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On the Determinants of the Okun's Law: New Evidence from Time-Varying Estimates

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Abstract

This paper revisits, by means of both time series and panel data analyses, the empirical regularity identified by Okun's (in: Proceedings of the business and economics statistics section, American Statistical Association, Washington, DC, 98–103, 1962) seminal paper. Based on a sample of 85 advanced and developing economies between 1978 and 2014, we confirm the existence of an average negative and statistically significant Okun's relationship. At the same time, results suggest that the relation varies substantially across countries and times. Finally, we identify several factors affecting the variation in Okun's coefficient across and within countries. Across countries, the relationship is stronger in countries with higher average unemployment, a larger share of public employment, lower informality and smaller agricultural sectors, and one that is more diversified. Within countries, in addition to some of these factors, we find that deregulation in labor and product markets and recessions have strengthened the response of unemployment to the business cycle.

Keywords Okun's law · Crises · Time-varying coefficients · Labor market regulations · Product market regulations · Urbanization · Public sector employment

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JEL Classification E24 · E34 · C10 · C30

Introduction

The so-called Okun's law [after Okun (1962) seminal paper] reported a bivariate negative relationship between unemployment and output—the "truly sturdy empirical regularity" (Blinder 1997). Since then several papers tried to test its validity using different econometric methods, samples and time periods. Some contributions include: Smith (1975), Knoester (1986), Paldam (1987), Kaufman (1988), Nguyen and Siriwardana (1988), Moosa (1997), Altig et al. (1997), Lee (2000), Freeman (2001), Sogner and Stiassny (2002), Huang and Chang (2005), Knotek (2007), Tillmann (2010) and Ball et al. (2019). These studies generally point to the empirical validity of the Okun's law despite the fact that coefficient estimates seem to vary across countries.[1]

Yet many economists question the Okun's law. Recent studies have suggested that the Okun's law is unstable in many countries, thereby questioning the temporal stability of Okun's coefficients (Huang and Lin 2008; Gordon 2010; Cazes et al. 2012; Meyer and Tasci 2012). Another reason behind skeptics of Okun's law validity is related to the observation that each of the last three US recessions was followed by a "jobless recovery" in which employment growth was weaker than what the US Okun's law predicted. In fact, some found that the empirical regularity broke down during the Global Financial Crisis (see, e.g., IMF 2010).[2] Such claims matter for the interpretation of unemployment movements and for macroeconomic policy. With this in mind, Ball et al. (2017), in particular, addressed the question of the stability of the Okun's coefficient focusing on the USA and 20 other advanced countries and found that while the coefficients are typically stable, especially for the USA, they tended to be larger during crises.

This paper revisits the issue of the Okun's law temporal stability and its determinants, adding several new aspects to the existing literature. Our contribution is fourfold. First, we extend Ball et al. (2017) by examining how the Okun's law has changed during crises for a large set of 85 countries (split between 33 advanced and 52 developing) between 1978 and 2014. The bulk of the literature on Okun's law has focused on advanced economies. Extending previous analysis to encompass developing countries is important since these account for a large and growing share of the global labor force. Second, we extend Ball et al. (2019) by taking one step further to the authors' static analysis and assess whether the Okun's law has changed over time for each individual country. Third, we identify, in a full panel framework, country-specific and time-varying drivers of the Okun's law. While several studies have analyzed the impact of shocks on unemployment and its determinants (Bruno and

[1] For the USA, many authors posit that a 1% deviation of output from potential causes an opposite change in unemployment of half a percentage point (Mankiw 2012).

[2] For the McKinsey Global Institute (2011) the Okun's law has broken down because of problems in the labor market, such as mismatch between workers and jobs.

Sachs 1985; Blanchard and Wolfers 2000; Nickell et al. 2005; Bernal-Verdugo et al. 2012a, b), very few papers have estimated employment–output elasticities and even fewer inspected the factors that may account for the cross-country variation (Döpke 2001; Mourre 2004; Crivelli et al. 2012). Given the general perception that labor market outcomes in developing countries reflect mostly structural factors rather than short-run cyclical fluctuations, shedding light on this has potentially important policy implications.

Our findings confirm the existence of strong negative and statistically significant Okun's coefficients in both advanced and developing countries, despite clear variation across countries. We find that the cyclical relationship between unemployment and growth is considerably weaker, on average, in developing than in advanced countries. Moreover, by estimating country-specific time-varying Okun's coefficients we highlight the fact that cyclical aspects between unemployment and output have been changing over time and should be taken seriously. Finally, we identify several factors affecting the variation in Okun's coefficient across and within countries. Across countries, the relationship is stronger in countries with higher average unemployment, a larger share of public employment, lower informality and smaller agricultural sectors, and those that are more diversified. Within countries, in addition to some of these factors, we find that deregulation in labor and product markets and recessions have strengthened the response of unemployment to the business cycle.

The remainder of the paper is organized as follows. "Methodology and Data" section discusses the data sources and empirical methodology. "Stylized Facts" section discusses some stylized facts and our key results. The last section concludes.

Methodology and Data

The Okun's law postulates an inverse relationship between cyclical fluctuations in output and the unemployment rate. It is assumed that shocks to the economy lead output to fluctuate around its potential; this in turn causes firms to hire and fire workers, changing the unemployment rate in the opposite direction. Following Ball et al. (2019), this relation can be expressed as:

$$u_t^c = \beta y_t^c + \varepsilon_t \tag{1}$$

where u_t^c and y_t^c are the cyclical components of the unemployment rate and (log) output, respectively. We compute u_t^c and y_t^c as the deviation of the unemployment rate (u) and (log) output (y) from their respective trends.[3] The error term in Eq. (1) captures factors that shift the cyclical unemployment–output relationship, such as unusual changes in productivity or in the labor force participation.

[3] These can be constructed using any filtering method. Ball et al. (2019) rely on the Hodrick–Prescott (1981, 1997) filter and take 2 values of the smoothness parameter, 100 and 12 [the latter for developing countries as suggested by Rand and Tarp (2002)].

Another version of Okun's law posits a relationship between changes in the unemployment rate and the growth rate of output:

$$\Delta u_t = \alpha + \beta \Delta y_t + \varepsilon_t \tag{2}$$

We refer to Eq. (1) as the "gap" version and Eq. (2) as the "changes" version of Okun's law.

To assess how the Okun's coefficient has changed over time in each country, we generalize the standard linear regression model by letting the slope of the regression to vary over time. We take, for illustration purposes, Eq. (2) and rewrite it as follows:

$$\Delta u_t = \alpha_t + \beta_t \Delta y_t + \varepsilon_t \tag{3}$$

The coefficient of interest β is assumed to change slowly and unsystematically over time, and its conditional expected value today is equal to yesterday's value. The change of the coefficient β is denoted by $v_{i,t}$, which is assumed to be normally distributed with expectation zero and variance σ_i^2:

$$\beta_t = \beta_{t-1} + v_t \tag{4}$$

Equations (3) and (4) are jointly estimated using the varying coefficient model proposed by Schlicht (1985). In this approach the variances σ_i^2 are calculated by a method-of-moments estimator that coincides with the maximum-likelihood estimator for large samples (see Schlicht 1985, 2003; Schlicht and Ludsteck 2006 for more details).[4] The model described in Eqs. (5) and (6) generalizes Eq. (1), which is obtained as a special case when the variance of the disturbances in the coefficients approaches to zero. Similarly, time-varying versions of Eqs. (2)–(4) are employed in our analysis.

As discussed by Aghion and Marinescu (2008), this method has several advantages compared to other methods to compute time-varying coefficients such as rolling windows and Gaussian methods. First, it allows using all observations in the sample to estimate the Okun's coefficient in each year—which by construction is not possible in the rolling windows approach. Second, changes in the Okun's coefficient in a given year come from innovations in the same year, rather than from shocks occurring in neighboring years. Third, it reflects the fact that changes in the relationship between unemployment and output are slow moving and depend on the immediate past.

