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Regional evidence on Okun's Law in Czech Republic and Slovakia

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ABSTRACT

We present regional evidence on Okun's Law using original data for two emerging countries, namely the Czech Republic and Slovakia. We unveil the presence of important regional heterogeneities, as in many Czech and Slovak regions Okun's Law is not significant. Among the drivers of these regional differences, we outline the level of unemployment and output, domestic and foreign investments, and R&D and infrastructure spending. Subsequently, we show that unemployment, output, and domestic investment are equally related to regional magnitude non-linearities, when it comes to Czech and Slovak regions in which Okun's Law is at work. We draw upon these rich results to discuss policies that could be implemented to avoid underemployment traps in the Czech and Slovak regions.

1. Introduction

The dawn of the 1990s brought massive changes in central and eastern European countries (CEEC). Politically, these changes marked the end of almost half a century of Cold War. Economically, CEEC entered a new era, characterized by progressive monetary and financial liberalization, free markets, free prices, and free trade. Many countries found themselves trapped in the tumult of increasing external competition, particularly since their industrial systems were characterized by obsolete techniques, over-designed production plants, and low labor productivity in a full employment context. Consequently, many such large loss-generating public plants were closed, causing massive unemployment in the second half of the 90s.[1]

These high unemployment levels draw the attention of policymakers. Indeed, according to the popular Okun's Law (Okun, 1962), there exists a strong relation between an increase in GDP above its potential, i.e. a positive output gap, and a decrease of unemployment below its trend. Thus, over the last two decades, an increasing strand of literature focused on exploring the robustness of Okun's Law on several grounds.[2]

First, regarding its significance and magnitude. In a very influential paper, Prachowny (1993) appends Okun's Law to include the effect of weekly hours and capacity utilization,[3] and shows that, although significant, the magnitude of the link between cyclical unemployment and the output gap is around −0.67, notably lower (in absolute value) than Okun's initial estimation of −3. Subsequent work continues this debate: using US quarterly data, Weber (1995) and Moosa (1999) emphasize Okun coefficients above 3 (in absolute value), while Attfield and Silverstone (1997) or Coen and Hickman (2006) outline Okun coefficients of lower magnitudes in absolute value, namely −2.25 and −1.90, respectively.

Second, Okun's coefficient was found to significantly differ across countries. Compared to their previous findings for the US, Attfield and Silverstone (1998) illustrate a lower (in absolute value) Okun coefficient of −1.45 for the UK, using a VECM augmented to account for cointegration in the presence of non-stationary output and unemployment series. Several authors, like Kaufman (1988) or Moosa (1997), present evidence on a small number of countries. For example, using data for G7 countries, Moosa (1997) concludes that all seven Okun coefficients are significant and have the expected negative sign, but their magnitude differs across countries. Comparable conclusions arise from the analysis of Harris and Silverstone (2001) for Australia, Canada, Western Germany, Japan, the UK, and the US, as they find that Okun coefficients are negative and significant, while rather different in UK and Japan compared to the other countries (for an identical finding for Japan, see also Freeman, 2001). Moreover, many studies focus on a

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[1] For example, unemployment in Slovakia in 1995 was 13.0%, while in Czech Republic in 1999 it equaled to 9.4%.

[2] In particular, the current Great Recession revived the question of the pertinence of Okun's Law (for recent discussions, see Ball et al., 2013; Daly and Hobijn, 2010; Owyang and Sekhposyan, 2012, or Daly et al., 2014).

[3] Alternatively, Evans (1989) and Mussard and Philippe (2009) emphasize the importance of time lags and money creation, respectively, in estimating Okun's Law.

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large set of countries, especially from the OECD area. Using annual data for 16 OECD countries, Lee (2000) not only confirms the significance of Okun's coefficient, but shows that its magnitude is subject to important country heterogeneities, ranging from −6.55 for Japan to −0.57 for Italy, based, for example, on the Hodrick–Prescott (HP, 1997) filter.[4]

Third, in addition to country heterogeneities, Okun's Law has been found to exhibit multiple non-linearities. Using US data, Moosa (1999) shows that Okun's coefficient is different in the short- compared to the long-run. Moreover, Harris and Silverstone (2001) and Cuaresma (2003) conclude that Okun's Law changes in business cycle upturns compared to downturns (or above compared to below the trend, see Holmes and Silverstone, 2006). In addition to the level of output, Virén (2001) and Fouquau (2008) find that Okun's Law is equally sensitive to the level of unemployment. Subsequent papers emphasize alternative mechanisms for threshold effects in Okun's Law, including the considered time period (Knotek, 2007, or Beaton, 2010), the level of effort in the labor market (Malley and Molana, 2008), changes in labor productivity (Huang and Lin, 2008), adhesion to the EMU (Mayes and Virén, 2009), or market regulations (Neely, 2010).

Finally, a more recent strand of literature focuses on the pertinence of Okun's Law at a subcountry, regional level.[5] Among the first studies, Freeman (2000) emphasizes differences between Okun's coefficients for pooled data (around −2) compared to US regions (between −3.57 and −1.84). Even more important disparities are outlined by Adanu (2005) for Canadian regions. On the one hand, in some regions the Okun coefficient is not significant. On the other hand, the magnitude of significant Okun coefficients ranges between −2.14 and −0.93, if we consider, for example, the HP filter.

