. (4), against the logarithmic approximation of the unemployment identity, Table A.1 presents the values of four popular error measures; namely, Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Relative Absolute Error (MRAE), and Root Mean Squared Relative Error (RMSRE). According to RMSE, MAE, and RMSRE criteria, for all the six countries in the sample, linear approximation in Eq. (4) has lower values and hence it is better than the logarithmic one (note that they are abbreviated as *Lin* and *Log*, respectively, in Table A.1). In the case of MRAE, the former approximation is again superior against the latter for the four countries but inferior for the other two countries.

As is clear from the formal analysis, linear approximation in Eq. (4) is better than the logarithmic approximation. This result is in line with the visual evidence.

<Table A.1>

Appendix B. Data Definitions and Sources

Definitions

F: Civilian labor force, number of persons (Approximating the US concepts)

L: Employment, number of persons (Approximating the US concepts)

U: Unemployment rate [U=1-L/F]

Y: Total GDP, in millions of 1990 US$ (converted at Geary Khamis PPPs) [$Y^d=Y^s=Y$]

H: Annual hours worked per employee

P: Output per hour of work [P=Y/(L.H)]

Note: The lower case letters represent logarithms and the log-difference of each variable gives the growth rate of that variable. For instance, f=ln(F) and Δf denotes the growth rate of civilian labor force (F).

Sources

Data on Y and H were taken from Groningen Growth and Development Centre (GGDC) and the Conference Board (2007) database and data on the remaining variables were taken from the US Department of Labor, Bureau of Labor Statistics (2007).

Appendix C. The Gap Version

This appendix attempts to extend the analysis by providing a theoretical framework for the currently popular gap version of Okun's Law (e.g. Weber, 1995; Moosa, 1997). By doing so, the cyclical (gap) version of the relation contained in Eq. (9) needs to be derived first. The following can be obtained after rearrangements[25]

$$\Delta U_{c,t} = -\varphi(\Delta y_{c,t}{}^{d} - \Delta y_{c,t}{}^{n}), \qquad \text{(C.1)}$$

where the subscript "c" indicates the cyclical component of a variable (e.g. $U_c = U - U^*$, $\Delta x_c = \Delta x - \Delta x^*$), $\Delta y_c{}^n = \Delta p_c + \Delta h_c + \Delta f_c$ and φ is a constant parameter as defined before. It should be noted that Eq. (C.1) can be restated in the level-form as follows

$$U_{c,t} = -\varphi(y_{c,t}{}^{d} - y_{c,t}{}^{n}), \qquad \text{(C.2)}$$

where x_c is the logarithm of the ratio of actual value to trend value of variable X, $y_c{}^n = p_c + h_c + f_c$ and other variables are as defined before.

As in Section 3.1, the following version of Okun's law is obtained by assuming $y_{c,t}{}^n = \theta\, y_{c,t}{}^d$,

$$U_{c,t} = \psi\; y_{c,t}{}^{d}, \qquad \text{(C.3)}$$

where ψ is the reduced-form of OLC and $\psi = -\varphi + \varphi\theta$.

As is clear from Eq. (C.3), OLC contains both the direct ($-\varphi$) and the indirect effects ($\varphi\theta$), and it can be interpreted as in Section 3.1. Table C.1 shows the estimates of the OLC of the gap version and its decomposition for both the overall period and the two sub-periods for the six countries.

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[25] Eq. (9) can be expressed as $\Delta U_t{}^* = -\varphi(\Delta y_t{}^{d*} - \Delta y_t{}^{n*})$, where asterisks indicate the time-varying "trend" of a variable. If we subtract this equation from Eq. (9), we can obtain Eq. (C.1).

<Table C.1>

As is clear from the comparison of Table 2 and Table C.1, the qualitative nature of empirical results for this version of Okun's law is broadly in line with the results in Section 3.2. However, as noted by previous researchers, the magnitude of Okun's coefficient seems to be sensitive to the choice of detrending methods (e.g. Moosa, 1997; Lee, 2000). Therefore, for the sake of comparison, results for other detrending methods should also be provided. This is beyond the scope of this paper.

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Table 1

Correlation between the demand-side and supply-side variables, 1961-2005

	Correlation of Δy^d with				Correlation of Δy^d with		
Country	Δp	Δh	Δf	Country	Δp	Δh	Δf
US	0.433***	0.660***	0.167	*France*	0.772***	0.068	0.538***
Canada	0.467***	0.255**	0.497***	*Italy*	0.823***	0.050	-0.206
UK	0.372***	0.590***	0.224*	*Japan*	0.938***	0.435***	0.574***

Notes: See Appendix B for the definitions and the sources of the data. Three (***), two (**) and one (*) asterisks denote statistically significant positive correlation at, or below, 1, 5 and 10 percent level, respectively.