We use 85 countries in our analysis, classified into 33 advanced and 52 developing countries. We use the IMF's *World Economic Outlook* (WEO) classification to decide which countries are considered "advanced"; the others are labeled "developing." The country sample is dictated by number of countries with at least 20 years

[4] The approach proposed by Schlicht (2003) is very similar to that used by Aghion and Marinescu (2008). The main difference is in the computation of the variances σ_i^2. Aghion and Marinescu (2008) use the Markov chain Monte Carlo (MCMC) method to approximate these variances, while Schlicht (2003) uses a method-of-moments estimator.

of continuous annual data. The time period is 1978–2014, but data for many developing countries start later. The data on the unemployment rate and real GDP come from the IMF's WEO database. To measure the trend values of the unemployment rate and output, we use the Hodrick–Prescott (1981, 1997) (HP) filter. The smoothness parameter in the HP filter is set equal to 100 in our baseline results, but we checked for sensitivity to alternative filters [including the Baxter–King (BK) and Christiano–Fitzgerald Random Walk (CFRW)].[5]

Several factors can explain the heterogeneity in the response of unemployment to changes in output across countries and over time. We formally test these factors by estimating the following specification:

$$\widehat{\beta}_{i,t} = \alpha_t + \delta_i + \boldsymbol{\Phi}' X_{i,t} + \xi_{i,t} \tag{5}$$

where α_t, δ_i are the time and country effects, to control for unobserved cross-country heterogeneity and global shocks, respectively. We first estimate Eq. (5) with ordinarily least squares (OLS) using both static (making Eq. (5), effectively a cross-sectional equation capturing average effects between 1978 and 2014—that is, without country- and time-fixed effects) and time-varying coefficient (TVC) estimates. Since our dependence variable is based on estimates (and it is measured with different levels of precision across our set of 85 countries), we also employ a weighted least squares (WLS) estimator to assess the impact of several determinants of the employment–output and unemployment–output responsiveness. Specifically, the WLS estimator assumes that the errors $\xi_{i,t}$ are distributed as $\xi_i \sim N(0, \sigma^2/s_i)$ in which s_i is the estimated standard deviation of the residuals of the static and time-varying coefficients for each country i, and σ^2 is an unknown parameters that is estimated in the second-state regression.

As for potential explanatory factors to be included in our vector of explanatory variables, $X_{i,t}$, we consider:

- Unemployment rate (*ur*). Ball et al. (2019) document a positive relation between the estimated Okun's coefficient and the average level of unemployment;
- Labor and product market regulations, which come from the Fraser Institute's Economic Freedom of the World (EFW). Recent studies suggest that the sensitivity of labor market outcomes to output movements could be a function of features such as labor and product market characteristics (Döpke 2001; Mourre 2004; Crivelli et al. 2012; Ahmed et al. 2012). These studies find that policies aiming at making labor and product markets more flexible have a significant effect on employment responsiveness. While we only consider the aggregate indices (*labregulations* and *businreg*), results for the set of sub-indicators are available from the authors upon request.[6] Improvements in these markets'

[5] The correlation matrices for unemployment and GDP using alternative filters are displayed in Table 10 in "Appendix."

[6] Labor market regulations are composed of the following sub-indicators: hiring regulations and minimum wage, hiring and firing regulations, centralized collected bargaining, hours regulations, mandated costs of worker dismissal and conscription. As far as product market sub-indicators are concerned, we

degree of efficiency are likely to need reforms in more than one field (Bassanini and Duval 2009). Note that EFW scores variables such that an increase in any index or sub-index means more flexibility or less regulation (the exception being bureaucracy costs where high means worse).

- Structural transformation proxies. First, we take the degree of urbanization (*urban*) [from World Bank's World Development Indicators (WDI)]. Migrant flows from rural areas keep on rising as migrants seek (more secure) opportunities in urban areas, mostly in the nonagricultural sector.[7] Moreover, it is in the nonurban labor market that informality is typically larger and hence where one may observe lower employment/unemployment fluctuations to changes in economic conditions. We also consider measure of informality or shadow economy (*informality*) coming from Schneider et al. (2010). Since this variable only covers the period 1999–2007, we will not be using it the econometric analysis so as to maximize the total number of observations. A second set of proxies we look at are the share of agriculture and manufacturing value added in GDP (*agricul_va_gdp* and *manufact_va_gdp*, respectively) (also from WDI). According to Blackley (1991) a larger share of nonmanufacturing activities in GDP is an indicator of a more diversified economy (and a more flexible labor market), suggesting that fluctuations in the unemployment rate may be less responsive to output fluctuations. The third aspect is the share of public sector employment in total employment (*pub_emp_share*). The public sector (which is part of nonmarket services) remains the main source of employment in many countries and also acts as a shock absorber given its inherent job security feature. The larger the number of people employed by the public sector, the lower one expects the degree of responsiveness of unemployment to output fluctuations will be. The final proxy is an index of economic diversification (*exp_div_index*) from the IMF.[8]
- Economic recessions (*recessions*), defined as years with negative real GDP growth in the baseline specification. As robustness check, we also consider recessions identified as: (i) episodes with a negative output gap—computed with an HP filter with smoothness parameter equal to 100—below the 10th percentile of output gap distribution; and (ii) those produced by the Harding and Pagan (2002) algorithm to identify economic turning points.

Table 10 in "Appendix" provides descriptive statistics for the above country-specific factors.

Footnote 6 (continued)
consider: administrative requirements, bureaucracy costs, starting a business, extra payments/bribes/favoritism, licensing restrictions and cost of tax compliance.

[7] While the migration process along with urbanization is almost completed in advanced economies, rural-to-urban migrant flows are still very significant in developing countries.

[8] https://www.imf.org/external/np/res/dfidimf/diversification.htm.

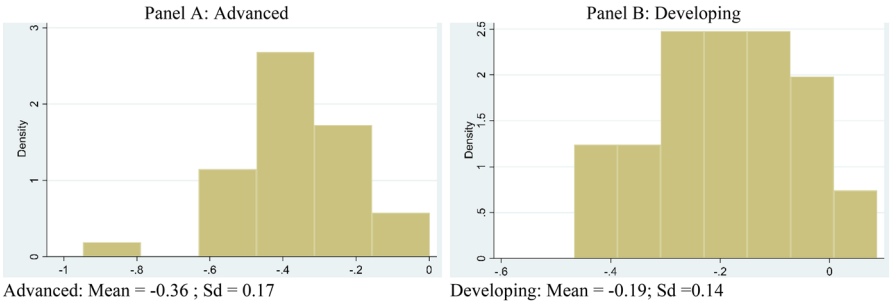

Fig. 1 Okun's gap version: histograms of static β. *Note*: Histograms using the gap version of the Okun's law. *Source*: Authors' calculations

Stylized Facts

Static Okun's Law Estimates

Figure 1 shows the histogram for the estimated β coefficients for the gap version of the Okun's law for the two income groups. In advanced countries, the average Okun's coefficient is -0.4 while for developing countries it is equal to 0.2. That is an increase in output growth by 1 percentage point reduces the unemployment rate by 0.4 (0.2) percentage point in advanced (developing) countries. For both groups there is considerable heterogeneity: The standard deviation is 0.17 and 0.14 for advanced and developing countries, respectively. Ball et al. (2019) also found that there is considerable heterogeneity in the responsiveness of unemployment changes to output growth across countries, with unemployment being more responsive in advanced economies. In the changes version (Fig. 6 in "Appendix"), the average value of the coefficient is slightly lower (in absolute terms) than before -0.3 for advanced countries and roughly the same for developing countries. Table 1 shows the country-specific static coefficients for each country in our sample organized by income group (note that the table also includes information about the start and end date of each country's unemployment time series).

