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Okun's Law: Fit at 50?

This paper asks how well Okun's Law fits short-run unemployment movements in the United States since 1948 and in 20 advanced economies since 1980. We find that Okun's Law is a strong relationship in most countries, and one that is fairly stable over time. Accounts of breakdowns in the Law, such as the emergence of "jobless recoveries," are flawed or exaggerated. We also find that the coefficient in the relationship—the effect of a 1% change in output on the unemployment rate—varies substantially across countries. This variation is partly explained by idiosyncratic features of national labor markets, but it is not related to differences in employment protection legislation.

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In 1962, Arthur Okun reported an empirical regularity: a negative short-run relationship between unemployment and output. Many studies have confirmed this finding, and Okun's Law has become a fixture in macroeconomics textbooks. For the United States, many authors posit that a 1% deviation of output from potential causes an opposite change in unemployment of half a percentage point (e.g., Mankiw 2012).

Yet many economists question Okun's Law. A number of recent papers have titles like "The Demise of Okun's Law" (Gordon 2010) and "An Unstable Okun's Law,

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Not the Best Rule of Thumb" (Meyer and Tasci 2012). Observers have suggested that each of the last three U.S. recessions was followed by a "jobless recovery" in which employment growth was weaker than Okun's Law predicts. Studies of international data suggest that Okun's Law is unstable in many countries (e.g., Cazes, Verick, and Al-Hussami 2011). Some find that the relationship broke down during the Great Recession of 2008–2009, when there was little correlation across countries between the changes in output and unemployment (e.g., IMF 2010).

These claims matter for the interpretation of unemployment movements and for macropolicy. Okun's Law is a part of textbook models in which shifts in aggregate demand cause changes in output, which, in turn, lead firms to hire and fire workers. In these models, when unemployment is high, it can be reduced through demand stimulus. Skeptics of Okun's Law question this policy view. McKinsey Global Institute (2011), for example, argues that Okun's Law has broken down because of problems in the labor market, such as mismatch between workers and jobs. They stress labor market policies such as job training, not demand stimulus, as the key to reducing unemployment.

This paper asks how well Okun's Law explains short-run unemployment movements. We examine data for the United States since 1948 and for 20 advanced countries since 1980. Our principal conclusions are that Okun's Law is a strong relationship in most countries, and one that is fairly stable over time. We find some deviations from a fixed Okun's Law, but they are usually modest in size. Overall, the data are consistent with traditional models in which fluctuations in unemployment are caused by shifts in aggregate demand.

There is one major qualification to the universality of Okun's Law. While this relationship fits the data in most countries, the coefficient in the relationship—the effect of a 1% change in output on the unemployment rate—varies quite a bit across countries. We estimate, for example, that the coefficient is –0.17 in Japan, –0.48 in the United States, and –0.82 in Spain. These differences reflect special features of national labor markets, such as Japan's tradition of lifetime employment and the prevalence of temporary employment contracts in Spain.

Section 1 of this paper introduces Okun's Law and alternative approaches to estimating it. The rest of the paper demonstrates the good fit of the relationship and points out common flaws in analyses that report breakdowns of the law.

Section 2 examines U.S. annual and quarterly data over the period 1948–2013. Simple linear versions of Okun's Law produce coefficients of –0.4 or –0.5, with $\bar{R}^2$s in the neighborhood of 0.8. We find statistical evidence of some nonlinearity and instability in the law, but allowing for these factors does not greatly improve its fit to the data.

Section 3 examines the common claim that U.S. recoveries since the 1990s have been "jobless." We find little evidence that Okun's Law broke down during these episodes. Confusion on this issue has arisen because output grew more slowly in recent recoveries than in earlier ones, leading to disappointing outcomes for employment. (Galí, Smets, and Wouters 2012 make a similar point.)

Section 4 discusses another apparent anomaly in U.S. data: since 2011, the unemployment rate has fallen substantially without higher-than-average output growth. We believe that this phenomenon (unlike jobless recoveries) is a true deviation from Okun's Law. It does not, however, reflect a change in how employment responds to output; rather, it has resulted from an unusual decrease in labor force participation, which has reduced the unemployment rate for a given level of employment.

Section 5 extends our analysis to international data. Okun's Law fits most advanced economies, although the typical $\bar{R}^2$ is somewhat lower than for the United States. The coefficient in the Law varies across countries, but it is relatively stable within a given country. We generally do not find that the coefficient has risen over time, as some studies suggest (e.g., IMF 2010).

Section 6 examines the Great Recession of 2008–2009. A number of international studies suggest that Okun's Law broke down during this period, but once again, we find that the law holds up well. Apparent anomalies mostly disappear if we account properly for cross-country differences in the Okun coefficient and in the lengths of recessions.

Section 7 seeks to explain the cross-country differences in Okun coefficients, with limited success. We propose explanations for the largest outliers, such as Spain and Japan, but we have not found a variable that explains the coefficients more generally. In particular, they are not correlated with the OECD's measure of legal employment protection, a variable suggested by previous authors. Section 8 concludes the paper.

1. ESTIMATING OKUN'S LAW

Here, we introduce Okun's Law and discuss how we assess its fit to the data.

1.1 Okun's Law

We presume there exist some long-run levels of output, employment, and unemployment. We use the term "potential output" for long-run output, and the "natural rate" for long-run unemployment. Potential output is determined by the economy's productive capacity, and it grows over time as a result of technological change and factor accumulation. The long-run level of employment and the natural rate of unemployment are determined by the size of the labor force and by frictions in the labor market. When output is at its long-run level, employment and unemployment are also at their long-run levels.

Okun's Law is a short-run relationship between the deviation of output from potential and the deviation of unemployment from its natural rate. Different economists interpret this relationship in different ways. Okun himself assumed that shifts in aggregate demand cause movements in output, which, in turn, drive fluctuations in the labor market: firms hire and fire workers to accommodate output changes, and these actions affect employment and unemployment. This interpretation led Okun to put output on the right side of his equation and the unemployment rate on the left.

Okun's interpretation of his law persists in economics textbooks (e.g., Blanchard 2011), and it is the interpretation we prefer. Some economists, however, derive Okun's Law from a production function in which employment determines output. These authors, such as Prachowny (1993) and Daly et al. (2012), put output on the left side of the law. One can also interpret Okun's Law as simply a stylized fact, a reduced-form relationship between two endogenous variables. This paper does not try to determine which interpretation of Okun's Law is best, but rather focuses on the empirical fit of Okun's original specification.

Under Okun's interpretation, Okun's Law can be derived from two underlying relationships. The first is the effect of output on employment, which we express as

$$E_t - E_t^* = \gamma \left(Y_t - Y_t^*\right) + \eta_t, \gamma > 0, \tag{1}$$

where E is the log of employment, Y is the log of output, and *indicates a long-run level. Equation (1) captures the idea that firms hire more workers when output rises.

If labor markets were frictionless, we could interpret equation (1) as an inverted production function. In that case, the parameter γ is the inverse of the elasticity of output with respect to labor. If we assume that this elasticity is about 2/3, based on factor shares of income, then γ is $3/2 = 1.5$.

However, as pointed out by Okun (1962) and Oi (1962), labor is a quasi-fixed factor. It is costly to adjust employment, so firms accommodate short-run output fluctuations in other ways: they adjust the number of hours per worker and the intensity of workers' effort (which produces procyclical movements in measured productivity). Because of these other margins, we expect that γ, the response of employment to output, is less than the 1.5 suggested by a production function.

The second relationship underlying Okun's Law is the effect of employment on the unemployment rate, U:

$$U_t - U_t^* = \delta \left(E_t - E_t^*\right) + \mu_t, \delta < 0. \tag{2}$$

If we assume a constant labor force, then the coefficient δ is approximately -1: the unemployment rate moves one-for-one with log employment. However, as Okun discussed, an increase in employment raises the returns to job search, which induces workers to enter the labor force. Procyclical movements in the labor force dampen the effects of employment on the unemployment rate, so we expect that δ is less than 1 in absolute value.

We derive Okun's Law by substituting equation (1) into equation (2):

$$U_t - U_t^* = \beta \left(Y_t - Y_t^*\right) + \varepsilon_t, \ \beta < 0, \tag{3}$$

where $\beta = \gamma\delta$ and $\varepsilon_t = \mu_t + \delta\eta_t$. The coefficient β in Okun's Law depends on the coefficients in the two relationships that underlie the law.

Since γ is less than 1.5 and δ is less than 1.0 in absolute value, the coefficient β should be less than 1.5 in absolute value. Aside from this bound, however, it is difficult to pin down the Okun coefficient *a priori*. The parameter γ depends on the costs of adjusting employment, which include both technological costs such as training and costs created by employment protection laws. The parameter δ depends on the number of workers who are marginally attached to the labor force, entering and exiting as employment fluctuates.

The error term ε_t in Okun's Law captures factors that shift the unemployment–output relationship. These factors include unusual changes in productivity or in labor force participation, which create errors in equations (1) and (2), respectively. Saying that "Okun's Law fits well" means that ε_t is usually small.

