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A state-level analysis of Okun's law[☆]

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ABSTRACT

Okun's law is an empirical relationship that measures the correlation between the deviation of the unemployment rate from its natural rate and the deviation of output growth from its potential. This relationship is often referred to by policy makers and used by forecasters. In this paper, we estimate Okun's coefficients separately for each U.S. state using an unobserved components framework and find variation of the coefficients across states. We exploit this heterogeneity of Okun's coefficients to directly examine the potential factors that shape Okun's law, and find that indicators of more flexible labor markets (higher levels of education achievement in the population, lower rate of unionization, and a higher share of non-manufacturing employment) are important determinants of the differences in Okun's coefficient across states.

1. Introduction

Okun's law is an empirically observed relationship between the deviation of the unemployment rate from its natural rate and the deviation of output growth from its potential. In his original specification, Okun (1962) used data on the quarter-to-quarter growth rate of the real gross national product (GNP) and the quarter-to-quarter difference in the unemployment rate from 1947 to 1960. He estimated that for each 1% increase in real GNP growth, the unemployment rate would decrease 0.3 percentage points.

While subsequent studies have attempted to develop theories explaining the existence of Okun's law, the original manifestation was a purely statistical relationship. Attributing an underlying mechanism for Okun's law, however, is problematic since any number of theories could be consistent with the observed empirical relationship. One way to help identify the mechanism is to exploit cross-sectional differences in the magnitude of Okun's coefficient. For example, past research has verified the existence of an Okun's law for other countries. More recently, the relationship has been estimated for various regional groupings within a country. While most of the literature has found significant regional disparities in Okun's coefficient (e.g., in the Czech Republic and Slovakia (Durech et al., 2014), Canada (Adanu, 2005), and France (Binet and Facchini, 2013)), some countries were not found to have significant regional variation (e.g., Spain (Villaverde and Maza, 2009) and Greece (Apergis and Rezitis, 2003)). Moreover, the strength of the relationship has been found to vary across countries (see Paldam (1987), Kaufman (1988), Moosa (1997), Lee (2000), Freeman (2001), Cazes et al. (2013) and Hutengs and Stadtmann (2013)). This variation is often attributed to differences in employment protection and minimum wage laws, the power of trade unions, and demographics.

Confounding these cross-country studies is the variation in the implementation of both monetary and national fiscal policy, which may change the timing or conditions under which shocks to either unemployment or output could affect each other. Concerns about the variation in national policy are mitigated for the U.S. states, which provide variation in labor markets, demographics, and industrial compositions while simultaneously residing in a single currency union. For the United States, Okun's law has been estimated at a state-level for selective states (Blackley, 1991) and larger regional groups (Freeman, 2000) with mixed results on regional differences.[1]

In this paper, we exploit state-level data to determine the effects of labor market structure on the strength of the Okun relationship. We first verify the existence of Okun's law at the state-level. We estimate Okun's law using an unobserved components (UC) framework, which has two main advantages over estimating the relationship in differences, as is common in the literature. First, the UC framework allows

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[1] Regional-level data has also been used to exploit spatial relationships to estimate Okun's law at a national level (Kosfeld and Dreger, 2006; Kangasharju et al., 2012).

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for the potential output and the natural rate of unemployment to be time varying. Second, UC allows us to estimate the Okun coefficient simultaneously with the potential output and the natural rate. This allows us to take into account the uncertainty of estimating the potential output and natural rate of unemployment, thereby allowing us to accurately estimate the coefficients and standard errors.

We confirm the existence of the Okun relationship at the state level and find substantial variation by state, with estimated coefficients ranging from -4.38 (North Dakota) to -1.25 (Colorado). These numbers compare with the national coefficient (-2.03) and are similar to other recent studies (Lee, 2000; Daly et al., 2014). We also find some interesting variation in the dynamics of potential output and the natural rate across states.

We next examine the potential factors that explain the geographic variation across the estimated Okun relationships. We consider indicators of labor market flexibility and demographic characteristics, which have been indicated as possible determinants of variation in the macroeconomic literature. Our results illustrate that indicators of labor market flexibility have a significant effect on the strength of the Okun relationship. In particular, we find that union membership, education, and industry concentration are statistically significant. More union membership and more concentrated industries are associated with a larger (magnitude) Okun's coefficient. Alternatively, states with a larger share of their population having a college education are associated with a lower (magnitude) of Okun's coefficient and more labor market flexibility.

The balance of the paper is organized as follows: Section 2 describes the model that we use to estimate Okun's coefficient. We employ an unobserved components decomposition that allows us to estimate both the time-varying potential output and the time-varying natural rate of unemployment. Section 3 describes the methods and data we use for the estimation. Section 4 discusses the estimated Okun's coefficients at the national and state level. Section 5 describes the methodology used to estimate the determinants of the state-level relationship. Section 6 summarizes and offers some concluding remarks.