The obtained Okun's coefficients are far smaller than one would expect from an inverted production function, especially in developing economies. The weaker unemployment response to cyclical fluctuations in developing countries is partly because of a smaller employment response (for instance, in developing countries a big share of the labor force is either unaccounted for or in the informal sector).

Our sample of developing countries includes some oil-exporting nations.[9] It is interesting to further explore whether the response in these economies to non-oil-GDP is larger than in the case of overall GDP. Re-estimating Eq. (2) using as regressor either oil-GDP or nonoil-GDP yields the Okun's coefficients displayed in Table 11 in "Appendix." The unemployment response is considerably (and

[9] The list includes: Venezuela, Trinidad and Tobago, Iran, Kuwait, Brunei, Algeria and Kazakhstan.

Table 1 Okun's static coefficients by country

Advanced economies	β	s.e.	Obs_start	Obs_end	Developing economies	β	s.e.	Obs_start	Obs_end
USA	−0.476	0.033	1978	2014	Turkey	−0.100	0.035	1978	2014
UK	−0.355	0.046	1978	2014	South Africa	−0.337	0.128	1980	2014
Austria	−0.121	0.051	1978	2014	Argentina	−0.108	0.053	1980	2014
Belgium	−0.433	0.097	1978	2014	Brazil	−0.216	0.049	1980	2014
Denmark	−0.402	0.050	1978	2014	Chile	−0.325	0.054	1978	2014
France	−0.412	0.041	1978	2014	Colombia	−0.445	0.043	1980	2014
Germany	−0.381	0.061	1978	2014	Costa Rica	−0.251	0.038	1980	2014
Italy	−0.227	0.064	1978	2014	Dominican Republic	−0.153	0.058	1991	2014
Luxembourg	−0.086	0.014	1978	2014	Ecuador	−0.237	0.101	1988	2014
Netherlands	−0.464	0.055	1980	2014	El Salvador	−0.014	0.050	1988	2014
Norway	−0.269	0.040	1978	2014	Honduras	−0.054	0.043	1979	2014
Sweden	−0.451	0.071	1978	2014	Mexico	−0.160	0.045	1980	2014
Switzerland	−0.288	0.050	1978	2014	Nicaragua	−0.197	0.056	1979	2014
Canada	−0.427	0.037	1978	2014	Panama	−0.218	0.031	1980	2014
Japan	−0.159	0.017	1978	2014	Peru	−0.114	0.025	1979	2014
Finland	−0.473	0.044	1978	2014	Uruguay	−0.218	0.040	1983	2014
Greece	−0.533	0.043	1978	2014	Venezuela	−0.255	0.033	1980	2014
Iceland	−0.259	0.036	1978	2014	Bahamas, The	−0.263	0.049	1986	2014
Ireland	−0.475	0.051	1978	2014	Barbados	−0.464	0.065	1981	2014
Portugal	−0.356	0.045	1978	2014	Belize	−0.111	0.051	1990	2014
Spain	−0.947	0.077	1978	2014	Jamaica	-0.317	0.082	1978	2014
Australia	−0.548	0.045	1978	2014	Trinidad and Tobago	−0.127	0.033	1981	2014
New Zealand	−0.386	0.054	1978	2014	Iran	−0.294	0.089	1990	2014
Cyprus	−0.361	0.057	1982	2014	Jordan	−0.181	0.060	1984	2014

Table 1 (continued)

Advanced economies	β	s.e.	Obs_start	Obs_end	Developing economies	β	s.e.	Obs_start	Obs_end
Israel	−0.325	0.067	1978	2014	Kuwait	0.021	0.013	1981	2014
Taiwan Province of China	−0.213	0.027	1978	2014	Egypt	−0.400	0.057	1990	2014
Hong Kong SAR	−0.183	0.032	1978	2014	Brunei Darussalam	0.087	0.105	1991	2014
Korea	−0.238	0.033	1978	2014	Sri Lanka	−0.172	0.046	1990	2014
Singapore	0.002	0.027	1978	2014	Indonesia	−0.005	0.037	1984	2014
Slovak Republic	−0.536	0.051	1993	2014	Malaysia	−0.096	0.021	1985	2014
Estonia	−0.397	0.044	1993	2014	Pakistan	−0.256	0.072	1983	2014
Latvia	−0.359	0.059	1992	2014	Philippines	−0.149	0.051	1985	2014
Slovenia	−0.223	0.033	1992	2014	Thailand	−0.107	0.016	1988	2014
					Vietnam	−0.251	0.074	1990	2014
					Algeria	0.033	0.111	1978	2014
					Mauritius	−0.259	0.097	1983	2014
					Sao Tome and Principe	0.007	0.020	1980	2014
					Sudan	0.005	0.013	1981	2014
					Tunisia	−0.424	0.105	1990	2014
					Fiji	−0.255	0.052	1986	2014
					Belarus	−0.061	0.009	1991	2014
					Albania	−0.241	0.050	1980	2014
					Kazakhstan	−0.084	0.028	1994	2014
					Kyrgyz Republic	−0.008	0.043	1994	2014
					Bulgaria	−0.213	0.066	1989	2014
					Moldova	−0.213	0.046	1993	2014
					Russia	−0.133	0.031	1992	2014
					China	−0.023	0.017	1980	2014

Table 1 (continued)

Advanced economies	β	s.e.	Obs_start	Obs_end	Developing economies	β	s.e.	Obs_start	Obs_end
					Hungary	−0.333	0.036	1980	2014
					Croatia	−0.334	0.085	1991	2014
					Poland	−0.467	0.126	1990	2014
					Romania	−0.047	0.037	1985	2014

Note: estimation of Eq. (1) (gap version). Results using Eq. (2) (changes version) instead available upon request. Only countries with at least 20 observations for the unemployment rate were considered. "s.e." denotes standard error of the estimated Okun's coefficient

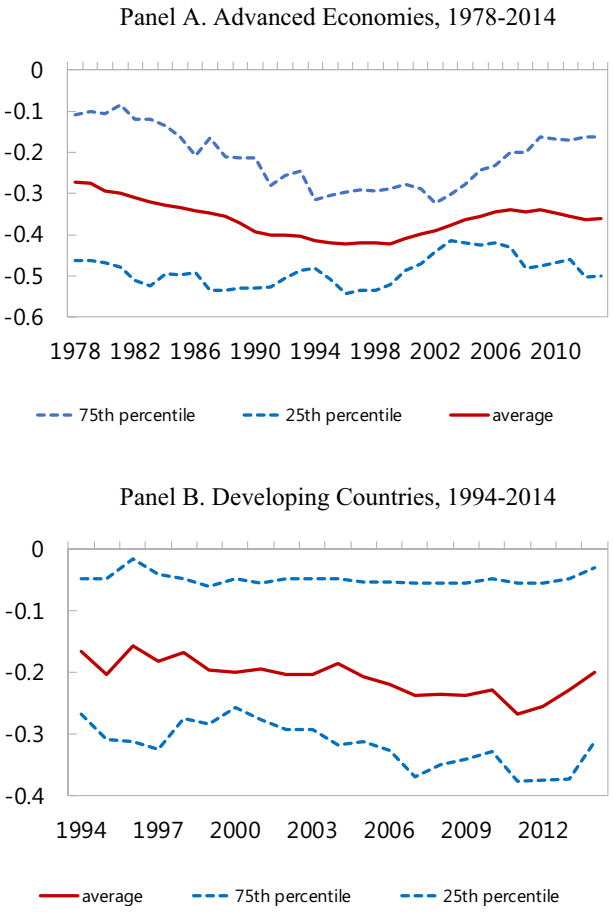

Fig. 2 Interquartile range of time-varying Okun's coefficients, within sample. *Note*: Figure displays the interquartile time profile of the TVC Okun's coefficient estimates for two income groups, Advanced and developing countries using the gap version of the Okun's law. **a** Includes 26 advanced economies with at least 34 observations; **b** contains 38 developing countries with at least 20 observations. *Source*: Authors' calculations

significantly) different depending on the measure of output employed. In general, using nonoil-GDP yields relatively more negative Okun's coefficients than when using oil-GDP.