In addition to the US and Canada, much of the regional analysis of Okun's Law has focused so far on European countries. Early studies by Kangasharju and Pehkonen (2001) outline both significance and magnitude differences in the Okun coefficient for regions in Finland (see also Kangasharju et al., 2012). Two other studies analyze regions in Greece. Apergis and Rezitis (2003) find little differences between Greek regions, except for two regions for which the estimated coefficients are quite large in absolute value (around −3). On the contrary, Christopoulos (2004) concludes that not only is the size of the Okun coefficient weaker, ranging between −1.70 and −0.32, but that Okun's Law is valid (at the 5% level) in only 5 out of the 13 Greek regions. In their analysis on the Spanish regions, Villaverde and Maza (2007, 2009) emphasize results in favor of Okun's Law in most regions (between 11 and 15 out of 17 regions), of relatively low (absolute value) magnitude (between −1.55 and −0.32 for the regions, and equal to −0.91 for Spain as a whole). Finally, comparable results are illustrated by Binet and Facchini (2013) for France: Okun's coefficient is significant in only 14 out of 22 regions, and ranges between −1.81 and −0.91.

In this paper we take stock of this latter strand of literature and explore the potential existence of Okun's Law in regions within the Czech Republic and Slovakia. By so doing, we aim to develop the existing literature in several directions. First, compared to previous research, this is the first paper that presents evidence on the regional Okun's Law in more than one country. Indeed, there are several reasons for jointly considering the Czech Republic and Slovakia. Historically, the two countries were part of the former Czechoslovakia for the period 1918–1992, during which time they shared common traditions, culture, history, and so forth, in addition to a common government and economic policy. Nowadays, there is a strong tradition for the elected prime minister of one country to make the first official foreign visit to the other one. Also, the two countries often disregard their common border when it comes to important development projects (i.e. highways), and students from one country can study in the other one in their own language (the two languages are fairly close). Finally, each country is the other's first (after Germany) foreign partner in terms of trade.

Second, to the best of our knowledge, this is the first paper analyzing Okun's Law in emerging countries at a regional level, while previous contributions focused exclusively on developed countries. As such, we are using an original output and unemployment regional dataset to provide estimations of a regional Okun's Law, as well as a set of regional variables, including domestic and foreign investment, R&D, or infrastructure public spending, in our subsequent analysis. Thus, we illustrate output and unemployment dynamics over two decades for two emerging countries that were confronted with major political, institutional and economic transformations in the 1990s.

Third, after emphasizing regional estimates for Okun's Law in both the Czech Republic and Slovakia, we augment our study in two ways. On the one hand, we present a systematic analysis of economic drivers of Okun's Law, in other words, the major factors explaining that the unemployment–output relation is significant only in some regions. On the other hand, we search for possible non-linearities in the significant estimated regional Okun coefficients across the two countries. Compared to previous studies in which relatively minor importance is given to explaining the underlying sources of regional heterogeneity, our analysis considers a wide range of variables that can affect not only the significance, but also the magnitude of regional Okun coefficients.

Our results are the following. First, we produce evidence on the presence of a negative relation between output and unemployment in the two emerging countries considered. Second, we highlight important regional disparities in both the Czech Republic and Slovakia, when it comes to the significance of Okun's Law. Third, we provide an extensive analysis regarding potential drivers of such regional heterogeneities. In particular, we find that cyclical unemployment is significantly related to changes in the output gap in the Czech and Slovak regions with relatively high output, high domestic and foreign investment, high R&D, and a developed network of highways. On the contrary, regions with high and persistent long-term unemployment or large populations cannot benefit from positive output gaps to reduce unemployment. Fourth, we look for subsequent discrepancies across Czech and Slovak regions, by focusing exclusively on regions in which Okun's Law is at work. We unveil important non-linearities, mainly related to the level of unemployment, economic growth, and the growth rate of domestic investment. Finally, capitalizing on our results, we discuss policy measures designed to reduce unemployment regional disparities in the Czech Republic and Slovakia.

The rest of the paper is organized as follows. Section 2 presents the empirical strategy and the data, Section 3 illustrates evidence on the regional Okun's Law in the Czech Republic and Slovakia, Section 4 analyses the determinants of both the significance and the magnitude of Okun's coefficient, and Section 5 discusses policy implications and concludes.

2. Empirical strategy and data

We first present the econometric specification and then discuss the data used in our study.

2.1. Econometric strategy

Let us consider a general specification of Okun's Law linking the cyclical components of output and unemployment

$$y_t - \overline{y}_t = \alpha_0 + \alpha_1 (u_t - \overline{u}_t) + \varepsilon_t, \qquad (1)$$

where y_t and u_t are, respectively, the (log of) real GDP and the unemployment rate, α_0 is a constant, and ε_t is the error term. Denoting by $\overline{y}_t$ the trend of GDP and by $\overline{u}_t$ the trend of unemployment, the terms $(y_t - \overline{y}_t)$ and $(u_t - \overline{u}_t)$ measure the cyclical components of output (the output gap) and unemployment (the unemployment gap), respectively.

[4] See also the analysis of Moazzami and Dadgostar (2009) performed on 13 OECD countries, or the work of Gabrisch and Buscher (2006) focusing on post-communist economies.

[5] To some extent, cross-country OECD or E(M)U studies can be also seen as regional, provided countries are considered as regions of the OECD or E(M)U areas.

One major difficulty for estimating the interest coefficient, α_1, is that the long-term components of output and unemployment, namely potential output $\overline{y}_t$ and the natural unemployment rate $\overline{u}_t$, are unobserved. However, the literature has by now emphasized numerous detrending techniques, which properly allow for estimating the long-run component of a time series, by taking into account the likely presence of a unit root.[6] To easily compare our results with the literature, we focus on the Hodrick–Prescott (HP) detrending filter for estimating $\overline{y}_t$ and $\overline{u}_t$.[7] Despite its popularity, the HP technique is the object of various criticisms, particularly regarding the value of the key smoothing parameter, λ. In particular, although some consensus emerges for quarterly data, the literature is much divided when observed series present an annual frequency. Consequently, we append the value recommended by HP, namely 100, to account for the popular correction emphasized by Ravn and Uhlig (2002) and use the value $\lambda = 6.25$.