1.2 Estimation

In estimating Okun's Law, we take two approaches that Okun introduced in his original article. The first is to estimate equation (3), the "levels" equation. In this case, we must estimate the natural rate U_t* and potential output Y_t*. We do so by smoothing the output and unemployment series with the Hodrick–Prescott (HP) filter, trying alternative values of the smoothing parameter as one check of robustness.

The other approach is to estimate the "changes" version of Okun's Law:

$$\Delta U_t = \alpha + \beta \Delta Y_t + \omega_t, \tag{4}$$

where Δ is the change from the previous period. This equation can be derived from the levels equation under certain assumptions. In particular, if we assume that the natural rate U* is constant and potential output Y* grows at a constant rate g, then differencing equation (3) yields equation (4) with $\alpha = -\beta g$ and $\omega_t = \Delta\varepsilon_t$. If U* and the growth of Y* vary over time, then we again get (4) but ω_t includes terms involving ΔU* and ΔY*.

Equation (4) looks easier to estimate than equation (3) because it does not include the unobservables U_t* and Y_t*. For many countries, however, it is not plausible that U* and the growth of Y* are constant. If these terms vary, then the component of the error ω_t that depends on ΔY* is probably correlated with ΔY: actual output growth tends to be high when potential growth is high. As a result, OLS estimates of (4) produce biased estimates of the coefficient β.[1]

For this reason, we generally prefer to estimate the levels version of Okun's Law, with U* and Y* measured as accurately as possible. Yet, the differences version provides an important robustness check, because some economists question the HP technique that we use to estimate U* and Y* (e.g., Phillips and Jin 2015). As we will see, the two versions of Okun's Law produce similar results in most (although not all) of our empirical work.

We estimate Okun's Law with both annual and quarterly data. With annual data, our specifications are exactly equations (3) and (4): we assume that the

1. Suppose that U* varies over time and ΔY* also varies with a mean of g. Then, differencing the levels equation (3) yields the differences equation (4) with $\alpha = -\beta g$ and $\omega_t = \Delta\varepsilon_t + \Delta U_t{*} - \beta\,(\Delta Y_t{*} - g)$. The last component of ω_t is presumably correlated with ΔY_t because increases in the growth rate of productivity or the labor force raise both ΔY* and ΔY.

TABLE 1

United States: Estimates of Okun's Law (Annual Data, 1948–2013)
Equation Estimated in Levels: $U_t - U_t^* = \beta(Y_t - Y_t^*) + \varepsilon_t$
Equation Estimated in First Differences: $\Delta U_t = \alpha + \beta \Delta Y_t + \varepsilon_t$

Equation in levels Hodrick–Prescott filter $\lambda = 100$	
β	-0.421^{**} (0.027)
Obs	66
Adjusted R^2	0.801
RMSE	0.455
Durbin–Watson statistic	1.165
Equation in levels Hodrick–Prescott filter $\lambda = 1{,}000$	
β	-0.372^{**} (0.025)
Obs	66
Adjusted R^2	0.773
RMSE	0.568
Durbin–Watson statistic	0.873
Equation in first differences	
β	-0.402^{**} (0.029)
α	1.323^{**} (0.126)
Obs	65
Adjusted R^2	0.717
RMSE	0.591
Durbin–Watson statistic	1.473

Note: Table reports point estimates and Newey–West (1987) standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% percent level, respectively.

output–unemployment relationship is contemporaneous. With quarterly data, we find that the fit of our equations improves if we include two lags of the output term. These lags capture the idea that it takes time for firms to adjust employment when output changes and for individuals to enter or exit the labor force.

2. OKUN'S LAW IN THE UNITED STATES

This section estimates Okun's Law for the United States over 1948–2013, checking the robustness and stability of this relationship along several dimensions.

2.1 Annual Data

Table 1 reports estimates of the levels equation (3) and the changes equation (4). We examine two versions of equation (3) with different series for U_t* and Y_t*, which we

TABLE 2

UNITED STATES: ESTIMATES OF OKUN'S LAW (QUARTERLY DATA, 1948Q1–2013Q4)
EQUATION ESTIMATED IN LEVELS: $U_t - U_t{}^* = \beta(L)(Y_t - Y_t{}^*) + \varepsilon_t$
EQUATION ESTIMATED IN FIRST DIFFERENCES: $\Delta U_t = \alpha + \beta(L)\Delta Y_t + \varepsilon_t$

	Equation in levels				Equation in differences	
	Hodrick–Prescott filter λ					
	1,600	1,600	16,000	16,000		
β_0	−0.440**	−0.251**	−0.428**	−0.221**	−0.288**	−0.220**
	(0.020)	(0.020)	(0.023)	(0.024)	(0.027)	(0.018)
β_1		−0.133**		−0.153**		−0.140**
		(0.026)		(0.036)		(0.021)
β_2		−0.122**		−0.088*		−0.073**
		(0.024)		(0.035)		(0.014)
$\beta_0+\beta_1+\beta_2$		−0.506**		−0.462**		−0.432**
		(0.021)		(0.023)		(0.035)
α					0.239**	0.351**
					(0.037)	(0.038)
Observations	264	262	264	262	263	261
Adjusted R^2	0.770	0.867	0.786	0.842	0.486	0.647
RMSE	0.395	0.299	0.490	0.422	0.285	0.237
Durbin–Watson stat.	0.583	0.508	0.377	0.262	1.397	1.396

NOTE: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

create by choosing different smoothing parameters in the HP filter. We try smoothing parameters of $\lambda = 100$ and $\lambda = 1{,}000$, the most common choices for annual data.

Our three specifications yield similar results. The estimates of the coefficient β are around –0.4, and the $\bar{R}^2$s range from 0.72 to 0.80. The levels equation with an HP parameter of $\lambda = 100$ yields the best fit by a small margin.

Figure 1 illustrates the fit of Okun's Law by plotting $U_t - U_t{}^*$ against $Y_t - Y_t{}^*$, and the change in U against the change in Y. We see that our simple versions of the law explain most fluctuations in unemployment since 1948.

2.2 *Quarterly Data*

Table 2 presents estimates of Okun's Law in levels and changes based on quarterly data. For the levels specification, we again estimate $U_t{}^*$ and $Y_t{}^*$ with the HP filter; we try smoothing parameters of $\lambda = 1{,}600$ and $\lambda = 16{,}000$, which are common choices for quarterly data. We present results with only the current output variable in the equation, and also with two lags included.

For the levels specification with no lags, the estimated Okun coefficients are –0.44 and –0.43, near the estimates with annual data. When lags are included, the coefficients on the current $Y_t - Y_t{}^*$ are smaller, and the two lags are significant, implying modest delays in the full adjustment of unemployment to output. The sums of the coefficients on current and lagged output are –0.51 and –0.46 for the two

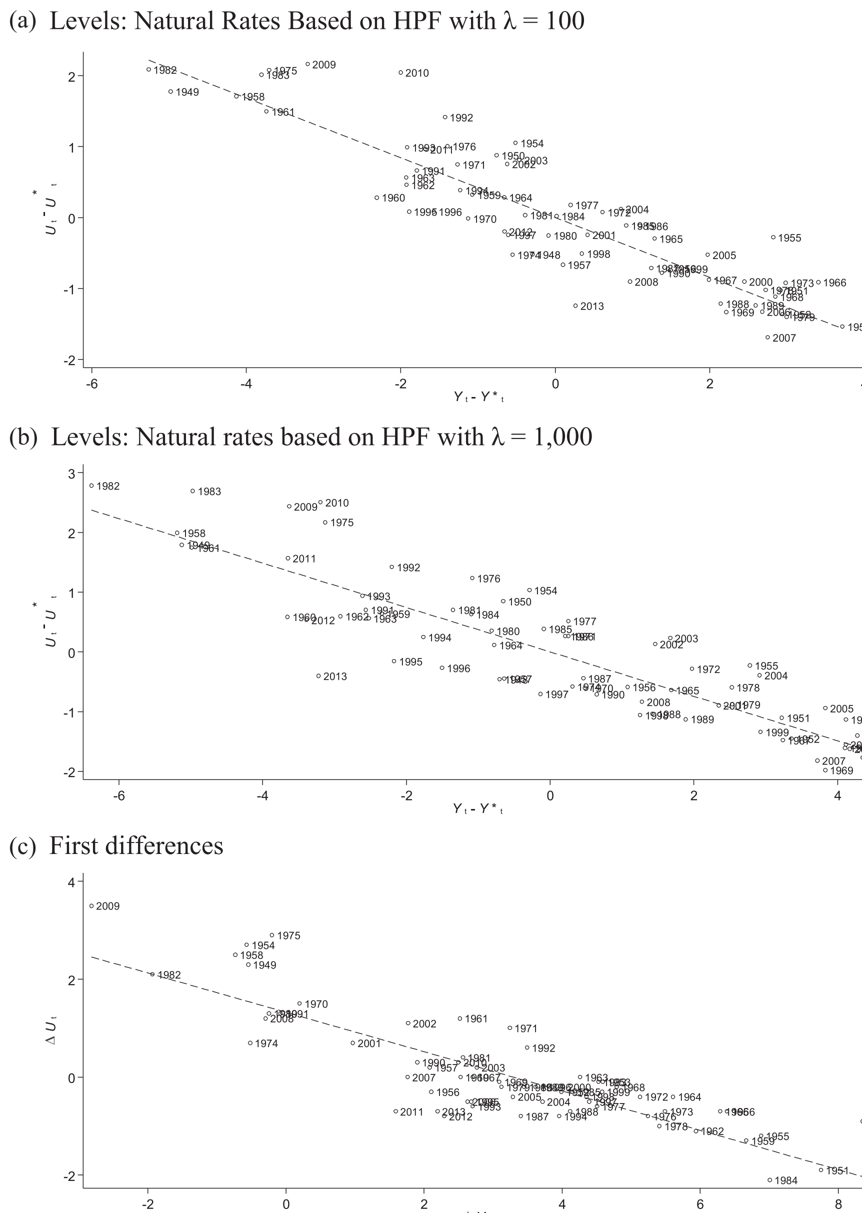

FIG. 1. United States: Okun's Law, 1948–2013. (Annual data) (a) Levels: Natural Rates Based on HPF with $\lambda = 100$. (b) Levels: Natural Rates Based on HPF with $\lambda = 1{,}000$. (c) First Differences.