2. The empirical model

Okun's law measures the correlation between the deviation of the unemployment rate from its natural rate and the deviation of output growth from its potential. This correlation can be estimated from:

$$Y_t - Y_t^* = \alpha + \beta(u_t - u_t^*) + \omega_t, \tag{1}$$

where Y_t is period $-t$ log real output, Y_t^* is log potential output, u_t^* is the natural rate of unemployment, u_t is the unemployment rate, and ω_t is a zero-mean i.i.d. innovation.[2] The intercept term α represents the expected growth rate of output at a stable unemployment rate and the coefficient β represents how a one-percentage-point increase in the unemployment rate affects the output growth rate—the so-called Okun's coefficient. While potential output and the natural rate of unemployment are unobserved, if they are assumed to be constant, it is straightforward to estimate the relationship in differences:

$$\Delta Y_t = \alpha + \beta \Delta u_t + \omega_t^{\dagger}. \tag{2}$$

However, if potential output and the natural rate are time-varying, (2) will return biased estimates of Okun's coefficient.[3]

One method used to estimate (1) is to obtain Y_t^* and u_t^* through prefiltering techniques (e.g., the Hodrick and Prescott (1997) filter). The HP-filter and some band-pass filters, however, can introduce spurious cycles into the resulting data. The results are also sensitive to the sample period and have poor end-of-sample properties. A second method uses third-party (e.g., Congressional Budget Office) estimates of Y_t^* and u_t^*, which can be problematic if they already assume an Okun-type relationship—i.e., the third party data may assume the result. Moreover, the data may not be available at the relevant level of disaggregation, as in our case. For both methods, potential output and the natural rate are often treated as *known quantities*, meaning that the coefficients associated with the estimation of (1) may be more uncertain than reported.

In this paper, we estimate (1) for U.S. states using the unobserved components (UC) framework, which allows for time variation in both Y_t^* and u_t^* and provides the state-level trend and cycle for the unemployment rate and output.[4] Let Y_{nt} and u_{nt} represent state n's period $-t$ log level of output and the unemployment rate, respectively. Each series is assumed to be $I(1)$ and can be decomposed into a permanent component, Y_{nt}^* and u_{nt}^*, and a transitory component, c_{nt}^i, $i = \{y, u\}$ so that

$$\begin{bmatrix} Y_{nt} \\ u_{nt} \end{bmatrix} = \begin{bmatrix} Y_{nt}^* \\ u_{nt}^* \end{bmatrix} + \begin{bmatrix} c_{nt}^y \\ c_{nt}^u \end{bmatrix}. \tag{3}$$

where Y_{nt}^*, u_{nt}^*, c_{nt}^y, and c_{nt}^u are unobserved.[5]

To identify the latent components, we assume the permanent components follow unit root processes with constant drift, μ_n^i:

$$Y_{nt}^* = \mu_n^y + Y_{nt-1}^* + \eta_{nt}^y, \tag{4}$$

$$u_{nt}^* = \mu_n^u + u_{nt-1}^* + \eta_{nt}^u, \tag{5}$$

and the transitory components follow stationary autoregressive processes:

$$c_{nt}^i = \phi_n^i(L) c_{nt-1}^i + \varepsilon_{nt}^i, \tag{6}$$

where $\phi_n^i(L)$ is a polynomial in the lag operator of at least order 2, $v_{nt} = [\eta_{nt}^y, \eta_{nt}^u, \varepsilon_{nt}^y, \varepsilon_{nt}^u]'$, and $v_{nt} \sim N(0, \Omega_n)$.[6]

While the canonical unobserved components model (e.g., Harvey (1985) and Clark (1987)) assumes that Ω_n is diagonal, recent work (e.g., Morley et al. (2003) and Sinclair (2009)) has shown that this assumption can be relaxed, but that it relegates most of the dynamics to the permanent component. We impose zero restrictions on the off-diagonal elements of the covariance matrix except for $\sigma_{n\varepsilon^y\varepsilon^u}$, the correlation between the innovations of the two transitory components:

$$\Omega_n = \begin{bmatrix} \sigma_{n\eta^y}^2 & 0 & 0 & 0 \\ 0 & \sigma_{n\eta^u}^2 & 0 & 0 \\ 0 & 0 & \sigma_{n\varepsilon^y}^2 & \sigma_{n\varepsilon^y\varepsilon^u} \\ 0 & 0 & \sigma_{n\varepsilon^y\varepsilon^u} & \sigma_{n\varepsilon^u}^2 \end{bmatrix}. \tag{7}$$

Thus, correlation between state-level output and the unemployment rate arises only through the transitory innovations, which is consistent

[2] Okun (1962) originally estimated deviations in the unemployment rate as the dependent variable and deviations in output as the independent variable. As it is common to assume that other shocks affect output more than unemployment, we prefer to treat output deviations as the dependent variable. This alternative specification, however, does not imply that the inverse of our coefficient is comparable with the original Okun (1962) results (Plosser and Schwert, 1979).

[3] Nelson and Plosser (1982) found evidence that most U.S. time series data are not well identified by a deterministic, linear trend. Additionally, Perry et al. (1970) and Adams and Coe (1990) find that the natural rate of unemployment varies over time, which may be due to changes in demographics, the unemployment insurance, relative

(footnote continued)
minimum wages, and other factors of labor market rigidities (such as unionization rates). We find that changing the specification (i.e., how we identify the permanent component) leads to different point estimates of Okun's coefficients, which is consistent with previous research (Lee, 2000; Prachowny, 1993).

[4] Unlike the HP-filter, the UC can be generalized to allow for multiple series and correlation between the innovations to the components, but it still suffers from the poor end-of-sample properties (Orphanides and Van Norden, 2002).

[5] The I(1) assumption for both variables is consistent with Sinclair (2009). Additionally, we fail to reject the null hypothesis that the data is stationary for 42 and 50 states at the 5% significance level for output and the unemployment rate, respectively. These results are available upon request from the corresponding author.

[6] Harvey (1985), Clark (1987), and Harvey and Jaeger (1993) suggest specifying the autoregressive lags greater than or equal to 2 is necessary for the cycle to be periodic.