2.2. Data

At the most disaggregated level, our study is conducted on a balanced panel of 22 regions (14 from the Czech Republic and 8 from Slovakia), using original yearly data over the period 1995–2011.[8] We measure output y_t by real GDP, while unemployment u_t is captured through the registered unemployment rate, based on the methodology developed by the Ministries of Labor, Social Affairs and Family of the Czech Republic and Slovakia.

We begin by estimating the output and unemployment gaps using the HP filter on observed series y_t and u_t. For a proper estimation of Okun's Law by Eq. (1), both cyclical components $y_t - \overline{y}_t$ and $u_t - \overline{u}_t$ must be stationary. The literature emphasizes, mainly, two alternatives for investigating the presence of a unit root, namely unit root (for example, Augmented Dickey–Fuller) and stationarity (for example, Kwiatkovski-Phillips-Schmidt-Shin, KPSS, 1992) tests.[9] If we consider stationarity tests, according to Carrion-i-Silvestre and Sanso (2006) a major shortcoming relates to the estimation of the long-run variance; thus, we estimate it using the correction of Sul, Phillips & Choi (SPC, 2005).

Table 1 presents the KPSS stationarity test for output and unemployment gaps. The results show that the HP filter was successful in extracting a potential unit root, as all considered cyclical components of output and employment are stationary. In addition to regional unit root tests,[10] these results are backed up by (i) panel unit root tests—for example, the Im, Pesaran & Shin (IPS, 2003)[11] statistic (and its p-value) for cyclical output is −5.69 (0.00), while that for cyclical unemployment is −5.19 (0.00), therefore rejecting the presence of a unit root in the panel—and by (ii) panel stationarity tests—for example, the Hadri (2000) statistic (and its p-value) equals −2.68 (0.996) for cyclical output and −2.43 (0.993) for cyclical unemployment, therefore accepting the null hypothesis of stationary panels. Consequently, we employ the cyclical components of output and unemployment in the next section to search for eventual regional evidence on Okun's Law.

Table 1
Stationarity tests for output and unemployment gap.

Region	Output gap	Unemployment gap
Czech Republic		
Central Bohemia (CB)	0.056	0.054
Hradec Kralove (HK)	0.061	0.049
Karlovy Vary (KV)	0.062	0.047
Liberec (LI)	0.051	0.047
Moravia Silesia (MS)	0.066	0.058
Olomouc (OL)	0.063	0.054
Pardubice (PD)	0.057	0.049
Plzen (PZ)	0.065	0.050
Prague (PG)	0.060	0.059
South Bohemia (SB)	0.064	0.050
South Moravia (SM)	0.061	0.055
Usti (UT)	0.069	0.059
Vysocina (VY)	0.054	0.046
Zlin (ZL)	0.055	0.051
Slovakia		
Banska Bystrica (BB)	0.047	0.086
Bratislava (BA)	0.072	0.084
Kosice (KE)	0.060	0.099
Nitra (NR)	0.065	0.091
Presov (PO)	0.055	0.088
Trencin (TR)	0.058	0.081
Trnava (TV)	0.062	0.088
Zilina (ZI)	0.059	0.083

Note: KPSS stationarity tests are computed with a time trend. The maximum lag length was chosen based on the Schwert (1989) criterion. The critical values for the KPSS test are 0.119 (10%), 0.146 (5%), and 0.216 (1%).

3. Results: regional evidence on Okun's Law in the Czech Republic and Slovakia

We proceed in two steps: first, we present a graphical illustration of the relationship between unemployment and output at the regional level and, second, we emphasize regional estimations of Okun's Law.

Fig. 1 illustrates the cyclical components of unemployment and output based on HP computations. For parsimony, we present four examples for the Czech Republic (the first two lines) and two examples for Slovakia (the last line).

As emphasized in Fig. 1, the output gap has a much higher magnitude compared to the unemployment gap. This is consistent with the fact that both the Czech Republic and Slovakia are emerging economies experiencing a catching-up process (possibly relative to advanced EU countries) characterized by relatively higher economic growth rates. Fig. 1 shows mixed evidence. On the one hand, there seems to be a strong inverse relation between the output gap and the unemployment gap in the regions on the left-hand side column, namely Moravia Silesia, South Moravia, and Trencin. On the other hand, in South Bohemia, Karlovy Vary, and Kosice, the negative correlation between the two series is not that clear-cut. Indeed, for the latter regions, the behavior of unemployment and output seems less consistent with Okun's Law, as the two series often cross at values fairly different from zero, namely a positive output gap is not always correlated with a negative unemployment gap (or vice versa). Capitalizing on these observations, we present the following regional estimations.