NOTE: HPF denotes Hodrick–Prescott filter. This figure reports change in unemployment rate and in log of real GDP in percentage points, and output gap and unemployment gap in percent.

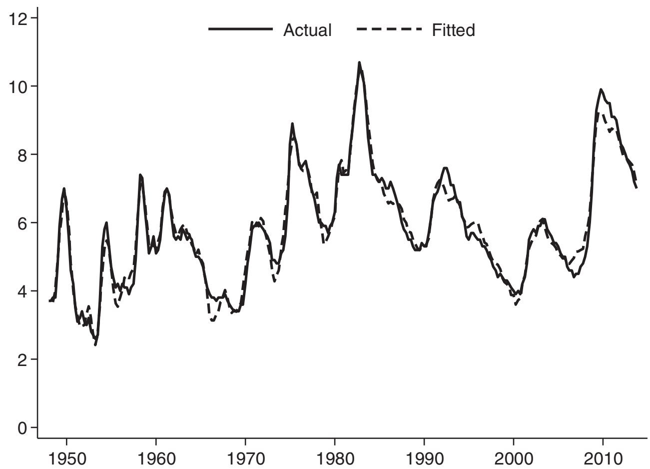

FIG. 2. United States: Actual and Fitted Unemployment Rate, 1948Q2–2013Q4.

NOTE: Figure reports fitted unemployment rate from Okun specification estimated on quarterly data in levels with two lags and natural rates based on Hodrick–Prescott filter with $\lambda = 1{,}600$.

values of λ. When the lags are included, the $\bar{R}^2$s are as high as 0.87 (for $\lambda = 1{,}600$), a nonnegligible improvement on the $\bar{R}^2$s with annual data.[2]

For the changes specification, the quarterly results are slightly less robust. With no lags, the coefficient on the change in output is only –0.29; when lags are included, the sum of coefficients is –0.43, close to the results for the levels specification. The $\bar{R}^2$ is on the low side with no lags (0.49), and rises to 0.65 when lags are included. Evidently, in quarterly data, the Okun relationship in changes is somewhat noisier than the relationship in levels.

We illustrate the fit of our levels specification by calculating fitted values for the unemployment rate. With lags included, these fitted values are

$$\hat{U}_t = U_t^* + \hat{\beta}_0 \left(Y_t - Y_t^*\right) + \hat{\beta}_1 \left(Y_{t-1} - Y_{t-1}^*\right) + \hat{\beta}_2 \left(Y_{t-2} - Y_{t-2}^*\right), \tag{5}$$

where U_t* and Y_t* are long-run levels from the HP filter, and the $\hat{\beta}$s are estimated coefficients on the current and lagged output gaps. In this exercise, we use a smoothing parameter of $\lambda = 1{,}600$ in the HP filter. Figure 2 compares the paths over time of $\hat{U}_t$ and of actual unemployment U_t. We see that unemployment is close to the level predicted by Okun's Law throughout the period since 1948.

2. For the levels specification, we have also estimated a version of Okun's Law with two lags of the dependent variable, $U - U^*$, as well as current and two lags of $Y - Y^*$. For $\lambda = 1{,}600$, the estimated coefficients on the lags of $U - U^*$ are 0.95 and -0.26, and the coefficients on current $Y - Y^*$ and its lags are -0.23, 0.06, and 0.01. Using repeated substitution, we can derive a reduced form in which $U - U^*$ depends only on Y–Y^* and its lags, and the sum of coefficients is -0.49. This equation is qualitatively similar to the second column of Table 2, in which the sum of coefficients on $Y - Y^*$ and its lags is -0.51.

TABLE 3

Okun's Law and Recessions

Equation Estimated in Levels (1)–(4): $U_t - U_t^* = \beta(L)(Y_t - Y_t^*) + \gamma(L)Rec_t + \delta(L)(Y_t - Y_t^*)Rec_t + \varepsilon_t$

Equation Estimated in First Differences (5)–(8): $\Delta U_t = \alpha + \beta(L)\Delta Y_t + \gamma(L)\text{Rec}_t + \delta(L)\Delta Y_t\text{Rec}_t + \varepsilon_t$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
α					0.351**	0.158**	0.250**	0.122**
					(0.038)	(0.041)	(0.044)	(0.040)
$\beta_0 + \beta_1 + \beta_2$	−0.506**	−0.488**	−0.474**	−0.468**	−0.432**	−0.283**	−0.343**	−0.248**
	(0.021)	(0.025)	(0.028)	(0.028)	(0.035)	(0.037)	(0.038)	(0.037)
$\gamma_0 + \gamma_1 + \gamma_2$		0.031		−0.099		0.474**		0.396**
		(0.108)		(0.108)		(0.070)		(0.063)
$\delta_0 + \delta_1 + \delta_2$			−0.113*	−0.127*			−0.432**	−0.287**
			(0.053)	(0.057)			(0.114)	(0.075)
Obs	262	262	262	262	261	261	261	261
Adjusted R^2	0.867	0.871	0.872	0.874	0.647	0.727	0.689	0.743
RMSE	0.299	0.296	0.294	0.292	0.237	0.209	0.223	0.203

Note: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

2.3 Stability

We have found that simple versions of Okun's Law, which are linear and fixed over our 66-year sample, yield a good fit to the short-run relationship between output and unemployment. Yet a number of previous studies question the fit of a simple Okun's Law. Some, such as Knotek (2007), suggest a nonlinearity: the effect of output on unemployment is larger during recessions than during expansions. Others, such as Meyer and Tasci (2012), suggest that the coefficient in Okun's Law varies over time.

Here, we examine these ideas. Using quarterly data, we find some evidence of deviations from a stable, linear Okun's Law. However, as shown below, in economic terms, the sizes of these deviations are modest—especially for the levels version of Okun's Law. This finding reflects the fact that the simple specifications in Table 2 produce $\bar{R}^2$s as high as 0.87. There is little scope for generalizations of the equations to improve their fit.

Effects of recessions. We estimate quarterly specifications that allow deviations from the usual Okun's law during NBER recessions. We examine both our levels equation (with $\lambda = 1{,}600$) and our changes equation, and allow recessions to alter Okun's Law in two ways. First, we introduce a dummy variable for a quarter that is part of a recession, and two lags of this dummy. These terms allow a fixed effect of the recession state on the level or change in unemployment. Second, we include interactions between the dummy variable and the output gap or change in output, again with two lags. These terms allow the output coefficient in Okun's Law to differ between expansions and recessions.

Table 3 reports the results. For the levels Okun's law, the estimated effects of recessions are modest. The dummy variable and its lags are jointly insignificant, and the interactions between the dummy and output gaps are borderline significant

($t = 2.2$). Including these extra terms raises the $\bar{R}^2$ only from 0.867 to 0.874. Based on point estimates, the sum of coefficients on the output gap and its lags is −0.47 in expansions and −0.60 in recessions (−0.60 is the sum of coefficients on the gap plus the sum of coefficients on the gap–recession interactions).

The equation for unemployment changes suggests larger effects of recessions. Both the recession dummies and their interactions with output changes are statistically significant, and including those terms raises the $\bar{R}^2$ from 0.65 to 0.74. These results confirm our earlier finding that the changes version of Okun's Law is less robust than the levels version (see Table 2).

To get a sense of how a recession can shift Okun's Law, we consider the economy in the first quarter of 2009, the height of the Great Recession. In that quarter, output growth (not annualized) was −1.4%, and its two lags were −2.1% and −0.5%. The recession dummy and its two lags were all 1. For this observation, the fitted value for the change in the unemployment rate is 1.0 in our basic changes version of Okun's Law, and 1.3 in the version that accounts for recessions. The actual unemployment change in 2009Q1 was 1.4.