While useful, a focus only on the averages (that is, taking a static approach) may miss the substantial heterogeneity illustrated in the histograms as well as the temporal dynamics. Moreover, understanding some of the sources of this heterogeneity requires a closer look at the country-by-country estimates. We turn to these aspects in the following (sub-)sections.

Fig. 3 Time-varying Okun's coefficient estimates: country profiles over time. *Note*: The red line denotes the TVC Okun's coefficient (using the gap version), while the black one denotes the average. Whenever only a black line is shown, note that it is superimposed the time-varying red line. *Source*: Authors' calculations

Dynamic Okun's Law Estimates

We now allow β to be time varying and run the model described in "Methodology and Data" section for advanced and developing countries using the gap version of the Okun's law.[10] In Fig. 2 we plot the average and the interquartile range of the

[10] Country results using the changes version instead are available from the authors upon request.

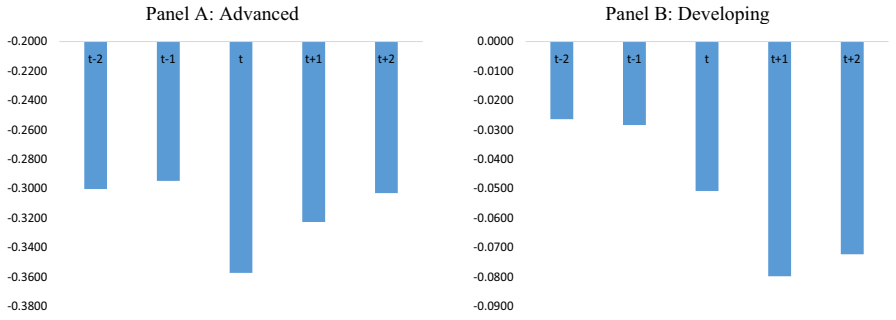

Fig. 4 Behavior of time-varying Okun's coefficients during recessions. *Note*: Using the gap version of the Okun's law. "*t*" denotes the year of the recessions measured by negative annual GDP growth. "$t-2$," "$t-1$," "$t+1$," "$t+2$" denote 2 or 1 years, prior or after the recession year. The figure displays the average TVC for the gap version of the unemployment–output relationships. *Source*: Authors' calculations

time-varying Okun's coefficient for each income group separately, using balanced samples. For advanced economies, the average Okun's coefficient has declined and become more negative from 1978 to the late 1990s, while it started increasing afterward. This is in line with Tillmann (2010) who stated that the relation started to get weak from the mid-1990s. In contrast, in developing economies, unemployment has, on average, become more responsive to business cycle over time.

However, as shown by the wide interquartile ranges, there is substantial variation in the evolution of the Okun's relationship across countries. This is further illustrated in Fig. 3, which reports the evolution of the responsiveness of cyclical unemployment for each country in the sample. The individual country patterns are displayed in Fig. 3 for advanced and developing countries. While each country has its own particular pattern, one key message is that while for several countries (including the USA) the Okun's relationship has been remarkably stable (and it has stabilized more in recent years, following the Global Financial Crisis), there are several cases where the Okun's coefficient has either increased or decreased. The degree of responsiveness of unemployment to output has increased in countries such as Belgium, Canada, Finland, Netherlands or Norway. In Iceland, Spain and Portugal, on the contrary, the Okun's coefficients have had a downward trend. Similar mix patterns emerge also for developing economies: The Okun's coefficient displays an upward trend in the cases of Hungary or Vietnam, but it has declined in Algeria, Chile or Poland.

A final aspect worth considering before moving on to explore the underlying key drivers of the Okun's coefficients is to inspect their behavior around recession periods. The stylized fact presented in Fig. 4 suggests that the magnitude of the Okun's coefficients tends to increase during and the following years of negative growth—similar results are obtained for alternative definition of economic recessions such as those episodes with a negative output gap below the 10th percentile of output gap distribution, and those identified with Harding and Pagan (2002) algorithm (Fig. 7). While this finding is consistent with previous evidence reported in Ball et al. (2017),

Fig. 5 Correlation between static Okun's coefficients and averaged determinants, 1978–2014. *Note*: The ▶ charts show unconditional correlations of the static Okun's coefficients and averaged key determinants using the gap version (results using the changes version are available upon request). A fitted line and the *R*-squared are shown in each scatterplot. *Source*: Authors' calculations

the role of recessions in affecting the strength of the Okun's law will be formally assessed in the next section.

Explaining Cross-Country Heterogeneity in Okun's Law Estimates

Before looking at the regression results of estimating Eq. (5), Fig. 5 shows the scatter plots of the magnitude of the static Okun's coefficients against the average of the above-mentioned potential determinants.[11] We observe that the Okun's coefficient is negatively associated with the average level of unemployment. Moreover, labor and product market characteristics do not seem to unconditionally affect the unemployment–output responsiveness (both *R*-squares are roughly zero). This result is in contrast with the findings of Economou and Psarianos (2016) that the relationship is weaker in countries with tighter labor market protection. Interestingly, the relationship is weaker in countries with larger informal and agricultural sector. In contrast, a larger share of public sector employment and a higher urbanization rate are negatively associated with the Okun's coefficient. Overall these bivariate unconditional scatter plots take us only so far and are not particularly strong, therefore inviting a proper inspection to be carried out using regression analysis.

Moving on to the regression analysis and starting with the static version, Tables 2 and 3 show the results for the simple cross-country bivariate and multivariable regressors based on Eq. (5) for all countries in our sample using OLS and WLS, respectively. These tables show the results using the gap version of the Okun's coefficient.[12] The main conclusions from the scatter plots continue to hold in the regression analysis. We find that the higher the level of unemployment, the more responsive (more negative) the Okun's coefficient becomes. As for aspects related to structural transformation, the strongest result (measured in terms of statistical significance) is the one for public sector employment.

Turning to the dynamic (panel) analysis, similarly to Tables 2 and 3, Tables 4 and 5 show the results for simple pooled cross-country bivariate and multivariate regressors based on Eq. (5) for all countries in our sample using OLS and WLS, respectively. These two tables show the results using the gap version of the TVC Okun's coefficient. Due to the limited coverage of data on some country-specific factors, in each table we first run bivariate regressions of the estimated TVC Okun's

[11] Rescaling each factor with weights corresponding to the inverse of the standard deviations of the TVC estimates does not qualitatively change the scatter results.

[12] Results using the changes versions yield qualitatively similar conclusions and are available upon request.