Table 2 presents OLS estimations of regional Okun coefficients for each of the 22 Czech and Slovak regions. HP-based results depicted in the first column are consistent with Okun's Law, as all coefficients are negative, emphasizing an inverse relation between the unemployment gap and the output gap. Similar results occur if we perform panel pooled or fixed effects estimations on Czech and Slovak regions; for example, the Okun coefficient based on a panel regression with regional fixed effects equals −1.23 (with a standard error of 0.108). The (absolute magnitude) value of the Okun coefficient is even higher if we consider country data, namely −1.50 (0.265) for a panel regression with country fixed effects, −1.58 (0.464) for the Czech Republic, and −1.47 (0.343)

[6] For an early excellent survey on detrending methods, see Canova (1998).
[7] The robustness section will provide results based on other detrending methods.
[8] The time length was selected based on data availability. In addition, assuming that data were available since 1990 (i.e. after the end of the Cold War), we would still use 1995 as the starting date of our sample, to allow several years for economies to stabilize after the massive shocks they experienced.
[9] The null hypothesis for unit root (stationarity) tests is that the series is non-stationary (stationary) against the alternative hypothesis of stationarity (non-stationarity); thus, the two tests can be seen as the reversal complement of each other.
[10] The results of the Elliott–Rothemberg–Stock (ERS, 1996) test are available upon request.
[11] As acknowledged by the literature, the IPS test is more appropriate for heterogeneous panels compared, for example, with the Levin et al. (2002) statistic, which is more appropriate for homogeneous panels.

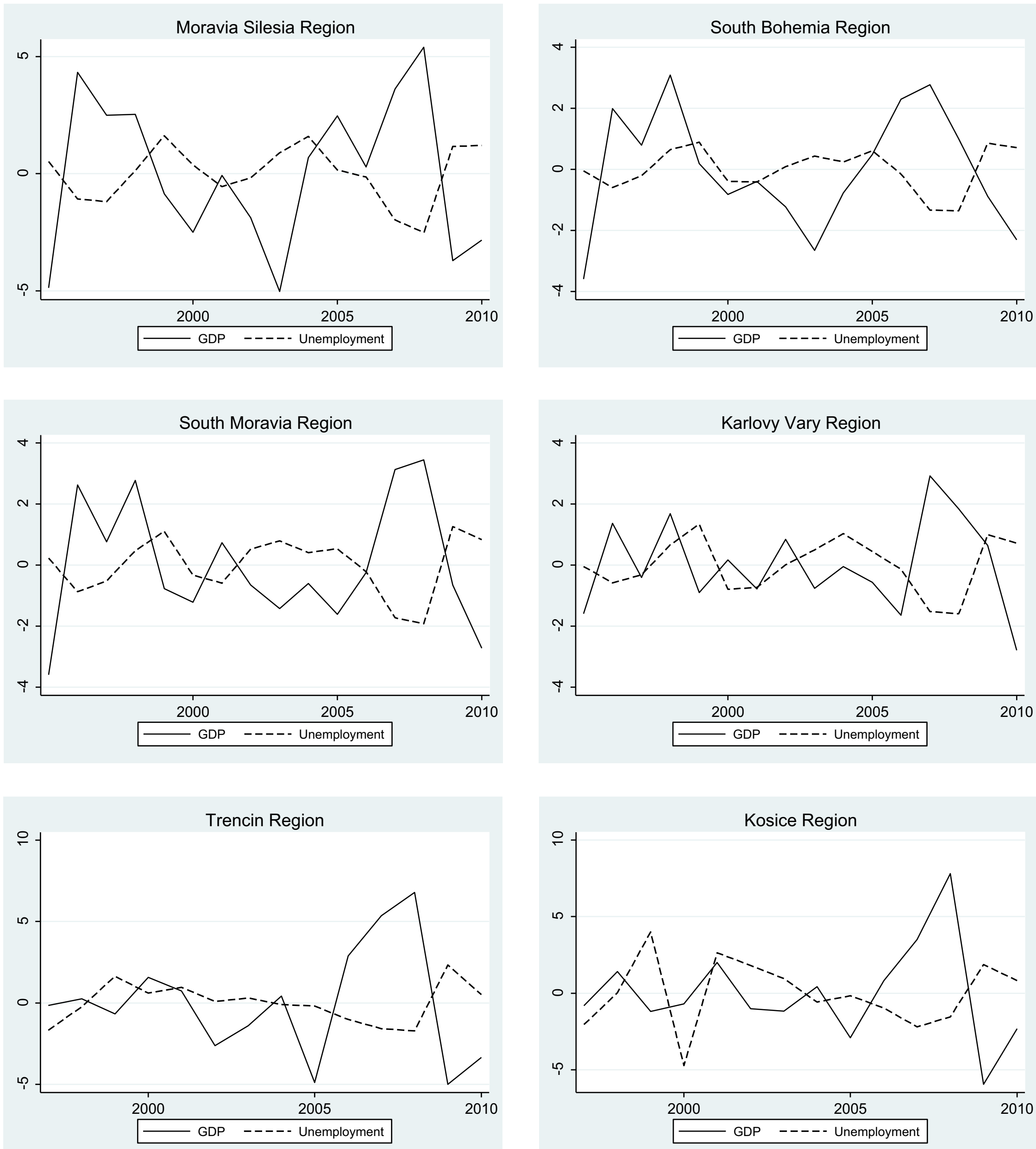

Fig. 1. Regional output and unemployment cycles in the Czech Republic and Slovakia.

for Slovakia. Altogether, these results confirm the presence of a negative link between cyclical unemployment and the output gap.[12]

However, results equally outline significant regional disparities. Regarding the Czech Republic, Okun's Law is statistically significant in 11 out of 14 regions, while in only 5 out of 8 regions for Slovakia. Moreover, when it comes to its magnitude, significant Okun coefficients lie between −3.00 for Prague and −2.58 for Bratislava, or between −0.92 for Olomouc and −1.11 for Nitra. Notice that these numbers are of higher (absolute value) magnitude than regional coefficients derived for developed countries (see Villaverde and Maza, 2009, for Spain, or Binet and Facchini, 2013, for France), confirming the strong link between unemployment and output in emerging countries, such as the Czech Republic and Slovakia.