Time variation in coefficients. For our linear Okun's Law equations, we test for stability over time, focusing on the sum of coefficients on current output and its two lags. We first test for equality of this sum for the periods 1948–83 and 1984–2014. We choose 1984 as a break point because it is the beginning of the "Great Moderation" period in U.S. macroeconomic history. Some researchers suggest that the labor market changed during this period; Gali and van Rens (2014), for example, argue that frictions in hiring fell, which could increase the responsiveness of employment and unemployment to output fluctuations.

The first part of Table 4 reports results, which are similar for the levels and differences versions of Okun's Law. We find that the sum of output coefficients rose somewhat in absolute value in our second subsample. For the levels equation, the sum of coefficients is −0.48 before 1984 and −0.61 after; for the changes specification, the corresponding numbers are −0.42 and −0.51. The differences across periods are statistically significant.

On the other hand, allowing different coefficients for the two periods makes almost no difference for the fit of our equations. Starting from an equation with stable coefficients, allowing the coefficients to change increases the $\bar{R}^2$ from 0.87 to 0.88 for the levels specification and from 0.65 to 0.66 for the changes specification. These results suggest that an Okun's Law with constant coefficients is a good approximation to reality.

We also test for the stability of our equations using the Andrews (2003) sup-Wald test with an unknown break date. Stability is again rejected, with break dates as suggested by the largest Wald statistic of 2003Q4 for the levels equation and 2004Q1 for the differences equation. In both cases, the sum of coefficients for the second, shorter subsample is larger in absolute value than the sum for the first subsample. For the levels specification, the sum of coefficients is −0.48 before 2003Q4 and −0.78 after.

TABLE 4

Okun's Law: Allowing for a Structural Break
Equation Estimated in Levels: $U_t - U_t^* = \beta_{t<\tau}(L)(Y_t - Y_t^*) + \beta_{t\geq\tau}(L)(Y_t - Y_t^*) + \varepsilon_t$
Equation Estimated in First Differences: $\Delta U_t = \alpha + \beta_{t<\tau}(L)\Delta Y_t + \beta_{t\geq\tau}(L)\Delta Y_t + \varepsilon_t$

		With break			With break	
	Levels baseline	Fixed τ = 1984Q1	Estimated τ = 2003Q4	Changes baseline	Fixed τ = 1984Q1	Estimated τ = 2004Q1
$\beta_0 + \beta_1 + \beta_2$	-0.506^{**}			-0.432^{**}		
	(0.021)			(0.035)		
$t < \tau$: $\beta_0 + \beta_1 + \beta_2$		-0.477^{**}	-0.476^{**}		-0.417^{**}	-0.423^{**}
		(0.017)	(0.016)		(0.033)	(0.033)
$t \geq \tau$: $\beta_0 + \beta_1 + \beta_2$		-0.608^{**}	-0.778^{**}		-0.512	-0.708^{**}
		(0.053)	(0.029)		(0.040)	(0.057)
F		5.474	84.565		8.861	26.651
p		0.020	0.000		0.003	0.000
Adjusted R^2	0.867	0.876	0.894	0.647	0.658	0.674

Note: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

Yet, once again, allowing a change in coefficients yields only a modest improvement in the fit of Okun's Law. The $\bar{R}^2$ rises from 0.87 to 0.89 for the levels equation, and from 0.65 to 0.67 for the differences equation.

We can gain further perspective from Figure 2, which shows the fit of a levels Okun's Law with constant coefficients. Starting in the early 2000s, when the Andrews test identifies a break, we see larger ups and downs in actual unemployment than in fitted unemployment. For example, from 2006Q4 to 2009Q4, actual unemployment rises by 5.5 percentage points (from 4.4% to 9.9%) and the fitted value rises only 4.2 points (from 5.0% to 9.2%). This pattern is consistent with a rise in the Okun coefficients near the end of the sample. However, the deviations between actual and fitted unemployment shown in Figure 2 are modest compared to the fluctuations in unemployment over time. Again, a stable Okun's Law appears to be a good approximation to reality.[3]

2.4 Comparison to Okun (1962)

We find that Okun's 50-year old specification yields a good fit to data from 1948 through 2013. Yet our coefficient estimates differ somewhat from those in Okun's original paper. Okun estimated that a 1% increase in output causes the unemployment rate to fall by about 0.3 percentage points. Inverting this coefficient, he posited the rule of thumb that a one-point change in unemployment occurs when output changes by 3%. Our coefficient estimates, by contrast, are around –0.4 or –0.5. These

3. Some papers (e.g., Meyer and Tasci 2012) argue for instability in Okun's Law based on rolling regressions. This is an informal test where the amount of estimated instability depends heavily on the window width. We prefer the sup-F-test where we can apply the statistical theory developed by Andrews.

TABLE 5

United States: Replication and Update of Okun's (1962) Regression (Quarterly Data) Equation Estimated: $\Delta U_t = \alpha + \beta_0 \Delta Y_t + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \varepsilon_t$

	1948Q2–1960Q4		1948Q2–2013Q4	
	Vintage data		Current data	
Sample	(1)	(2)	(3)	(4)
β_0	−0.307**	−0.233**	−0.288**	−0.220**
	(0.039)	(0.023)	(0.027)	(0.018)
β_1		−0.168**		−0.140**
		(0.030)		(0.021)
β_2		−0.039**		−0.073**
		(0.019)		(0.014)
$\beta_0+\beta_1+\beta_2$		−0.441**		−0.432**
		(0.044)		(0.035)
α	0.305**	0.424**	0.239**	0.351**
	(0.076)	(0.069)	(0.037)	(0.038)
Obs	51	51	263	261
Adjusted R^2	0.584	0.758	0.486	0.647
RMSE	0.382	0.292	0.285	0.237
Durbin–Watson stat.	1.625	1.580	1.397	1.396

Note: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

estimates fit roughly with modern textbooks, which report an inverted coefficient of 2.

Why do our coefficient estimates differ from Okun's? The natural guess is differences in data—either the sample period or the vintage of the data. But that is not the case; instead, the differences in results arise from differences in the specification of Okun's Law.

This point is easiest to see for the changes version of the law, where the key specification issue is lag structure. Okun estimates the changes equation, our equation (4), in quarterly data with no lags. Based on data for 1947Q2 through 1960Q4, he reports a coefficient of –0.30. When we estimate the same specification for our longer sample, the coefficient is almost the same: −0.29. For the changes equation, we obtain larger coefficients only if we use annual data or include lags in our quarterly specification (see Tables 1 and 2).

To pin down this issue, Table 5 reports quarterly estimates of the changes equation with and without lags of output growth. We compare estimates for two periods: our full sample, and 1948Q2–1960Q4, which is our best approximation of Okun's sample with currently available data. For Okun's sample, we use 1965Q4 vintage data for output, which should be close to the data that Okun used.[4] With no lags,

4. The 1965Q4 vintage data are the earliest vintage of data for real GNP/GDP available from the Federal Reserve Bank of Philadelphia *Real-Time Data Set for Macroeconomists* (http://www.philadelphiafed.org/research-and-data/real-time-center/real-time-data/data-files/ROUTPUT/). The results are similar if we use the 1948Q2–1960Q4 sample and current (revised) data.

the estimated coefficient is –0.31 for Okun's sample (column 1) and –0.29 for our full sample (column 3). When two lags are included, the sums of coefficients are –0.44 for Okun's sample (column 2) and −0.43 for our full sample (column 4). Thus, we confirm that lag structure rather than data differences explains the variation in results.

Since lags are significant when they are included, we interpret their absence from Okun's quarterly equation as a modest misspecification. Okun underestimated the effects of output on unemployment because he assumed that they are fully contemporaneous at the quarterly frequency.[5]

By the standards of empirical macroeconomics, it is remarkable that a relationship estimated from the late 1940s to 1960 yields almost identical estimates when the sample is extended through 2013. This finding supports our broad view that Okun's Law is a strong and reliable relationship.

2.5 Output, Employment, and Unemployment

We derived Okun's Law, equation (3), from underlying relationships between employment and output, and between unemployment and employment (equations (1) and (2)). To check the logic behind the law, we now estimate it along with the two underlying relationships, using data on employment from the BLS household survey. We use quarterly data from 1948–2013, include two lags in each equation, and measure the long run levels of all variables—employment as well as unemployment and output—with the HP filter and $\lambda = 1{,}600$. We estimate our three equations jointly as a system of seemingly unrelated regressions (SURs).

Table 6 presents the results. The fit of the equations is good: the $\bar{R}^2$s are all 0.74 or above. When we explain employment with output and two lags of output, the sum of coefficients is 0.67, which is higher in absolute value than the sum of −0.50 when unemployment is the dependent variable. When we regress the unemployment rate on employment, the sum of coefficients is −0.73, which is substantially less than one in absolute value.[6]

These results are consistent with the framework underlying Okun's Law, which we discussed in Section 1. An increase in output raises employment, which, in turn, raises labor force participation. The rise in participation implies that the unemployment rate moves less than one-for-one with employment, so the effects of output on unemployment are smaller than the effects on employment.