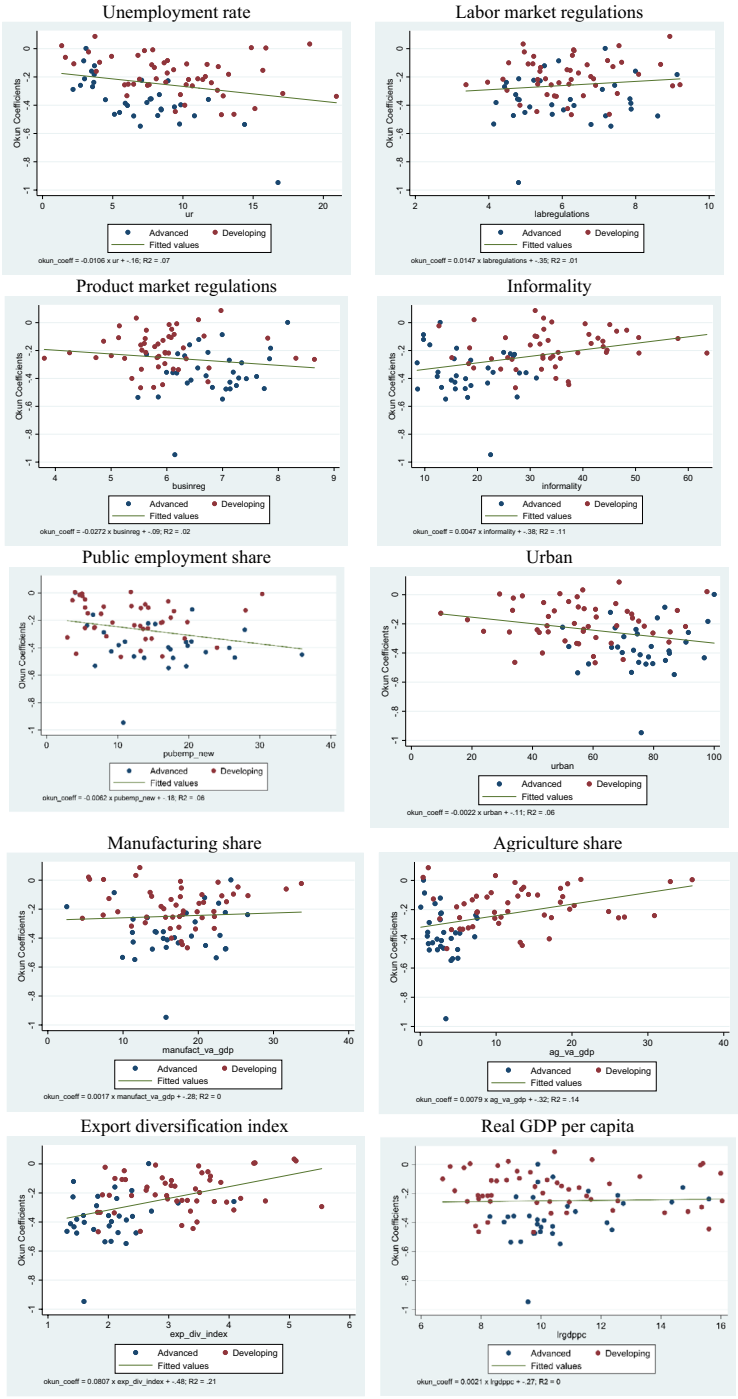
Unemployment rate
Okun Coefficients
ur
Advanced
Developing
Fitted values
okun_coeff = -0.0106 x ur + -.16; R2 = .07
Labor market regulations
labregulations
okun_coeff = 0.0147 x labregulations + -.35; R2 = .01
Product market regulations
businreg
okun_coeff = -0.0272 x businreg + -.09; R2 = .02
Informality
informality
okun_coeff = 0.0047 x informality + -.38; R2 = .11
Public employment share
pubemp_new
okun_coeff = -0.0062 x pubemp_new + -.18; R2 = .08
Urban
urban
okun_coeff = -0.0022 x urban + -.11; R2 = .06
Manufacturing share
manufact_va_gdp
okun_coeff = 0.0017 x manufact_va_gdp + -.28; R2 = 0
Agriculture share
ag_va_gdp
okun_coeff = 0.0079 x ag_va_gdp + -.32; R2 = .14
Export diversification index
exp_div_index
okun_coeff = 0.0807 x exp_div_index + -.48; R2 = .21
Real GDP per capita
lrgdppc
okun_coeff = 0.0021 x lrgdppc + -.27; R2 = 0

Table 2 OLS regression of Okun's static coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
real GDP pc	0.002 (0.008)									−0.010 (0.008)
ur		−0.011** (0.004)								−0.018*** (0.005)
labregulations			0.015 (0.014)							0.038** (0.017)
businreg				−0.027 (0.021)						−0.036 (0.026)
pub_emp_share					−0.006** (0.003)					−0.000 (0.002)
agricul_va_gdp						0.008*** (0.002)				0.003 (0.003)
manufact_va_gdp						0.001 (0.003)				0.010** (0.004)
urban							−0.002** (0.001)			−0.001 (0.001)
oilgdp_share								0.138** (0.046)		
exp_div_index									0.081*** (0.018)	0.080*** (0.025)
Constant	−0.272*** (0.088)	−0.161*** (0.041)	−0.349*** (0.088)	−0.089 (0.132)	−0.185*** (0.045)	−0.341*** (0.059)	−0.110* (0.063)	−0.233*** (0.045)	−0.479*** (0.051)	−0.369 (0.244)
Observations	85	85	82	82	68	81	84	14	82	63
R-squared	0.001	0.066	0.013	0.021	0.065	0.141	0.062	0.431	0.208	0.527

Ordinary least squares regression. Robust standard errors in parenthesis

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 3 WLS regression of Okun's static coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
real GDP pc	0.002									−0.009
	(0.007)									(0.007)
ur		−0.010**								−0.019***
		(0.004)								(0.005)
labregulations			0.012							0.033**
			(0.014)							(0.015)
businreg				−0.025						−0.030
				(0.020)						(0.024)
pub_emp_share					−0.008***					−0.000
					(0.003)					(0.002)
agricul_va_gdp						0.007***				0.003
						(0.002)				(0.003)
manufact_va_gdp						0.001				0.009**
						(0.002)				(0.004)
urban							−0.002**			−0.001
							(0.001)			(0.001)
oilgdp_share								0.102**		
								(0.043)		
exp_div_index									0.087***	0.091***
									(0.016)	(0.024)
Constant	−0.221***	−0.129***	−0.296***	−0.064	−0.118***	−0.282***	−0.087	−0.169***	−0.456***	−0.388*
	(0.077)	(0.035)	(0.086)	(0.129)	(0.042)	(0.047)	(0.058)	(0.045)	(0.050)	(0.231)
Observations	85	85	82	82	68	81	84	14	82	63
R-squared	0.001	0.063	0.010	0.019	0.097	0.152	0.049	0.319	0.261	0.583

Weighted least squares regression where the weights are given by the inverse of the standard deviation of the estimated static Okun's coefficients. Robust standard errors in parenthesis

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 4 Pooled OLS regressions of time-varying Okun's coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	0.005** (0.002)										0.002 (0.004)
ur		−0.008*** (0.001)									−0.006*** (0.002)
labregulations			−0.026*** (0.008)								0.039*** (0.014)
businreg				−0.016 (0.018)							−0.026 (0.019)
pub_emp_share					−0.007*** (0.001)						0.001 (0.001)
agricul_va_gdp						0.009*** (0.001)					0.008*** (0.001)
manufact_va_gdp						0.002*** (0.001)					0.004*** (0.001)
urban							−0.003*** (0.000)				−0.001** (0.000)
recessions								0.001 (0.014)			0.008 (0.019)
oilgdp_share									0.126*** (0.010)		
exp_div_index										0.089*** (0.006)	0.088*** (0.009)
Constant	−0.304*** (0.025)	−0.183*** (0.008)	−0.104** (0.042)	−0.165 (0.108)	−0.175*** (0.011)	−0.372*** (0.015)	−0.083*** (0.014)	−0.249*** (0.005)	−0.275*** (0.016)	−0.491*** (0.017)	−0.629*** (0.169)
Observations	2769	2736	2617	1634	1905	2151	2732	2769	315	2326	1006
R-squared	0.002	0.026	0.005	0.000	0.036	0.120	0.043	0.000	0.174	0.131	0.278
Country effects	No	No	No	No	No	No	No	No	No	No	No

Table 4 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Ordinary least squares regression. Robust standard errors in parenthesis. See Eq. (5) and main text for further details