Using the HP filter as a benchmark, in columns 2 and 3 we present robustness tests, which consider alternative detrending methods allowing for comparison with the related literature, namely a Quadratic Trend (QT, in column 2; see Adanu, 2005) and the Baxter and King (1999) filter (BK, in column 3; see Villaverde and Maza, 2009). The negative coefficients are yet again compatible with Okun's Law and of comparable amplitude with those based on the HP filter, namely between −2.56 (−2.64) for Prague (Bratislava) and −0.856 (−0.676) for Olomouc (Kosice) for QT, and between −2.05 (−2.90) for Moravia Silesia (Bratislava) and −1.15 (−1.29) for Zlin (Presov). However, compared to the HP filter, the use of a QT increases the number of significant

[12] Note also the existence of some differences in the magnitude of the Okun coefficient between the Czech Republic and Slovakia. Indeed, although the difference between the two countries is rather weak if we compare regional-average coefficients, namely −1.3 for the Czech Republic versus −1.2 for Slovakia, it becomes more important if we focus only on significant regional coefficients, as their averages are −1.6 for the Czech Republic and −1.9 for Slovakia. The more vigorous (in absolute value) Okun coefficient in Slovakia might be attributable, for example, to a better integration with trade partners (mostly EU countries), fostered by the convergence process prior to the adoption of the Euro in 2009.

Table 2
Okun's Law in the Czech Republic and Slovakia: regional evidence.

Region	HP	QT	BK
Czech Republic			
Central Bohemia (CB)	−2.30**	−1.72**	−1.94
	(.729)	(.545)	(1.00)
Hradec Kralove (HK)	−1.04**	−.904	−1.20**
	(.461)	(.479)	(.407)
Karlovy Vary (KV)	−.535	−1.10**	−.539
	(.408)	(.329)	(.564)
Liberec (LI)	−1.51**	−1.14**	−1.21**
	(.476)	(.470)	(.515)
Moravia Silesia (MS)	−1.90**	−2.17**	−2.05**
	(.478)	(.306)	(.602)
Olomouc (OL)	−.919**	−.856**	−.980
	(.408)	(.263)	(.505)
Pardubice (PD)	−1.45**	−1.64**	−1.29**
	(.451)	(.394)	(.523)
Plzen (PZ)	−1.53**	−2.17**	−1.25
	(.609)	(.446)	(.877)
Prague (PG)	−3.00**	−2.56**	−2.78
	(1.17)	(.806)	(1.41)
South Bohemia (SB)	−.724	−1.37**	−.553
	(.623)	(.551)	(.594)
South Moravia (SM)	−1.51**	−1.13**	−1.25**
	(.407)	(.356)	(.493)
Usti (UT)	−.619	−1.57**	−.403
	(.478)	(.312)	(.490)
Vysocina (VY)	−1.40**	−1.55**	−.947
	(.357)	(.261)	(.597)
Zlin (ZL)	−1.22**	−1.41**	−1.15**
	(.510)	(.467)	(.396)
Slovakia			
Banska Bystrica (BB)	−1.32	−.501	−2.33**
	(.722)	(.399)	(.771)
Bratislava (BA)	−2.58**	−2.64**	−2.90**
	(.884)	(.607)	(1.07)
Kosice (KE)	−.471	−.676**	−.226
	(.397)	(.290)	(.384)
Nitra (NR)	−1.11**	−.872**	−1.34
	(.433)	(.217)	(.661)
Presov (PO)	−.986	−.750**	−1.29**
	(.493)	(.291)	(.542)
Trencin (TR)	−1.89**	−1.45**	−2.29**
	(.610)	(.407)	(.656)
Trnava (TV)	−2.16**	−2.20**	−1.44
	(.929)	(.580)	(.945)
Zilina (ZI)	−1.72**	−1.06**	−2.70**
	(.500)	(.297)	(.570)

Note: HP stands for the Hodrick–Prescott filter. QT signals the use of a quadratic trend. BK stands for the Baxter–King filter. Standard errors robust to autocorrelation and heteroskedasticity are reported in brackets.
** Shows significance at the 5% level.

coefficients to 13 in the Czech Republic and to 7 in Slovakia, while drawing upon the BK filter drops the number of significant regions to 6 for the Czech Republic and to 5 in Slovakia.[13]

Based on the three alternative detrending methods, we can identify three patterns when it comes to assessing the significance of the regional Okun's Law. In the first group there are several regions in which the coefficient is strongly significant (at the 5% level), irrespective of the method used. Regarding the Czech Republic, such regions are South Moravia or Moravia Silesia, while for Slovakia we can identify Bratislava and Trencin. Regarding the second group, in several regions the unemployment and output cycles do not seem to be significantly correlated, as the estimated coefficient is not significant in at least 2 out of 3 cases. This is the case for Karlovy Vary, Usti, and South Bohemia for the Czech Republic, and for Banska Bystrica and Kosice for Slovakia. Finally, in the last group we identified regions with mixed results, namely, in which significant and non-significant Okun coefficients coexist, depending on the econometric method used. For example, for the Czech Republic, Central Bohemia and Vysocina would be associated with the first and second groups, while for Slovakia, Trnava and Presov would be closer to the first and second groups, respectively. Building on these findings, in the next section we aim to emphasize potential factors that could drive such important regional differences.

4. Discussion: a closer look at driving factors of regional disparities

The goal of this section is to explore two issues. In the first subsection we investigate what might differentiate regions in which Okun's Law holds from regions in which it does not. In the second subsection we focus exclusively on the regions in which the relation between the cyclical components of unemployment and output is significant and search for potential variables that might significantly influence its magnitude.