5. It is more difficult to compare our estimates of Okun's Law in levels to Okun's estimates, because of differences in the series for U^* and Y^*. Okun assumed that U^* is 4.0% (Okun, 1962, p. 3) even though unemployment averaged 4.6 over his sample, and he constructed a Y^* series that usually exceeds actual output. Our estimation of U^* and Y^* imposes the modern assumption that unemployment and output equal their long-run levels on average. Presumably, this issue, along with lag structure, helps explain why our levels results differ from Okun's.

6. In Table 6, we report classical OLS standard errors for our coefficients, not Newey–West standard errors as in other tables. It appears nontrivial to develop a version of Newey–West standard errors for SUR. We have compared OLS and Newey–West standard errors when we estimate the equations in Table 6 separately, and the differences are modest.

TABLE 6

United States: Estimates of Okun's Law and Unemployment–Employment Relation (Quarterly Data, 1948Q1–2013Q4)
Seemingly Unrelated Regressions

	Equation in levels		
	Hodrick–Prescott filter λ = 1,600		
	$U_t - U_t^* = \beta(L)(Y_t - Y_t^*) + \varepsilon_t$	$E_t - E_t^* = \beta(L)(Y_t - Y_t^*) + \varepsilon_t$	$U_t - U_t^* = \beta(L)(E_t - E_t^*) + \varepsilon_t$
β_0	−0.240**	0.314**	−0.736**
	(0.023)	(0.035)	(0.022)
β_1	−0.134**	0.181**	−0.010
	(0.034)	(0.051)	(0.031)
β_2	−0.122**	0.176**	0.019
	(0.023)	(0.035)	(0.020)
$\beta_0+\beta_1+\beta_2$	−0.496**	0.670**	−0.728**
	(0.012)	(0.020)	(0.013)
Obs	262	262	262
Adjusted R^2	0.869	0.739	0.843
Durbin–Watson	0.503	0.503	0.503

Note: Table reports point estimates and standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

3. JOBLESS RECOVERIES?

Many observers suggest that Okun's Law has broken down in a particular way: recoveries following recessions have become "jobless," with weaker employment growth and higher unemployment than Okun's Law predicts (e.g., Gordon 2010). The recoveries from the last three U.S. recessions—those of 1990–91, 2001, and 2008–2009—have all been called jobless. Many economists treat the emergence of jobless recoveries as a fact to be explained. In 2011, for example, Barcelona's Center for International Economic Research held a conference on "Understanding Jobless Recoveries" that focused on the three U.S. episodes.

We can look for evidence of jobless recoveries in the Figure 2 discussed earlier. After the 1990 and 2008 recessions, unemployment peaks at higher levels than its fitted values according to Okun's Law. This fact implies some unexplained "joblessness"—but the deviations from Okun's Law are far too small to suggest a qualitative change in the nature of recoveries. After the 2001 recession, the peak unemployment rate is almost exactly the same as its fitted value. As we have stressed before, the overall message of Figure 2 is that Okun's Law does not change much over time or phases of the business cycle.

A potentially important nuance is that economists who discuss jobless recoveries, such as Schreft and Singh (2003) and Gordon (2010), often examine the behavior of *employment* rather than the unemployment rate. In principle, a recovery might be jobless in the sense of subnormal employment growth, yet not produce an anomalous rise in the unemployment rate, if labor force participation falls.

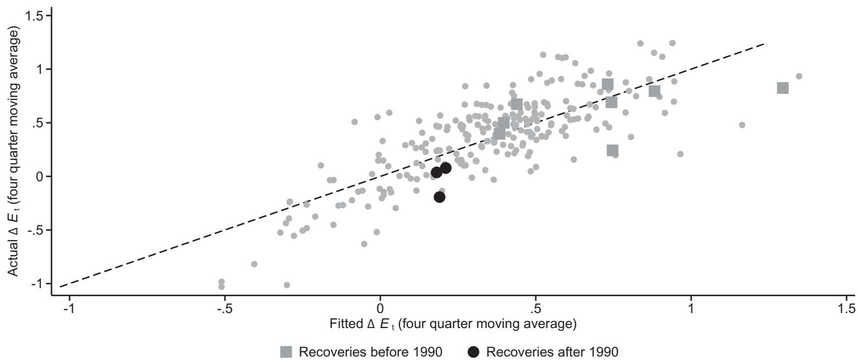

FIG. 3. United States: Okun's Law for Employment: Actual and Fitted Values.

NOTE: The label is the first quarter of the recovery.

To investigate this possibility, we examine the behavior of employment during recoveries. Specifically, we examine employment growth in the first four quarters after an NBER trough, the recovery period studied by Schreft and Singh (2003).

In this exercise, we first estimate the normal output–employment relationship in quarterly differences: we regress the change in log employment on the change in log output and its first two lags. We then compute fitted values of the change in log employment, average these fitted values over four-quarter periods, and compare these averages to actual changes in log employment. Figure 3 shows the results for all four-quarter periods in our sample, and highlights the recoveries following NBER troughs. This figure tells us whether employment growth during recoveries is unusually low conditional on output growth.[7]

In Figure 3, the observations marked by black dots are the recovery periods after the last three NBER troughs—the allegedly jobless recoveries. In all three episodes, the fitted value of the change in employment is greater than the actual change. In two cases, however, the difference is trivial. In the third case—the recovery after the Great Recession of 2008–09—the difference is somewhat larger, but the observation is hardly an outlier. Overall, the figure shows that employment growth has *not* been anomalous in recent recoveries.

If the employment–output relationship has not shifted, then why have observers seen recent recoveries as jobless? Galí, Smets, and Wouters (2012) give the answer: recoveries since 1990 have been weaker than earlier recoveries. We can see this fact in Figure 3, where gray squares mark the eight recoveries between 1948 and 1990. These observations lie above and to the right of the more recent recoveries: actual employment growth is higher and so are fitted values, because of higher output growth. Averaging across the two groups of recoveries, employment growth fell from 2.5% before 1990 to −0.1% after 1990, and output growth fell from 7.3% to 2.5%.

7. In the estimated equation for the change in log employment, the constant is −0.46 and the coefficients on the change in log output and its two lags are 0.22, 0.23, and 0.047.

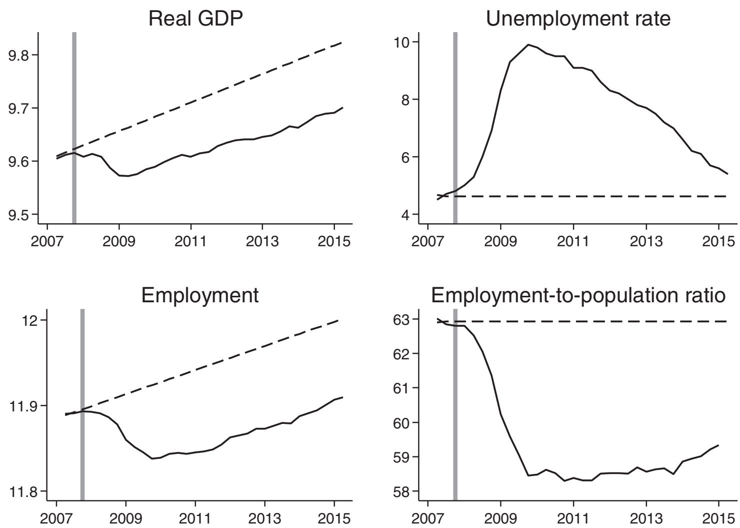

FIG. 4. United States and the Great Recession.

NOTE: Figure reports actual values and natural rates based on HP-filtered values with $\lambda = 1{,}600$ and estimated through 2007Q3. Natural rates extended beyond 2007Q3 based on assumption of no change from the 2007Q3 level of the natural rate of unemployment and employment-to-population ratio, as well as no change from the 2007Q3 natural rates of growth of output and employment. Vertical lines indicate 2007Q4.

In sum, recent recoveries have been jobless in the sense that employment stagnated, but those outcomes are explained by weak output growth and a stable output–employment relationship. Galí, Smets, and Wouters (2012) discuss possible reasons for weak output growth, such as the zero bound that constrained monetary policy in the post-2008 recovery.

4. LABOR FORCE PARTICIPATION AND THE RECENT BEHAVIOR OF UNEMPLOYMENT

In the last several years, observers such as Bernanke (2012) have suggested a new anomaly: unemployment has been *lower* than one would expect based on Okun's Law. In contrast to the alleged phenomenon of jobless recoveries, we believe that the behavior of unemployment since 2011 really has deviated significantly from Okun's Law, because of an unusual fall in labor force participation.

We can see these points from Figure 4. The top two panels of the figure show the paths of output and the unemployment rate from 2007 through 2014. We also show paths for the long-run levels of these variables, U^* and Y^*, based on their prerecession behavior. Specifically, we estimate long-run levels with the HP filter through 2007Q3, and then assume that U^* and the growth of Y^* remain at their 2007Q3 levels over the period from 2007Q4 through 2014.

For the first part of the period in Figure 4, from 2007 through 2011, the data are consistent with Okun's Law. In 2011Q4, the estimated deviations of output and unemployment from their long run levels are -10% and 4 percentage points, respectively, suggesting an Okun coefficient of -0.4, close to our estimates for the United States since 1948. But after 2011, we see a substantial fall in unemployment that is not consistent with Okun's Law. The output gap widens by about 2 percentage points from 2011Q4 to 2014Q4, which should imply a slight rise in unemployment, but the estimated unemployment gap decreases by almost 3 percentage points.