Table 2

Decomposition of Okun's law coefficient

Country & Period	OLC: OLS Est. α_1	Decomposition: Net Effect α_1'	Direct Effect $-\varphi$	Indirect Effect $\varphi\delta$	Sources of Indirect Effect: Productivity Effect $\varphi\delta_1$	Hours Worked Effect $\varphi\delta_2$	Labor Force Effect $\varphi\delta_3$
US							
Overall	-0.40***	-0.40	-0.94	0.54	0.22	0.26	0.06
Pre 1980	-0.41***	-0.41	-0.94	0.53	0.23	0.35	-0.04
Post 1980	-0.43***	-0.44	-0.94	0.50	0.19	0.24	0.07
Canada							
Overall	-0.31***	-0.31	-0.93	0.61	0.28	0.11	0.22
Pre 1980	-0.38***	-0.38	-0.94	0.56	0.61	-0.08	0.04
Post 1980	-0.42***	-0.43	-0.92	0.49	0.11	0.26	0.11
UK							
Overall	-0.35***	-0.35	-0.94	0.59	0.26	0.25	0.08
Pre 1980	-0.17***	-0.16	-0.96	0.80	0.45	0.33	0.02
Post 1980	-0.48***	-0.48	-0.92	0.44	0.10	0.22	0.11
France							
Overall	-0.15***	-0.15	-0.93	0.78	0.62	0.03	0.12
Pre 1980	-0.19***	-0.19	-0.97	0.78	0.50	0.18	0.10
Post 1980	-0.47***	-0.47	-0.90	0.43	0.35	0.01	0.08
Italy							
Overall	-0.06	-0.06	-0.94	0.87	0.93	0.02	-0.07
Pre 1980	-0.07*	-0.07	-0.96	0.90	0.81	0.13	-0.04
Post 1980	-0.14	-0.14	-0.92	0.78	0.51	0.17	0.10
Japan							
Overall	-0.03***	-0.03	-0.97	0.94	0.72	0.10	0.12
Pre 1980	-0.03***	-0.03	-0.98	0.96	0.75	0.11	0.10
Post 1980	-0.12***	-0.12	-0.97	0.85	0.45	0.16	0.24

Notes: Overall Period: 1961-2005, Pre 1980: 1961-1979, Post 1980: 1980-2005. See Appendix B for the definitions and the sources of the data. α_1 is estimated by applying OLS to the stochastic version of Eq. (11). φ=average employment rate for the respective period. δ_1, δ_2 and δ_3 are estimated by applying OLS to the stochastic versions of Eq. (12), (13) and (14), respectively. Net effect or the derived OLC, α_1', is calculated from the reduced-form coefficient contained in Eq. (16); $\alpha_1' = -\varphi + \varphi\delta$, where $\delta = \delta_1 + \delta_2 + \delta_3$. Three (***), two (**) and one (*) asterisks, respectively, denote that the estimated coefficient is statistically significant at, or below, 1, 5 and 10 percent level [The results are based on Newey-West standard errors].

Table A.1

Error measures: Linear vs logarithmic approximation

Country & Approx.	Error Measure RMSE	MAE	RMSRE	MRAE	Country & Approx.	Error Measure RMSE	MAE	RMSRE	MRAE
US					*France*				
Lin	0.0156	0.0083	0.0152	0.0112	Lin	0.0210	0.0166	0.0395	0.0366
Log	0.0666	0.0469	0.0654	0.0628	Log	0.0593	0.0428	0.0860	0.0735
Canada					*Italy*				
Lin	0.0188	0.0133	0.1259	0.0418	Lin	0.0174	0.0114	0.0311	0.0274
Log	0.0809	0.0572	0.1693	0.0775	Log	0.0519	0.0305	0.0746	0.0659
UK					*Japan*				
Lin	0.0320	0.0226	0.9466	0.1938	Lin	0.0175	0.0121	0.5047	0.2174
Log	0.0770	0.0502	1.0185	0.0655	Log	0.0195	0.0150	0.5222	0.0262

Notes: See Appendix B for the definitions and the sources of the data. Error measures are calculated as follows:

$RMSE=\sqrt{\sum_{t=1}^{T}(\Delta U_{o_t}-\Delta U_{a_t})^2}$, $MAE=\frac{1}{T}\sum_{t=1}^{T}\left|\Delta U_{o_t}-\Delta U_{a_t}\right|$, $RMSRE=\sqrt{\sum_{t=1}^{T}\left[(\Delta U_{o_t}-\Delta U_{a_t})/\Delta U_{o_t}\right]^2}$, $MRAE=\frac{1}{T}\sum_{t=1}^{T}\left|(\Delta U_{o_t}-\Delta U_{a_t})/\Delta U_{o_t}\right|$.