4.1. What explanations exist for a significant regional Okun's Law?

Let us first focus on our main variables, namely unemployment and GDP. Regarding unemployment in Slovakia, the regions where Okun's Law is not significant are associated with high unemployment, as well as high long-term unemployment. Average unemployment for Banska Bystrica, Kosice, and Presov equals 19.2%, compared to 8.83% in Bratislava, Zilina, and Trnava, while for long-term unemployment the numbers are 11.2% and 3.52%, respectively. Turning to the Czech Republic, average unemployment and average long-term unemployment together for Karlovy Vary and Usti are 10.8% and 4.04%, well above the values for Central Bohemia and Prague, namely 4.40% and 0.87%. Consequently, an identical initial explanation arises for both countries: demand-based policies are found to be inefficient in reducing unemployment in the Czech and Slovak regions characterized by high and persistent unemployment.[14] Given the beginning date of our sample, namely 1995, we can suspect that this long-term unemployment is mainly related to the end of the Cold War and the transition to a market economy in the 1990s, which was typically associated with deindustrialization and massive job destruction. In particular, the skills of the unemployed rapidly became obsolete with respect to the requests of the new types of industries. Therefore, these regions should draw upon supply-based policies designed to reduce labor market rigidities, allowing, for example, for the long-term unemployed to acquire new skills through requalification.

We now turn to GDP. Regarding the Czech Republic, the regions Karlovy Vary, Usti, and Vysocina are below the average GDP per capita, in contrast with Prague, South Moravia, and Central Bohemia, which are (decreasingly) ranked 1, 2, and 4, respectively. The same holds in Slovakia, as, according to their average GDP per capita, Bratislava and Trnava are the two richest regions, while Banska Bystrica and Presov are the two poorest. Thus, it seems that demand-based policies may create important unemployment regional disparities in both the Czech Republic and Slovakia, with the formation of “clubs,” namely, rich regions with low and decreasing unemployment, which coexist with poor regions with high and persistent (long-term) unemployment. To better emphasize the potential existence of such underdevelopment traps, we can augment our analysis using GDP growth rates. For Slovakia, the regions of Bratislava and Zilina present the two highest growth rates, in contrast with Banska Bystrica and Presov which exert the two lowest growth rates. For the Czech Republic, Karlovy Vary and Usti are associated with the lowest average growth rates (3.8% and 4.7%, respectively), below the average of 5.5% for the Czech Republic and well below the most rapidly growing regions, namely Prague (7.7%), Central Bohemia (6.8%), and South Moravia (6.3%). Since

[13] Moreover, to control for the fact that, as with most of the CEECs, the Czech Republic and Slovakia experienced changes in the dynamics of their population after the end of the Cold War, we used real per capita GDP as a measure of output. We report that HP-based results are unchanged when it comes to the sign and significance of Okun's coefficient in all Czech and Slovak regions (results are available upon request).

[14] Our results confirm previous findings for Greece (Christopoulos, 2004) and for the OECD (Sogner and Stiassny, 2002).

average growth rates are computed over the period 1995–2011, these important differences in magnitude over such a long period support the idea of the formation of significant regional disparities involving regional development paths at different speeds (absence of regional convergence).

Capitalizing on the evidence for unemployment and GDP, we consider, in the following, additional explanatory variables for the regional Okun's Law. Let us first focus on domestic and external investments. An interesting feature for both countries is that domestic and foreign investments seem to be highly complementary. Indeed, for the Czech Republic, the lowest and highest volumes of per capita gross fixed capital formation (GFCF) and foreign direct investment (FDI) are registered in Karlovy Vary and in (except Prague) South Moravia and Central Bohemia, respectively. Similarly, Banska Bystrica and Presov, and Bratislava and Trnava, present, respectively, the lowest and highest per capita GFCF and FDI volumes for Slovakia. The fact that domestic and foreign investments often go hand in hand, signifying that one type of investment can hardly substitute the other, yet again supports the potential danger of regional underdevelopment traps in the Czech and Slovak regions.

Second, we discuss innovation, measured alternatively by two variables. On the one hand, the largest volume of R&D investment in the Czech Republic occurs in (except Prague) Central Bohemia, South Moravia, and Moravia Silesia, and the smallest in Karlovy Vary, Vysocina, and Usti. The same pattern appears for R&D growth rates, as the former (latter) three regions are all above (below) the average. For Slovakia, R&D investment volumes are roughly 10–20 times (2–4 times) higher in Bratislava (Trnava) compared to the lowest amounts of R&D investment, which is registered in Presov and Banska Bystrica. These high magnitudes still hold when we compare the average growth rate of R&D for Bratislava (11.1%) and Trnava (9.95%) with that of Presov (4.39%). On the other hand, we consider the number of students, as a proxy for human capital, which itself can foster innovation. If the highest number of students over the period 2007–2011 occurs as expected in Bratislava, note that the region of Presov has among the lowest number of students. The figures for the Czech Republic for the same period are even more conclusive: the top four regions regarding the number of students are Prague, Moravia Silesia, South Moravia, and Central Bohemia, while Karlovy Vary, Vysocina, Usti, and South Bohemia are all below the average. Thus, evidence for innovation, proxied alternatively by R&D investment or the number of students as a measure of human capital, confirms the patterns established for previous variables.

Finally, we explore to what extent demographic and geographic variables may explain differences in the significance of Okun's Law. In the former group of variables, for Slovakia, the most populated regions are Presov and Kosice, while Bratislava and Trnava are among the least populated regions; in addition, Banska Bystrica and Presov are the lowest two regions when it comes to population density.[15] For the Czech Republic, the regions with the highest average net migration are Central Bohemia, Prague, and South Moravia, while Karlovy Vary and Vysocina have virtually no net migration.