What explains this deviation from Okun's Law? It was *not* caused by anomalous behavior of employment. The bottom two panels of Figure 4 make this point by showing the paths of employment and the employment-population ratio (e-pop), along with their long run levels (once again estimated through 2007Q3 and then extrapolated). In contrast to the unemployment rate, employment and e-pop do not return toward their prerecession paths after 2011. Rather, the gap between employment and its long run level widens slightly, consistent with the slight increase in the output gap.

Recall that Okun's Law (equation (3) above) is derived from underlying relationships between employment and output (equation (1)), and between unemployment and employment (equation (2)). Figure 4 suggests that the employment–output relationship has not shifted substantially in recent years, but unemployment has fallen by more than Okun's Law predicts; in other words, we have seen stability in equation (1) but instability in equation (3). We can reconcile these facts if equation (2) has shifted—specifically, if the unemployment rate has fallen by more than we would expect based on employment. That happens if there is an unusual decrease in labor force participation.

And indeed, there has been a substantial fall in the labor force participation rate, from 66% in 2008Q4 to 63% in 2014Q4. As discussed by Erceg and Levin (2013), this decrease is far greater than expected based on the behavior of output and the modest procyclicality of participation before 2008.

The explanation for the fall in participation is not clear. Some economists cite demographic changes and other trends that began before 2008, such as rising school enrollments (e.g., Krueger 2016). Erceg and Levin, by contrast, emphasize the unusual depth and duration of the Great Recession. In their view, costs of entering and exiting the labor force normally mean that participation does not respond much to employment fluctuations, but a protracted recession eventually leads workers to exit.

5. OKUN'S LAW IN 20 ADVANCED ECONOMIES

Here, we examine the fit of Okun's Law in 20 countries: those with populations above one million that were members of the OECD in 1985. We use data on output and unemployment from the OECD.[8]

8. We present results for OECD data based on national definitions of unemployment. The results are similar when we use the OECD's harmonized unemployment series.

TABLE 7

ADVANCED ECONOMIES: ESTIMATES OF OKUN'S LAW
EQUATION ESTIMATED:
QUARTERLY: $U_t - U_t^* = \beta_0(Y_t - Y_t^*) + \beta_1(Y_{t-1} - Y_{t-1}^*) + \beta_2(Y_{t-2} - Y_{t-2}^*) + \varepsilon_t$
ANNUAL: $U_t - U_t^* = \beta(Y_t - Y_t^*) + \varepsilon_t$

	Quarterly data (1980Q1–2013Q4)			Annual data (1980–2013)		
	Levels version					
	$\beta_0+\beta_1+\beta_2$		Adjusted R^2	β		Adjusted R^2
Australia	−0.554**	(0.042)	0.748	−0.563**	(0.046)	0.785
Austria	−0.172**	(0.029)	0.264	−0.132**	(0.035)	0.156
Belgium	−0.476**	(0.056)	0.590	−0.538**	(0.097)	0.600
Canada	−0.524**	(0.031)	0.811	−0.443**	(0.035)	0.785
Denmark	−0.434**	(0.033)	0.700	−0.434**	(0.042)	0.677
Finland	−0.420**	(0.061)	0.694	−0.490**	(0.089)	0.749
France	−0.370**	(0.036)	0.672	−0.353**	(0.039)	0.665
Germany	−0.304**	(0.055)	0.488	−0.363**	(0.091)	0.461
Ireland	−0.415**	(0.043)	0.538	−0.384**	(0.049)	0.613
Italy	−0.217**	(0.040)	0.253	−0.295**	(0.089)	0.301
Japan	−0.151**	(0.014)	0.643	−0.165**	(0.023)	0.705
Netherlands	−0.451**	(0.055)	0.635	−0.520**	(0.102)	0.609
New Zealand	−0.335**	(0.059)	0.370	−0.397**	(0.058)	0.659
Norway	−0.261**	(0.031)	0.497	−0.272**	(0.036)	0.609
Portugal	−0.310**	(0.029)	0.471	−0.308**	(0.038)	0.718
Spain	−0.939**	(0.067)	0.742	−0.824**	(0.059)	0.866
Sweden	−0.434**	(0.071)	0.638	−0.538**	(0.111)	0.607
Switzerland	−0.256**	(0.028)	0.575	−0.222**	(0.031)	0.425
United Kingdom	−0.360**	(0.048)	0.665	−0.357**	(0.070)	0.559
United States	−0.563**	(0.039)	0.846	−0.476**	(0.047)	0.779

NOTE: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

5.1 Basic Results

We examine the period from 1980 to 2013. We start our samples in 1980 because, in a number of countries, unemployment was very low in earlier periods. An extreme example is New Zealand, where unemployment rates between 1960 and 1975 ranged from 0.04% to 0.66%. Evidently, some countries' economic regimes in the 1960s and 1970s differed from those of more recent decades, or unemployment was measured differently.

For each country in our sample, Table 7 reports estimates of Okun's Law in levels. We report a version with annual data, with U_t* and Y_t* measured with an HP parameter of $\lambda = 100$, and a version with quarterly data, with an HP parameter of 1,600 and two lags of the output gap in the equation.

The fit is good for most countries, though usually not as close as for the United States. The $\bar{R}^2$ exceeds 0.4 in all countries but Austria and Italy for annual data, and for all but Austria, Italy, and New Zealand for quarterly data. The average $\bar{R}^2$ for the 20 countries is 0.62 for annual data and 0.59 for quarterly data.[9]

The estimated coefficients on the output gap vary considerably across countries. For annual data, most coefficients are spread between –0.27 and –0.55, but three are lower in absolute value (Austria, Japan, and Switzerland), and Spain is an outlier with –0.82. The average coefficient is −0.40. The results for quarterly data are similar: the average of the sum of coefficients is −0.40, and the correlation across countries between this sum and the annual coefficient is 0.94. Spain is even more of an outlier in quarterly data, with a sum of coefficients of −0.94.

Countries with higher $\bar{R}^2$'s generally have higher coefficients. Japan, however, is an exception: it has fairly high $\bar{R}^2$s (0.71 in annual data) but low coefficients (–0.17 in annual data). Japan's unemployment movements are small and are well explained by its output movements and a low coefficient in Okun's Law.

As a robustness check, Table 8 reports estimates of the differences version of Okun's Law, both annual and quarterly. Averaging across countries, the Okun coefficients are somewhat smaller than those in the levels equation: the average coefficient falls from −0.40 to −0.32 for annual data, and for quarterly data, the sum of coefficients falls from −0.40 to −0.31. Yet, the variation in coefficients across countries is quite similar for levels and differences. For annual data, the cross-country correlation of the level and difference coefficients is 0.92, and for quarterly data, the correlation of the sums of coefficients is 0.94.

5.2 *Stability over Time*

We now ask whether the Okun's Law coefficient is stable over time in a given country. Previous studies have suggested that it is not stable: Cazes, Verick, and Al-Hussami (2011) find that the coefficient varies erratically in many countries, and IMF (2010) finds that it has generally risen over time. The IMF study's explanation is that legal reforms have reduced the costs of firing workers.

We have examined the stability of our annual and quarterly specifications of Okun's Law in levels (Table 7). An online Appendix presents detailed results. Following our approach with U.S. data, we first do simple stability tests with a fixed break date. We break the sample in half, estimating separate coefficients for 1980–96 and 1997–2013.

We find some evidence of instability. With annual data, we reject stability of the Okun coefficient at the 5% level for 7 of the 20 countries. However, in five of these seven cases, the coefficient is *lower* in absolute value in the second half of the sample. The average coefficient for the 20 countries is –0.44 in the first half of the sample and –0.34 in the second. The quarterly results are not very different: there is a significant change in the sum of output coefficients in nine countries, and five of these changes are decreases in absolute value. Our data generally do not support the view that the Okun coefficient has risen over time.

9. We estimate the Okun coefficient for each country with OLS. The results are similar if we estimate the coefficients jointly in a panel framework with SURs.