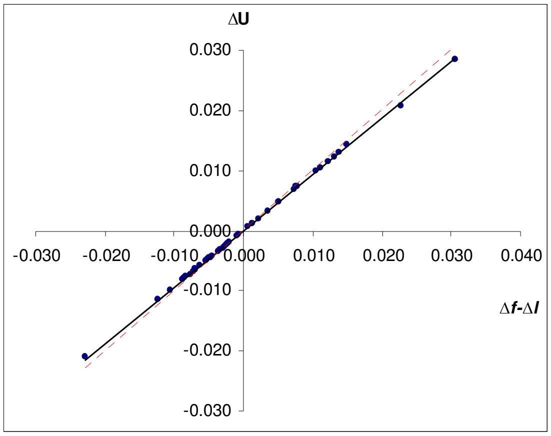
Subscript "o" indicates the *observed* or actual value and the subscript "a" indicates the *approximated* value. Lin: Linear approximation in Eq. (4), $\Delta U_a = \varphi(\Delta f - \Delta l)$; Log: Logarithmic approximation, $\Delta U_a = \Delta f - \Delta l$.

Table C.1

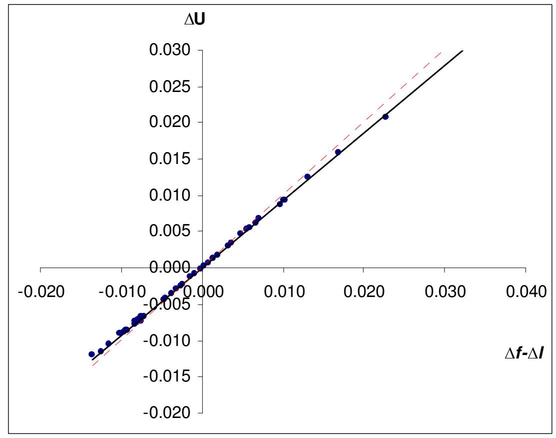
Decomposition of OLC: The gap version

	OLC	Decomposition			Sources of Indirect Effect		
Country & Period	OLS Est. ψ	Net Effect ψ'	Direct Effect $-\varphi$	Indirect Effect $\varphi\theta$	Productivity Effect $\varphi\theta_1$	Hours Worked Effect $\varphi\theta_2$	Labor Force Effect $\varphi\theta_3$
US							
Overall	-0.43***	-0.44	-0.94	0.50	0.11	0.29	0.10
Pre 1980	-0.42***	-0.43	-0.95	0.52	0.12	0.29	0.10
Post 1980	-0.45***	-0.46	-0.94	0.48	0.10	0.28	0.10
Canada							
Overall	-0.45***	-0.46	-0.93	0.46	0.08	0.28	0.11
Pre 1980	-0.37***	-0.39	-0.94	0.55	0.24	0.17	0.14
Post 1980	-0.47***	-0.48	-0.92	0.43	0.03	0.31	0.10
UK							
Overall	-0.35***	-0.35	-0.94	0.59	0.24	0.26	0.09
Pre 1980	-0.25***	-0.25	-0.96	0.71	0.42	0.27	0.03
Post 1980	-0.48***	-0.46	-0.92	0.46	0.05	0.25	0.16
France							
Overall	-0.36***	-0.36	-0.93	0.57	0.39	0.06	0.12
Pre 1980	-0.20***	-0.20	-0.97	0.77	0.50	0.10	0.17
Post 1980	-0.50***	-0.51	-0.90	0.39	0.29	0.02	0.08
Italy							
Overall	-0.12***	-0.12	-0.94	0.82	0.55	0.18	0.08
Pre 1980	-0.07*	-0.09	-0.97	0.88	0.63	0.17	0.08
Post 1980	-0.23**	-0.21	-0.92	0.71	0.39	0.24	0.08
Japan							
Overall	-0.06***	-0.10	-0.97	0.88	0.57	0.21	0.10
Pre 1980	-0.03***	-0.08	-0.98	0.90	0.62	0.19	0.09
Post 1980	-0.14***	-0.15	-0.97	0.81	0.44	0.26	0.11