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 5 Pooled WLS regressions of time-varying Okun's coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	−0.007 (0.010)										−0.006 (0.013)
ur		−0.011** (0.005)									−0.009 (0.011)
labregulations			0.012 (0.039)								0.103** (0.043)
businreg				−0.296*** (0.093)							−0.277*** (0.097)
pub_emp_share					−0.011*** (0.002)						−0.005 (0.003)
agricul_va_gdp						0.004 (0.003)					−0.002 (0.009)
manufact_va_gdp						0.004* (0.002)					0.002 (0.003)
urban							−0.002*** (0.001)				−0.003 (0.002)
recessions								−0.115 (0.074)			−0.131 (0.095)
oilgdp_share									0.116*** (0.012)		
exp_div_index										0.078*** (0.029)	0.081** (0.038)
Constant	−0.117 (0.128)	−0.109*** (0.032)	−0.254 (0.217)	1.589*** (0.564)	−0.061 (0.046)	−0.301*** (0.065)	−0.066 (0.064)	−0.173*** (0.032)	−0.220*** (0.017)	−0.426*** (0.058)	1.022* (0.559)
Observations	2679	2646	2530	1577	1824	2081	2642	2679	281	2248	959
R-squared	0.003	0.022	0.000	0.092	0.029	0.017	0.010	0.015	0.278	0.057	0.229
Country effects	No	No	No	No	No	No	No	No	No	No	No

Table 5 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Weighted least squares regression where the weights are given by the inverse of the standard deviation of the estimated time-varying Okun's coefficients. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Time and fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 6 Country effect OLS regressions of time-varying Okun's coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	−0.074*** (0.010)										−0.233*** (0.066)
ur		−0.006*** (0.001)									−0.004 (0.003)
labregulations			−0.033*** (0.004)								−0.003 (0.011)
businreg				−0.016** (0.008)							−0.009 (0.009)
pub_emp_share					−0.003 (0.004)						−0.025** (0.010)
agricul_va_gdp						0.002** (0.001)					−0.008** (0.004)
manufact_va_gdp						0.004*** (0.001)					−0.002 (0.003)
urban							−0.005*** (0.001)				0.009*** (0.002)
recessions								−0.016* (0.009)			−0.025* (0.013)
oilgdp_share									0.018* (0.010)		
exp_div_index										0.025*** (0.007)	0.009 (0.010)
Constant	0.311*** (0.101)	−0.435*** (0.008)	−0.294*** (0.024)	−0.387*** (0.047)	−0.417*** (0.059)	−0.552*** (0.015)	−0.066 (0.052)	−0.472*** (0.003)	−0.258*** (0.011)	−0.507*** (0.011)	1.862** (0.763)
Observations	2769	2736	2617	1634	1905	2151	2732	2769	315	2326	1006
R-squared	0.703	0.701	0.715	0.773	0.734	0.705	0.705	0.698	0.598	0.716	0.793
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Ordinary least squares regression. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Country-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 7 Country effect WLS regressions of time-varying Okun's coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	−0.048 (0.031)										−0.473* (0.271)
ur		−0.008 (0.015)									0.010 (0.038)
labregulations			0.006 (0.042)								0.046 (0.111)
businreg				−0.296*** (0.096)							−0.213** (0.098)
pub_emp_share					−0.026 (0.044)						−0.025 (0.083)
agricul_va_gdp						−0.010 (0.009)					−0.021 (0.017)
manufact_va_gdp						0.004 (0.008)					−0.039** (0.018)
urban							−0.003 (0.004)				−0.005 (0.011)
recessions								−0.125 (0.084)			−0.211* (0.122)
oilgdp_share									0.019 (0.016)		
exp_div_index										0.095 (0.064)	−0.109 (0.079)
Constant	0.032 (0.325)	−0.421*** (0.100)	−0.504** (0.227)	1.308** (0.583)	−0.048 (0.724)	−0.527*** (0.118)	−0.240 (0.274)	−0.456*** (0.014)	−0.265*** (0.011)	−0.611*** (0.095)	7.108** (3.133)
Observations	2679	2646	2530	1577	1824	2081	2642	2679	281	2248	959
R-squared	0.199	0.201	0.192	0.257	0.184	0.173	0.199	0.214	0.773	0.207	0.402
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 7 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Weighted least squares regression where the weights are given by the inverse of the standard deviation of the estimated time-varying Okun's coefficients. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Country-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

coefficients on each country-specific factor separately; then, we turn to the multivariate regression.

As in the static case, we find that the higher the level of unemployment, the more responsive (more negative) the Okun's coefficient becomes. Moreover, results show that our aggregate indices of labor and product market flexibility are statistically different from zero in explaining cross-country variation in time-varying Okun's coefficients. The proxy for labor market (see Table 4 specification 2) and product market characteristics (see Table 5 specifications 3 and 10) comes out negative and statistically significant, suggesting that as these markets become less rigid, the responsiveness of unemployment to output changes is reduced. As for aspects related to structural transformation, the strongest result is for public sector employment in both Tables 4 and 5. The coefficient for urbanization is negative and statistically significant. Finally, an increase in economic diversification is associated with a smaller (less negative) unemployment response.

In Tables 6 and 7 we re-run the previous set of regressions by adding country-fixed effects to shed light on whether changes in the different determinants of interest also explain changes in the Okun's coefficients over time within each country.[13] Results are qualitatively similar to those shown in Tables 4 and 5. The main difference is that recession has a significant effect, increasing the response of unemployment to business cycle fluctuations [see Ball et al. (2017) for a similar finding].[14]

In Table 8 we split between advanced and developing countries to uncover some interesting differences. First, the level of unemployment comes out negative and significant only in the advanced countries sample. The coefficient on the public sector employment remains equally important when country-fixed effects are considered in both sub-samples (coefficients are negative and statistically significant) but stronger (in absolute value) in developing economies. Labor market regulation has different effects between advanced and developing countries: In advanced economies, more deregulation is associated with more negative unemployment–output responsiveness, while the opposite for developing economies. A similar pattern can be observed in the case of the share of agriculture in GDP. Finally, the recessions dummy seems to only matter in the case of developing countries (specification 6).

[13] Results using the changes versions yield qualitatively similar conclusions and are available in Appendix Tables' 12 and 13.

[14] In Appendix Table 14 we re-run Table 7 with both country and time effects for robustness purposes. We can observe that our previous conclusions remain qualitatively valid. The results in Table 15 also show that similar results are obtained when we exclude the Global Financial Crisis (years 2008 and 2009) and when we consider recessions identified as: (i) episodes with a negative output gap—computed with an HP filter with smoothness parameter equal to 100—below the 10th percentile of output gap distribution; and (ii) those produced by the Harding and Pagan (2002) algorithm to identify economic turning points.

Table 8 Pooled and country effect OLS and WLS regressions of time-varying Okun's coefficients on main determinants by income group—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimator	OLS	OLS	WLS	WLS	OLS	OLS	WLS	WLS
Sample	AE	DEV	AE	DEV	AE	DEV	AE	DEV
real GDP pc	−0.017***	0.002	−0.014***	−0.007	−0.107*	−0.256**	−0.106**	−0.442
	(0.005)	(0.004)	(0.004)	(0.014)	(0.061)	(0.100)	(0.050)	(0.319)
ur	−0.030***	−0.000	−0.027***	−0.006	0.006	−0.003	0.002	0.021
	(0.003)	(0.002)	(0.003)	(0.017)	(0.004)	(0.004)	(0.004)	(0.045)
labregulations	0.057***	0.021	0.039***	0.106*	0.088***	−0.070***	0.056***	0.065
	(0.017)	(0.018)	(0.014)	(0.058)	(0.016)	(0.014)	(0.013)	(0.147)
businreg	0.021	−0.036	0.015	−0.331***	0.010	−0.007	0.009	−0.265**
	(0.024)	(0.025)	(0.021)	(0.115)	(0.011)	(0.014)	(0.008)	(0.129)
pub_emp_share	0.002	0.003***	0.002**	−0.001	−0.086***	−0.022*	−0.066***	−0.010
	(0.001)	(0.001)	(0.001)	(0.005)	(0.017)	(0.012)	(0.015)	(0.085)
agricul_va_gdp	0.005	0.007***	−0.004	−0.004	0.045***	−0.013***	0.029***	−0.017
	(0.005)	(0.001)	(0.005)	(0.010)	(0.013)	(0.004)	(0.011)	(0.018)
manufact_va_gdp	0.007***	0.006***	0.009***	−0.000	0.009**	−0.003	0.005	−0.051**
	(0.001)	(0.002)	(0.001)	(0.006)	(0.004)	(0.004)	(0.003)	(0.024)
urban	−0.001	−0.001**	−0.001	−0.003	0.003	0.016***	0.005**	−0.008
	(0.001)	(0.000)	(0.001)	(0.003)	(0.002)	(0.004)	(0.002)	(0.017)
recession	0.029	−0.007	0.034	−0.165	−0.024	−0.040***	−0.017	−0.268
	(0.024)	(0.023)	(0.021)	(0.125)	(0.017)	(0.015)	(0.014)	(0.177)
exp_div_index	0.053***	0.074***	0.053***	0.034	0.025	0.010	0.043**	−0.112
	(0.014)	(0.013)	(0.013)	(0.038)	(0.024)	(0.011)	(0.022)	(0.086)
Constant	−0.671***	−0.507**	−0.601***	1.548**	0.960	1.501**	0.776	6.158***
	(0.211)	(0.230)	(0.186)	(0.689)	(0.812)	(0.716)	(0.705)	(2.218)
Observations	406	600	406	553	406	600	406	553
R-squared	0.359	0.160	0.400	0.225	0.847	0.749	0.866	0.365