TABLE 8

Advanced Economies: Estimates of Okun's Law
Equation Estimated:
Quarterly: $\Delta U_t = \alpha + \beta_0 \Delta Y_t + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \varepsilon_t$
Annual: $\Delta U_t = \alpha + \beta \Delta Y_t + \varepsilon_t$

	Quarterly data (1980Q1–2013Q4)			Annual data (1980–2013)		
	Changes version					
	$\beta_0+\beta_1+\beta_2$		Adjusted R^2	β		Adjusted R^2
Australia	−0.410**	(0.061)	0.455	−0.461**	(0.064)	0.628
Austria	−0.204**	(0.034)	0.108	−0.135**	(0.032)	0.168
Belgium	−0.317**	(0.087)	0.177	−0.315**	(0.072)	0.357
Canada	−0.433**	(0.070)	0.500	−0.433**	(0.049)	0.766
Denmark	−0.326**	(0.034)	0.414	−0.346**	(0.043)	0.557
Finland	−0.354**	(0.076)	0.398	−0.347**	(0.105)	0.521
France	−0.331**	(0.035)	0.389	−0.274**	(0.039)	0.409
Germany	−0.229**	(0.053)	0.290	−0.223*	(0.082)	0.245
Ireland	−0.327**	(0.067)	0.376	−0.348**	(0.065)	0.528
Italy	−0.187**	(0.056)	0.123	−0.170*	(0.073)	0.179
Japan	−0.075**	(0.026)	0.193	−0.079**	(0.020)	0.306
Netherlands	−0.315**	(0.054)	0.423	−0.363**	(0.094)	0.459
New Zealand	−0.165**	(0.041)	0.109	−0.310**	(0.062)	0.408
Norway	−0.120**	(0.038)	0.063	−0.171**	(0.040)	0.274
Portugal	−0.312**	(0.043)	0.149	−0.304**	(0.040)	0.659
Spain	−0.744**	(0.094)	0.578	−0.802**	(0.090)	0.786
Sweden	−0.423**	(0.083)	0.507	−0.388**	(0.124)	0.486
Switzerland	−0.205**	(0.034)	0.293	−0.188**	(0.045)	0.377
United Kingdom	−0.322**	(0.051)	0.505	−0.326**	(0.059)	0.562
United States	−0.443**	(0.049)	0.625	−0.430**	(0.047)	0.731

Note: This table reports point estimates and Newey–West standard errors in parentheses. ** and * indicate statistical significance at the 1% and 5% level, respectively.

The differences in coefficients across countries are similar in the two time periods. For example, the annual coefficient for Spain is the highest in both periods, and those for Austria, Switzerland, and Japan are among the lowest. Overall, the correlation of annual coefficients across the two periods is 0.42.

For our quarterly specification, we have also performed the Andrews test for a break at an unknown date. With that test, stability of the sum of coefficients is rejected at the 5% level for 13 of the 20 countries. Once again, the number of significant decreases in coefficients exceeds the significant increases, 8 to 5. The break dates, as identified by the largest Wald statistic, vary widely across countries: from 1985 in Canada and 1988 in Switzerland to 2008 in Germany and France. This heterogeneity in results suggests that there was no international change in Okun's Law during any particular time period.[10]

10. For an alternative perspective, see Daly et al (2014), who argue that Okun's Law coefficients changed around 2008 in many countries.

6. OKUN'S LAW IN THE GREAT RECESSION

Skepticism about Okun's Law has grown in the wake of the Great Recession of 2008–09. One reason, emphasized by IMF (2010), Bakker and Zeng (2014), and McKinsey Global Institute (2011), is that there is little correlation across countries between decreases in output and increases in unemployment during the countries' recessions. Once again, we believe that claims of a breakdown in Okun's Law are exaggerated.

6.1 Output and Unemployment from Peak to Trough

We can see why a quick look at the data might suggest a breakdown of Okun's Law. Nineteen of the countries in our sample (all but Australia) experienced a recession that began in either late-2007 or 2008, according to Harding and Pagan's (2002) definitions of peaks and troughs in output. For these countries, Figure 5(a) plots the change in output from peak to trough against the change in unemployment over the same period. This figure is similar to one in IMF (2010).

The figure shows that changes in output and unemployment are uncorrelated across countries. When the change in U is regressed on a constant and the change in Y, the $\bar{R}^2$ is –0.002. Commentators have used subsets of the observations in Figure 5(a) as an evidence against Okun's Law. McKinsey, for example, points out that Germany and the United Kingdom had larger output falls than the United States and Spain, yet unemployment increased by less in the UK and fell in Germany. Bakker and Zeng (2014) cite Ireland and Spain as countries where unemployment rose more than Okun's Law predicts.

Such evidence has led researchers to propose novel factors to explain unemployment changes. IMF (2010) suggests that financial crises and house price busts raise unemployment for a given level of output. McKinsey suggests that output growth may fail to decrease unemployment because workers lack the skills for available jobs.

6.2 Correcting for the Length of Recessions

It is misleading to compare output and unemployment changes during different countries' recessions, because recessions last for varying lengths of time. For the set of recessions in Figure 5(a), the period from peak to trough ranges from two quarters in Portugal to seven quarters in Denmark. Okun's Law implies a relationship between the changes in unemployment and output only if we control for this factor.

To see this point in a simple way, suppose that the changes version of Okun's Law holds exactly in quarterly data:

$$\Delta U_t = \alpha + \beta \Delta Y_t, \alpha > 0, \beta < 0, \tag{6}$$

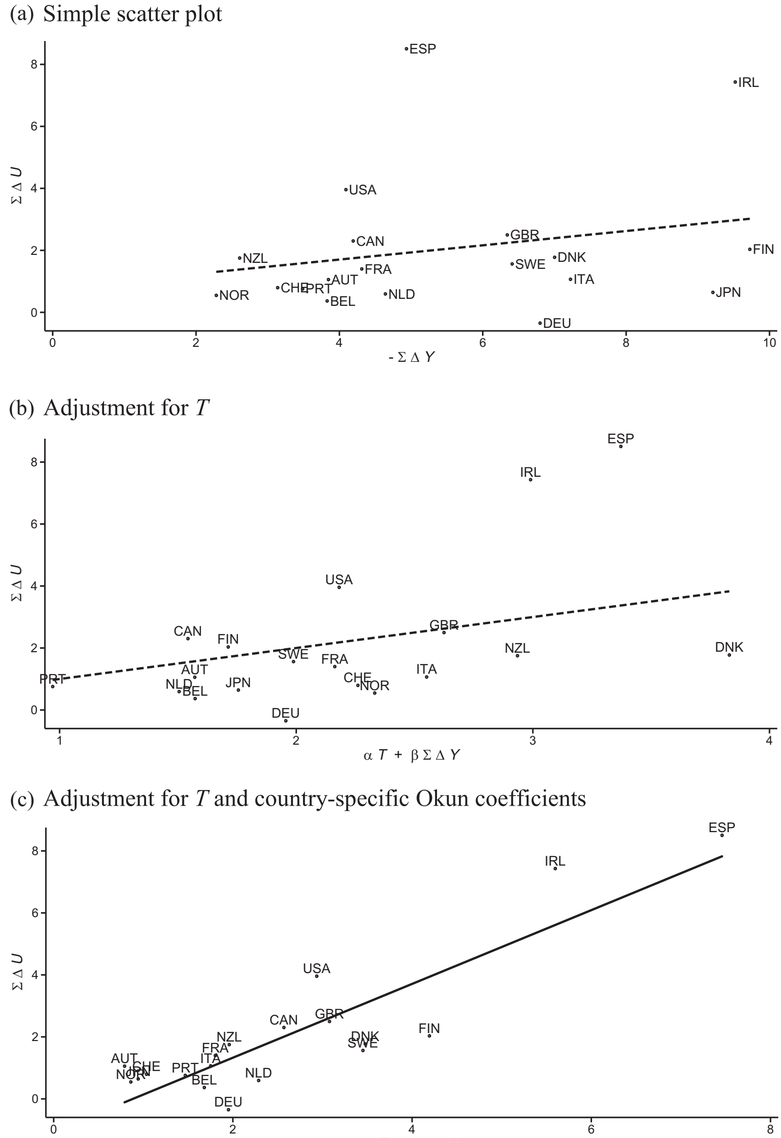

FIG. 5. The Great Recession: Peak-to-Trough Output and Unemployment Changes. (a) Simple Scatter Plot. (b) Adjustment for T. (c) Adjustment for T and Country-Specific Okun Coefficients.

NOTE: $\Sigma\ \Delta U$ and $\Sigma\ \Delta Y$ denote the cumulative peak-to-trough change in the unemployment rate and in the log of real GDP, respectively. T denotes the duration of the recession (peak to trough in quarters). α_i and β_i denote country-specific Okun coefficients.

where for the moment, we assume that the parameters α and β are the same for all countries. Let T be the number of quarters in a recession. Cumulating equation (6) over T quarters gives

$$\Sigma\, \Delta U = \alpha\, T + \beta \Sigma\, \Delta Y, \tag{7}$$

where Σ indicates the cumulative change over a recession.

Recall that $\alpha > 0$ because potential output grows over time. Thus, holding constant the change in output, a longer recession implies a larger rise in unemployment. With potential output on an upward path, a given absolute fall in output translates into a larger output gap and higher unemployment if it occurs over a longer period.

We examine the fit of equation (7) across countries by regressing the cumulative change in U during a country's recession on the cumulative change in Y and the recession length T (without a constant term). This regression yields estimates of $\alpha = 0.63$ (standard error = 0.30) and $\beta = –0.08$ (standard error = 0.22). Figure 5(b) plots the cumulative change in U against the fitted values from this regression. We see that the version of Okun's Law in equation (7) explains a substantial part of the cross-country variation in $\Sigma\ \Delta U$: the $\bar{R}^2$ is 0.53. Notice that Spain is less of an outlier than it was in Figure 5(a). The large increase in Spanish unemployment is partly explained by the length of Spain's recession—six quarters, the second longest in the sample.