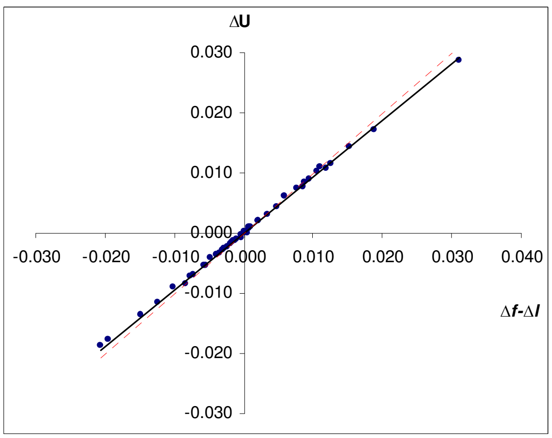
Notes: Overall Period: 1961-2005, Pre 1980: 1961-1979, Post 1980: 1980-2005. See Appendix B for the definitions and the sources of the data. The trends of the variables are estimated by using Hodrick-Prescott filter with the smoothing parameter, λ, set to 6.25 on the basis of Ravn and Uhlig's (2002) frequency rule suggestion. ψ is estimated by applying OLS to the stochastic version of equation $U_c = \psi\, y_c^d$. φ=average employment rate for the respective period. θ_1, θ_2 and θ_3 are estimated by applying OLS to the stochastic versions of equations $p_c = \theta_1\, y_c^d$, $h_c = \theta_1\, y_c^d$ and $f_c = \theta_1\, y_c^d$, respectively. Net effect or derived OLC, ψ', is calculated from the reduced-form coefficient contained in Eq. (C.3); $\psi' = -\varphi+\varphi\theta$, where $\theta = \theta_1 + \theta_2 + \theta_3$. Three (***), two (**) and one (*) asterisks, respectively, denote that the estimated coefficient is statistically significant at, or below, 1, 5 and 10 percent level [The results are based on Newey-West standard errors].



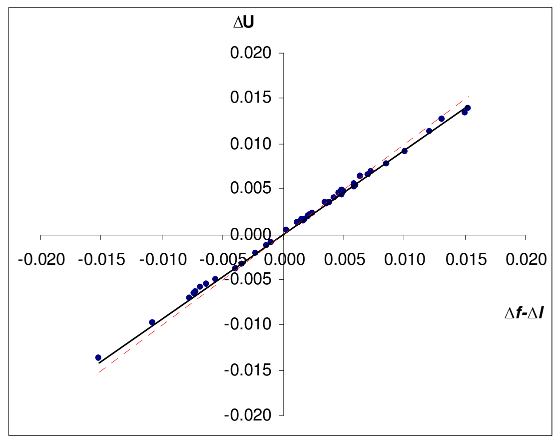
a. US



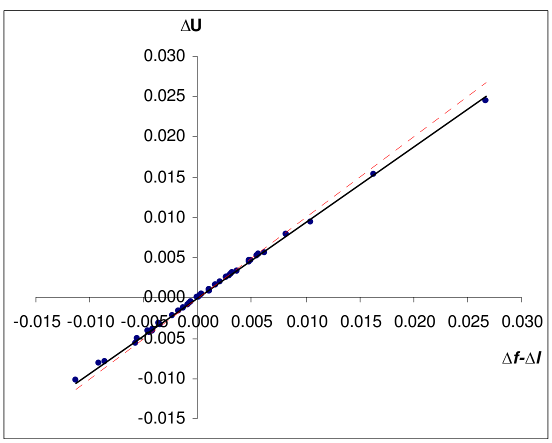
b. Canada



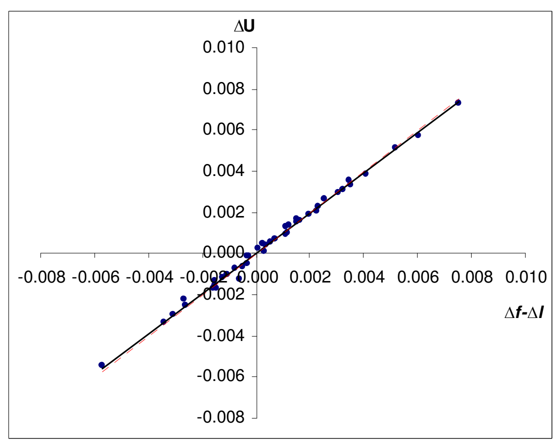
c. UK



d. France



e. Italy



f. Japan

Note: See Appendix B for the definitions and the sources of the data.

Fig. A.1 Scatterplots of ΔU against Δf-Δl, 1961-2005