Table 8 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimator	OLS	OLS	WLS	WLS	OLS	OLS	WLS	WLS
Sample	AE	DEV	AE	DEV	AE	DEV	AE	DEV
Country effects	No	No	No	No	Yes	Yes	Yes	Yes
Time effects	No	No	No	No	No	No	No	No

Ordinary and weighted least squares regressions where the weights are given by the inverse of the standard deviation of the estimated time-varying Okun's coefficients. Robust standard errors in parenthesis

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Conclusion

The evidence presented in this paper lends support to a focus on policies to address these structural challenges relative to the cyclical considerations that are more dominant in advanced countries. Many countries face structural challenges in their labor markets fueling academic and policy interest. In many countries, unemployment rates, particularly youth unemployment rates, remain alarmingly high since the onset of the Global Financial Crisis. This paper employed recent data up to 2014 and covered 85 advanced and developing countries to revisit, by means of both time series and panel data analyses, the empirical regularity popularized by Okun's (1962) seminal paper.

Our findings confirm what many others have established before—the existence of a negative and statistically significant Okun's relationship. As acknowledged in the literature there is clear variation across countries. We find that the cyclical relationship between unemployment and growth is considerably weaker, on average, in developing than in advanced countries. At the same time, the finding of a significant Okun's law relationship in many developing countries suggests that cyclical considerations should not be ignored. Moreover, the degree of unemployment–output responsiveness has been changing over time. As dispersion between Okun's coefficients has been on the rise in recent times, we conjecture that some (structural) characteristics must be behind such phenomenon. In particular, the average level of unemployment increases the estimated unemployment–output elasticities. There is also a role played by both labor and product market policies. Structural transformation matters as evidenced by the relevance played by the rate of urbanization and share of manufacturing in value added for instance. Moreover, the portion of total employment attributed to the public sector reveals itself as a strong determinant of the Okun's coefficient. Overall, this paper's findings suggest that cyclical aspects between unemployment and output should be taken seriously. Also, evidence suggests an interaction of cyclical and structural characteristics of the economy sustaining the fact that aggregate demand policies aiming at increasing output growth can equally contribute to recover labor markets.

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Appendix

See Figs. 6, 7 and Tables 9, 10, 11, 12, 13, 14, 15.

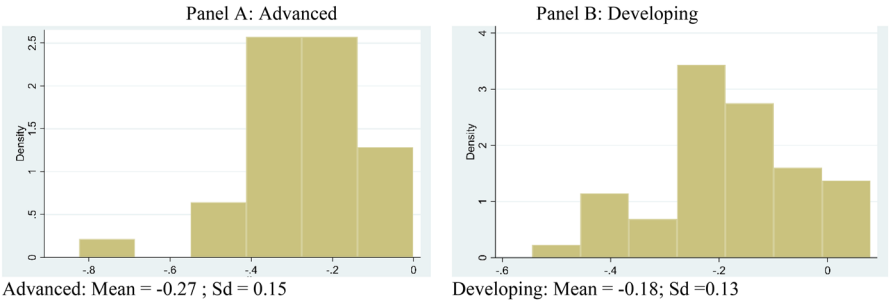

Fig. 6 Okun's changes version: histograms of static β. *Note*: Histograms using the changes version of the Okun's law. *Source*: Authors' calculations

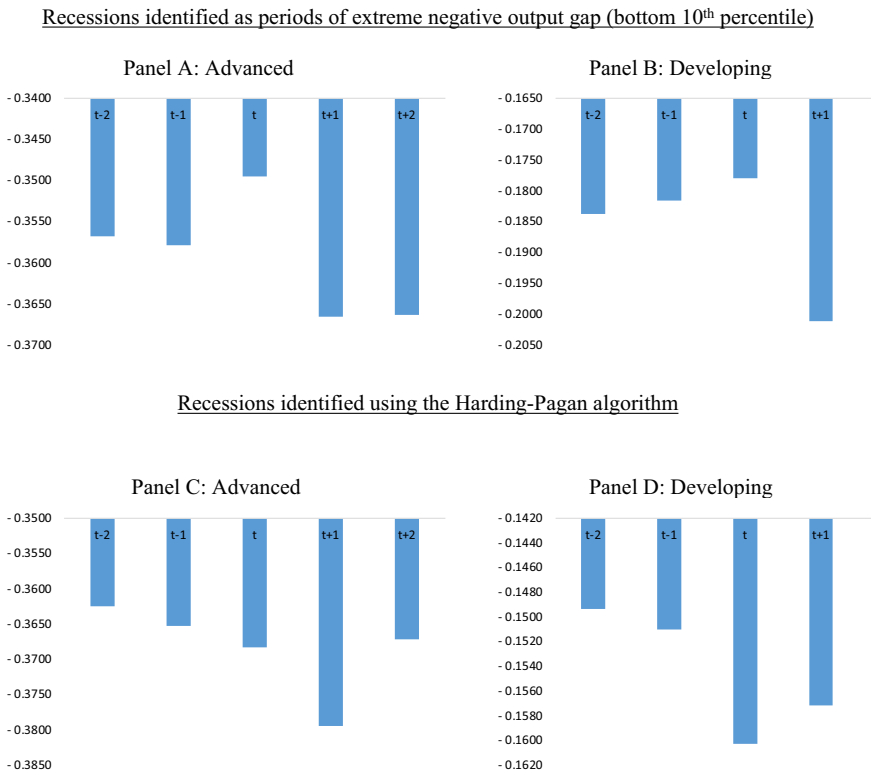

Fig. 7 Behavior of time-varying Okun's coefficients during recessions. *Note*: Using the gap version of the Okun's law. "t" denotes the year of the recession. "$t-2$," "$t-1$," "$t+1$," "$t+2$" denote 2 or 1 years, prior or after the recession year. The figure displays the average TVC for the gap version of the unemployment–output relationships

Table 9 Correlation matrices

	Cyclical component HP	Cyclical component BK	Cyclical component CFRW
Variable—unemployment rate			
Cyclical component HP	1.00		
Cyclical component BK	0.69	1.00	
Cyclical component CFRW	0.62	0.97	1.00
Variable—real GDP			
Cyclical component HP	1.00		
Cyclical component BK	0.77	1.00	
Cyclical component CFRW	0.71	0.91	1.00

"HP" denotes the Hodrick–Prescott filter; "BK" denotes the Baxter–King filter; "CFRW" denotes the Christiano–Fitzgerald Random Walk