To capture geographic variables, we searched for data on highways, since, particularly for developing and emerging countries, they can be a strong vector of economic development. Fig. 2 displays the network of highways in the Czech Republic and Slovakia.[16]

Visually, the map confirms the three areas along which the Okun's Law was found to be significant. First, around the capital Prague, namely for the regions Prague and Central Bohemia, where there is an important concentration of highways. Second, along the highway linking the two capital cities Prague and Bratislava, namely for the regions South Moravia and Bratislava. Third, Okun's coefficient is equally significant along the highway connecting Bratislava to Trencin, namely for the regions of Bratislava, Trnava, and Trencin. For example, regarding the Czech Republic, out of the 546 km of highways in 2005, 298 km is located in Central Bohemia (174) and South Moravia (124), while for Slovakia the three regions with the longest highways are Bratislava (101), Trnava (67), and Trencin (67), for a national highway network of 317 km in 2005.[17] Strongly related to the presence of high-quality transport infrastructure, the automobile industry is equally developed in these regions. For example, regarding Slovakia, Volkswagen is implanted in the region of Bratislava, Peugeot–Citroen in Trnava, and Kia Motors in Zilina. Similarly, regarding the Czech Republic, Skoda is implanted in Central Bohemia, while Moravia Silesia and South Moravia are traditionally highly industrialized regions.[18] Conversely, Okun's Law is not significant in northern regions of the Czech Republic (especially Karlovy Vary and Usti) and in eastern regions of Slovakia (Banska Bystrica, Kosice and Presov).

This preceding analysis suggests that, in addition to common historical and cultural traditions between the Czech Republic and Slovakia, there exists a regional pattern of where Okun's Law holds, namely in border regions between the Czech Republic and Slovakia (Czech Republic: South Moravia, Zlin, and Moravia Silesia; Slovakia: Trnava, Trencin, and Zilina). Consequently, the following analysis considers all regions pooled, i.e. irrespective of the country to which they belong.

4.2. Are there regional non-linearities in the regional Okun's Law?

In complement to the previous analysis, we focus in this subsection exclusively on the regions in which the Okun coefficient is significant. Precisely, we aim to look at whether, when significant, the relation between unemployment and output is related to non-linearities among Czech and Slovak regions. To this end, we consider several variables that may generate such non-linear effects. Let us first focus on the influence of average unemployment on Okun coefficients.

As emphasized by Fig. 3.a, there exists an increasing relation between average (1995–2011) unemployment and Okun coefficients. In addition, since the slope is significant (the p-value associated with the slope equals 2.7%), our analysis reveals that the relation between unemployment and output is significantly different depending on the level of average unemployment. For example, the Okun coefficient is 2–3 times stronger in Central Bohemia or Bratislava compared to its value in Olomouc or Hradec Kralove. Thus, in addition to the result from the previous subsection, according to which the level of unemployment matters when it comes to the significance of the Okun coefficient, we find that the level of unemployment is equally related to significant magnitude non-linearities across Czech and Slovak regions for which Okun's Law is at work.

Second, we look for a potential role of economic growth. According to Fig. 3.b, there exists a decreasing and significant (the p-value associated with the slope equals 2.5%) link between the size of the Okun coefficient and the 1995–2011 average economic growth (RGDP).

[15] Note also that the largest Slovak regions are Banska Bystrica and Presov (together they represent 38% of the total land area of Slovakia).

[16] We looked for maps for the beginning and the end of our sample. However, the lack of available data forced us to use the map for 2005—as close as we could get to the middle year of our sample, 2003.

[17] Note that our conclusions still hold if we consider other national rapid roads, i.e. 1st roads, in addition to highways. For example, among the regions with the lowest density of highways and 1st roads in 2005 in the Czech Republic we find South Bohemia and Karlovy Vary, while Prague (corrected for the surface covered by historical buildings) and the Moravian Silesian region contain the highest density of highways and 1st roads. Regarding Slovakia, there is a major gap between the density of the last three ranked regions, namely Kosice, Banska Bystrica, and Presov (the average value is around 6.4 km of such roads per 100 km^2 of surface), and the first three regions, namely Bratislava, Trnava, and Trencin (the average is around 9.5 per 100 km^2 of surface).

[18] For example, the industrial tradition of the Moravian Silesian region goes back (at least) to 1763 (discovery of coal in the region) and currently Moravia Silesia is among the most industrialized regions in all of Central Europe. Previously focused on mining and heavy industry, the region has undergone a significant restructuring process, leading to the development of new industries, including automotive and related supply chains. Important firms include Moravia Steel (ranked 7th in the Czech Republic according to net sales in 2011), OKD (coal and coke production, ranked 6th in the Czech Republic according to the number of employees in 2011), or the famous automotive company Tatra. In particular, note that the high magnitude (in absolute value) of the Okun coefficient for Moravia Silesia is in line with the work of Blackley (1991), emphasizing high Okun coefficients in large manufacturing sectors.