6.3 Adjusting for Country-Specific Coefficients

We saw in Section 5 that the coefficient in Okun's Law varies substantially across countries. We now ask whether changes in unemployment during the Great Recession fit the law, given the usual coefficient for each country. That is, we examine the fit of

$$\Sigma\, \Delta U = \alpha_i T + \beta_i \Sigma\, \Delta Y, \tag{8}$$

where α_i and β_i are the parameters of Okun's Law for country i.

We compute the fitted values of $\Sigma\ \Delta U$ implied by equation (8). For α_i and β_i, we use estimates of Okun's Law in changes for annual data over 1980–2013 (with α_i divided by four to fit the current exercise with quarterly data). The α_is average 0.84 across countries (0.21 once we divide by four). The β_is are given in Table 8.

Figure 5(c) compares the actual and fitted values of $\Sigma\ \Delta U$. We see that equation (8) fits well: the $\bar{R}^2$ is 0.77. Again, Spain is a good example. Its large rise in unemployment is explained almost entirely by the fact that its Okun coefficient β_i is unusually large, along with the length of its recession. In other words, Spain *did* experience a larger rise in unemployment than other countries, but that is what we should expect based on its historical Okun's Law.

6.4 A German Miracle?

When economists discuss deviations from Okun's Law, many stress the recent experience of Germany. As Figure 5 shows, Germany is the one country where unemployment fell during its recession, an outcome that is often called a "miracle" (e.g., Burda and Hunt 2011). Many economists explain this experience with work-sharing—decreases in hours per worker—encouraged by government subsidies to employers who retained workers.

Figure 5(c) confirms that Germany deviated from Okun's Law during its recession. Its predicted change in unemployment was 2 percentage points, and its actual change was –0.3 percentage points. This episode reminds us that Okun's Law does not explain 100% of unemployment behavior. Yet "miracle" may be an exaggeration of Germany's experience. The residual in Germany's Okun's Law is modest compared to cross-country differences in unemployment changes.

7. EXPLAINING CROSS-COUNTRY VARIATION IN OKUN'S LAW

We have seen that Okun's Law fits the data in most countries, but that the Okun coefficient differs across countries. What explains these differences? In addressing this question, we focus on the levels version of Okun's Law estimated with annual data.

7.1 Looking for Explanatory Variables

We can gain some insight about the Okun coefficient from Figure 6, which plots the estimated annual coefficients for our 20 countries against the average level of unemployment over 1980–2013 (left panel). We see an inverse relationship: in countries where unemployment is higher on average, it also fluctuates more in response to output movements. This result is driven primarily by a cluster of countries with low unemployment and low coefficients—Switzerland, Japan, Austria, and Norway—and by Spain, which has very high unemployment and a very high coefficient. It appears likely that the underlying factors that determine the Okun coefficient also influence average unemployment.

We have looked for the underlying determinants of the Okun coefficient, but our results are largely negative. A notable failure is the OECD's well-known index of employment protection legislation (EPL). In theory, greater employment protection should dampen the effects of output movements on employment and therefore reduce the Okun coefficient. In Figure 6 (right panel), we test this idea by plotting the coefficient against the OECD's overall EPL index (averaged over 1985–2008, the period for which it is available). The relationship has the wrong sign, and it is statistically insignificant.[11]

11. For New Zealand, the EPL index is available over 1990–2008. We also find no relationship between the Okun coefficient and the various components of the EPL index.

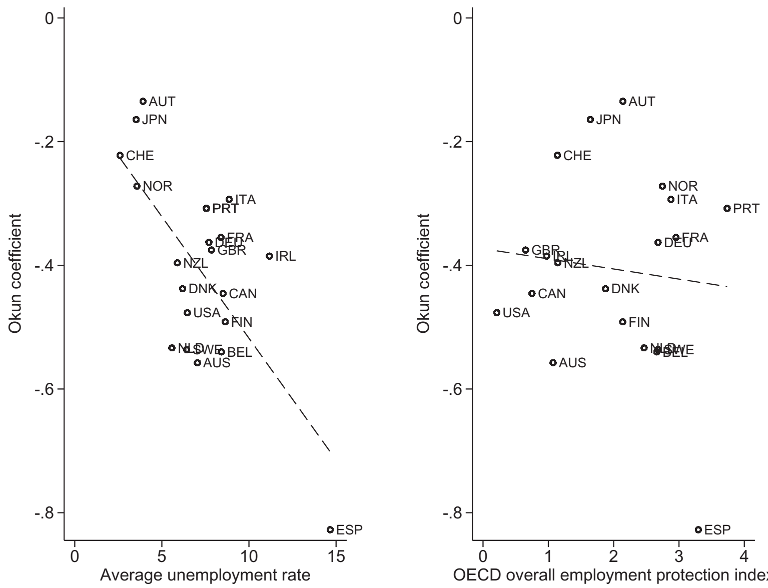

Fig. 6. Explaining Cross-Country Variation in Okun Coefficients (Okun Coefficient versus Candidate Variables).

Note: Average unemployment rate denotes 1980–2013 mean. OECD overall employment protection index denotes 1985–2008 mean based on available data.

7.2 *Individual Countries*

We can also learn about the Okun coefficient by examining individual countries. It appears that the labor markets of many countries have idiosyncratic features that influence the coefficient. These features—not one or two variables that we can measure for all countries—probably account for most of the variation in the coefficient. To support this idea, we examine the country with the highest estimated coefficient, Spain, and the three countries with the lowest coefficients (focusing again on the levels equation with annual data).

Spain. This country's Okun coefficient, –0.82, is substantially higher in absolute value than any other country's. The natural explanation is the unusually high incidence of temporary employment contracts. Labor market reforms in the 1980s made it easier for Spanish employers to hire workers on fixed-term contracts, without the employment protection guaranteed to permanent workers. Over the 1990s and 2000s, such contracts have accounted for around a third of Spanish employment. Temporary contracts make it easier for firms to adjust employment when output changes, raising the Okun coefficient.

Notice that the OECD's EPL index assigns a fairly high number to Spain, suggesting that it is *not* easy for Spanish employers to adjust employment. However, close observers of Spain argue that the OECD index is not a good measure of flexibility in this case. One reason is that the OECD does not account for the nonenforcement of *de jure* restrictions on fixed-term contracts (Bentolila et al. 2010).

Japan. This country's Okun coefficient, –0.17, is the second smallest in absolute value. The likely explanation is Japan's tradition of "lifetime employment," which makes firms reluctant to lay off workers. This feature of the labor market is a choice of employers, not a legal mandate, and therefore is not captured by the EPL index.

Ono (2010) reports that the lifetime employment tradition has weakened somewhat over time. This suggests that Japan's Okun coefficient may have risen—and indeed, Japan is one of the two countries with a statistically significant increase in the coefficient from the first half of our sample period to the second (see online Appendix). However, the coefficient is low compared to other countries in both parts of the sample (-0.12 in the first and -0.22 in the second).

Switzerland. This country's coefficient, –0.22, is the third smallest. A likely explanation is the large use of foreign workers in Switzerland. When employment rises or falls, migrant workers move in and out of the country. Changes in employment are accommodated by changes in the labor force, and unemployment is stable.

Recall that Okun's Law is derived from an employment–output relationship, equation (1), and an unemployment–employment relationship, equation (2). We estimate these two equations for our 20 countries and examine where Switzerland lies in the ranges of coefficients. Switzerland's coefficient in the *E-Y* equation, 0.49, is near the middle of the range for the 20 countries. Switzerland's coefficient in the *U-E* equation is the second smallest, and it is statistically insignificant. These results confirm that Switzerland's unusual feature is the nonresponsiveness of unemployment to employment.

Austria. Austria's data are puzzling. Its Okun coefficient, –0.13, is the smallest for our 20 countries, and we have not found an explanation for this result. When we estimate the *E-Y* and *U-E* relationships, the coefficients are 0.16 and -0.04, respectively. Both coefficients are the lowest (in absolute value) for our set of 20 countries and the latter estimate is implausibly small. We leave further investigation of Austria for future research.

8. CONCLUSION

It is rare to call a macroeconomic relationship a "law." Yet we believe that Okun's Law has earned its name. It is not as universal as the law of gravity (which has the same parameters in all advanced economies), but it is strong and stable by the standards of macroeconomics. Reports of deviations from the Law are often exaggerated. Okun's Law is certainly more reliable than a typical macrorelationship like the Phillips curve, which is constantly under repair as new anomalies arise in the data.

The evidence in this paper is consistent with traditional macromodels in which shifts in aggregate demand cause short-run fluctuations in unemployment. At this point, we do not claim that the evidence is *not* consistent with other theories of unemployment, such as those based on sectoral shocks or extensions of unemployment benefits. The usefulness of Okun's Law in testing macrotheories is a topic for future research.

A possible starting point is the fact that the Okun coefficient is far smaller than one would expect from an inverted production function (even when we put employment rather than unemployment on the left side of the law). Traditional macro explains this fact with costs of adjusting employment to aggregate demand shifts. It is not clear whether a small Okun's coefficient arises naturally in other models of unemployment.

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