Table 10 Summary statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
real GDP pc	3598	10.593	2.344	6.543	17.204
ur	1673	7.555	4.443	0.025	30.409
informality	441	24.584	11.256	8.1	60.2
labregulations	2773	5.563	0.649	4.684	6.534
businreg	1790	6.051	0.336	5.009	6.535
pub_emp_share	2057	13.556	7.410	2.142	39.283
agricul_va_gdp	1364	7.397	6.600	0.0344	33.032
manufact_va_gdp	1319	19.544	5.709	1.291	40.179
oilgdp_share	329	0.5815	0.770	−0.0273	3.543
exp_div_index	2458	2.713	1.007	1.137	6.063
urban	1.674	70.151	16.471	19.358	100

Summary statistics computed over the sample for which the time-varying Okun's coefficients were computed

Table 11 Okun's coefficient in oil-exporting countries

Country	Using total GDP as regressor	Using oil-GDP as regressor	Using nonoil-GDP as regressor
Venezuela	−0.206***	−0.011	−0.187***
Trinidad Tobago	−0.170***	−0.063**	−0.127***
Iran	−0.344***	−0.068**	−0.397***
Kuwait	−0.015	0.005	−0.013
Brunei	0.079	−0.011	−0.050
Algeria	0.017	0.003	−0.186
Kazakhstan	−0.116***	0.051**	−0.095***

Using the changes version of the Okun's law. Standard errors omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 12 Country effect OLS regressions of time-varying Okun's coefficients on main determinants—changes version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	−0.058*** (0.009)										−0.092*** (0.027)
ur		−0.007*** (0.001)									−0.000 (0.002)
labregulations			−0.030*** (0.003)								−0.024*** (0.006)
businreg				−0.011* (0.006)							0.001 (0.004)
pub_emp_share					−0.011*** (0.002)						−0.027*** (0.005)
agricul_va_gdp						0.003*** (0.001)					−0.001 (0.001)
manufact_va_gdp						0.003*** (0.001)					0.000 (0.001)
urban							−0.004*** (0.001)				0.001 (0.001)
recessions								−0.013* (0.007)			−0.019** (0.009)
oilgdp_share									0.025*** (0.003)		
exp_div_index										0.015** (0.006)	0.022*** (0.007)
Constant	0.139 (0.097)	−0.431*** (0.016)	−0.312*** (0.020)	−0.445*** (0.041)	−0.289*** (0.041)	−0.563*** (0.024)	−0.155*** (0.047)	−0.476*** (0.014)	−0.229*** (0.001)	−0.478*** (0.015)	0.961*** (0.340)
Observations	2651	2617	2533	1615	1826	2093	2615	2651	286	2216	990
R-squared	0.728	0.733	0.735	0.778	0.800	0.770	0.730	0.722	0.825	0.736	0.888
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 12 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Ordinary least squares regression. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Country-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 13 Country effect WLS regressions of time-varying Okun's coefficients on main determinants—changes version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	−0.020***										−0.036**
	(0.003)										(0.014)
ur		−0.005***									−0.002
		(0.001)									(0.001)
labregulations			−0.016***								−0.017***
			(0.002)								(0.004)
businreg				−0.002							−0.001
				(0.004)							(0.003)
pub_emp_share					−0.004***						−0.016***
					(0.002)						(0.003)
agricul_va_gdp						0.000					−0.002
						(0.000)					(0.001)
manufact_va_gdp						0.002***					0.001
						(0.000)					(0.001)
urban							−0.001***				0.002**
							(0.000)				(0.001)
recessions								−0.011***			−0.009*
								(0.004)			(0.005)
oilgdp_share									0.023***		
									(0.002)		
exp_div_index										0.008**	0.010*
										(0.003)	(0.005)
Constant	−0.256***	−0.437***	−0.384***	−0.486***	−0.389***	−0.536***	−0.358***	−0.469***	−0.229***	−0.465***	0.110
	(0.033)	(0.013)	(0.014)	(0.030)	(0.029)	(0.024)	(0.020)	(0.013)	(0.001)	(0.012)	(0.153)
Observations	2491	2457	2379	1520	1713	1962	2455	2491	256	2076	927
R-squared	0.883	0.888	0.887	0.902	0.902	0.891	0.883	0.882	0.907	0.893	0.931
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 13 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	No	No	No	No	No	No	No	No	No	No	No

Weighted least squares regression where the weights are given by the inverse of the standard deviation of the estimated time-varying Okun's coefficients. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Country-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 14 Country and time effect WLS regressions of time-varying Okun's coefficients on main determinants—gap version

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
real GDP pc	0.025 (0.052)										−0.174 (0.194)
ur		−0.002 (0.007)									0.001 (0.019)
labregulations			−0.063** (0.027)								−0.092 (0.209)
businreg				0.700 (0.639)							1.129 (1.892)
pub_emp_share					−0.016 (0.027)						−0.080* (0.046)
agricul_va_gdp						−0.013* (0.007)					−0.025** (0.010)
manufact_va_gdp						−0.004 (0.006)					−0.039*** (0.012)
urban							0.002 (0.001)				0.017** (0.008)
recessions								−0.078** (0.036)			−0.062 (0.070)
oilgdp_share									0.022 (0.013)		
exp_div_index										0.040 (0.037)	−0.055 (0.060)
Constant	−0.666 (0.520)	−0.399*** (0.049)	−0.136 (0.136)	−5.019 (4.088)	−0.140 (0.464)	−0.164 (0.153)	−0.543*** (0.110)	−0.409*** (0.033)	−0.255*** (0.002)	−0.445*** (0.065)	−4.491 (11.380)
Observations	2679	2646	2530	1577	1824	2081	2642	2679	281	2248	959
R-squared	0.439	0.441	0.436	0.432	0.496	0.461	0.444	0.444	0.803	0.469	0.613
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 14 (continued)

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Weighted least squares regression where the weights are given by the inverse of the standard deviation of the estimated time-varying Okun's coefficients. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. Country- and time-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

Table 15 Country effect OLS regressions of time-varying Okun's coefficients on main determinants—gap version, alternative recession definitions

Specification	(1) Baseline	(2) Baseline excluding GFC	(3) OG bottom 10%	(4) Harding–Pagan
real GDP pc	−0.233***	−0.271***	−0.244***	−0.227***
	(0.066)	(0.074)	(0.045)	(0.044)
ur	−0.004	−0.006*	−0.003	−0.004*
	(0.003)	(0.003)	(0.002)	(0.002)
labregulations	−0.003	−0.003	−0.002	−0.005
	(0.011)	(0.012)	(0.013)	(0.013)
businreg	−0.009	−0.006	−0.010	−0.010
	(0.009)	(0.008)	(0.011)	(0.011)
pub_emp_share	−0.025**	−0.027**	−0.024***	−0.024***
	(0.010)	(0.012)	(0.006)	(0.006)
agricul_va_gdp	−0.008**	−0.012***	−0.007***	−0.008***
	(0.004)	(0.005)	(0.002)	(0.002)
manufact_va_gdp	−0.002	−0.003	−0.002	−0.002
	(0.003)	(0.003)	(0.002)	(0.002)
urban	0.009***	0.008***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
recessions	−0.025*	−0.041**	−0.038**	−0.008
	(0.013)	(0.017)	(0.018)	(0.015)
exp_div_index	0.009	0.002	0.008	0.010
	(0.010)	(0.013)	(0.014)	(0.014)
Constant	1.862**	2.391***	1.938***	1.786***
	(0.763)	(0.882)	(0.482)	(0.479)
Observations	1006	876	1006	1006
R-squared	0.793	0.801	0.793	0.792
Country effects	Yes	Yes	Yes	Yes
Time effects	No	No	No	No

Ordinary least squares regression. Robust standard errors in parenthesis. See Eq. (5) and main text for further details. "OG_bottom 10%" denotes recessions identified as periods of extreme negative output gap (bottom 10th percentile). "Harding–Pagan" denotes recessions identified using the Harding–Pagan algorithm. Country-fixed effects included but omitted for reasons of parsimony

*, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively

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