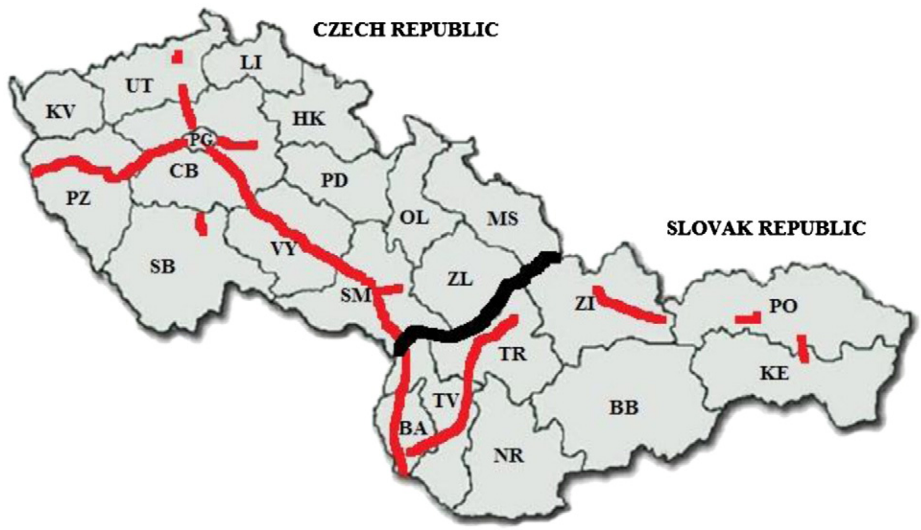

Fig. 2. The network of highways in the Czech Republic and Slovakia in 2005.

Specifically, in regions such as Bratislava, Central Bohemia, Prague, or Trnava, Okun coefficients are above 2 (in absolute value), but only around 1 in Hradec Kralove, Olomouc, or Zlin. Consequently, there exist significant regional disparities in the reaction of unemployment to output-based policies among Czech and Slovak regions with rapid, versus moderate, economic growth paths.[19]

Third, let us look more in detail at important economic growth drivers, namely research and development (R&D), foreign direct investment (FDI), and the gross fixed capital formation (GFCF). Despite presenting the expected negative sign, the correlations between Okun coefficients and the growth rates of both R&D and FDI are not significant.[20] On the contrary, as illustrated by Fig. 3.c, the higher the growth rate of the gross fixed capital formation (RGFCF), the higher the Okun coefficient (in absolute value). Even though the significance of the relation is relatively weaker (the p-value associated to the slope equals 9.4%), GFCF appears, in addition to unemployment and the growth rate of GDP, as a potential key determinant of the magnitude of the relation between unemployment and output.

Finally, we explored other potential sources of heterogeneities among Okun's coefficients in the Czech and Slovak regions. We report that population dynamics (measured by the growth rate of migrants), the evolution of human capital (measured by the growth rate of students), or the change in wages were not found to be significant drivers of regional heterogeneities in the relation between unemployment and output in the Czech and Slovak regions.

5. Conclusion

We presented in this paper evidence on the regional Okun's Law in the Czech Republic and Slovakia. Compared to the few previous contributions that focused exclusively on developed countries, our paper is, to the best of our knowledge, the first attempt to present such regional evidence in two emerging countries, selected for their historical, cultural, and economic closeness.

Using annual data for the period 1995–2011, we emphasized important heterogeneities among Czech and Slovak regions regarding the significance of the Okun coefficient. Considering alternative methods for estimating Okun's Law, three patterns arise: regions for which the Okun's Law is (i) always validated, (ii) never or weakly validated, and (iii) mixed results. The existence of these disparities calls for a more detailed analysis of the underlying mechanisms explaining such regional differences. On the one hand, we searched for determinants that might explain what drives regional disparities in the relation between unemployment and output. According to our findings, the Okun's Law appears not to be statistically significant in the Czech and Slovak regions in which average and long-term unemployment are high and average economic growth is relatively lower. These results are to be related to the deindustrialization process that followed the end of the Cold War, generating high and persistent unemployment due to obsolete skills. Furthermore, these findings raise serious regional development concerns, as regions with high unemployment may be caught in an underemployment trap, in addition to the underdevelopment trap due to the presence of relatively lower economic growth rates over such a long period. In addition, the regions where the Okun coefficient is not significant are jointly characterized by low domestic (GFCF) and foreign (FDI) investments, which equally raises the danger of regional underdevelopment traps in the Czech Republic and Slovakia. Unfortunately, the same holds when considering other potential sources of economic development, like R&D spending, population, the number of students, or the network of highways. On the other hand, we found that the level of unemployment, economic growth, or the growth rate of the GFCF are related to significant non-linearities among the Czech and Slovak regions for which the Okun's Law is statistically significant.

Altogether, these results have important policy implications. First, it appears that demand-side policies are inappropriate in many of the Czech and Slovak regions for dealing with unemployment. In such regions, policymakers should draw upon supply-based policies, including supporting the unemployed in acquiring new skills through requalification, subsidizing the formation of human capital (for example, through increasing the number of students), or subsidizing the development of R&D activities is poor regions with high unemployment.[21] In addition, from a more demand-side perspective, since domestic and foreign investments seem to go hand in hand in the Czech and Slovak

[19] A positive link between output and the absolute size of the Okun coefficient is similarly reported by Adanu (2005) for Canada.

[20] An unpublished appendix provides a graphical illustration. The lack of a significant relation between R&D growth and Okun coefficients can be related to the time needed for R&D investment to generate sizable effects at the macroeconomic level (and all the more in emerging or developing countries, as is the case for our analysis). Besides, there is currently a debate over the sign of the effect of R&D growth on the Okun coefficient; for example, Villaverde and Maza (2009) find a positive relation, contrary to the not significant slope we find. However, R&D and FDI growth rates explain regional differences when it comes to the significance of Okun's Law (see also the previous subsection). For example, in regions with high FDI growth rates, such as Moravia Silesia or South Moravia, Okun's coefficient is significant, while not significant in regions with low FDI growth rates (Karlovy Vary or Usti).

[21] Supply-based policies are likewise defended by Apergis and Rezitis (2003) and Apergis (2005) for Greece, or Villaverde and Maza (2009) for Spain.

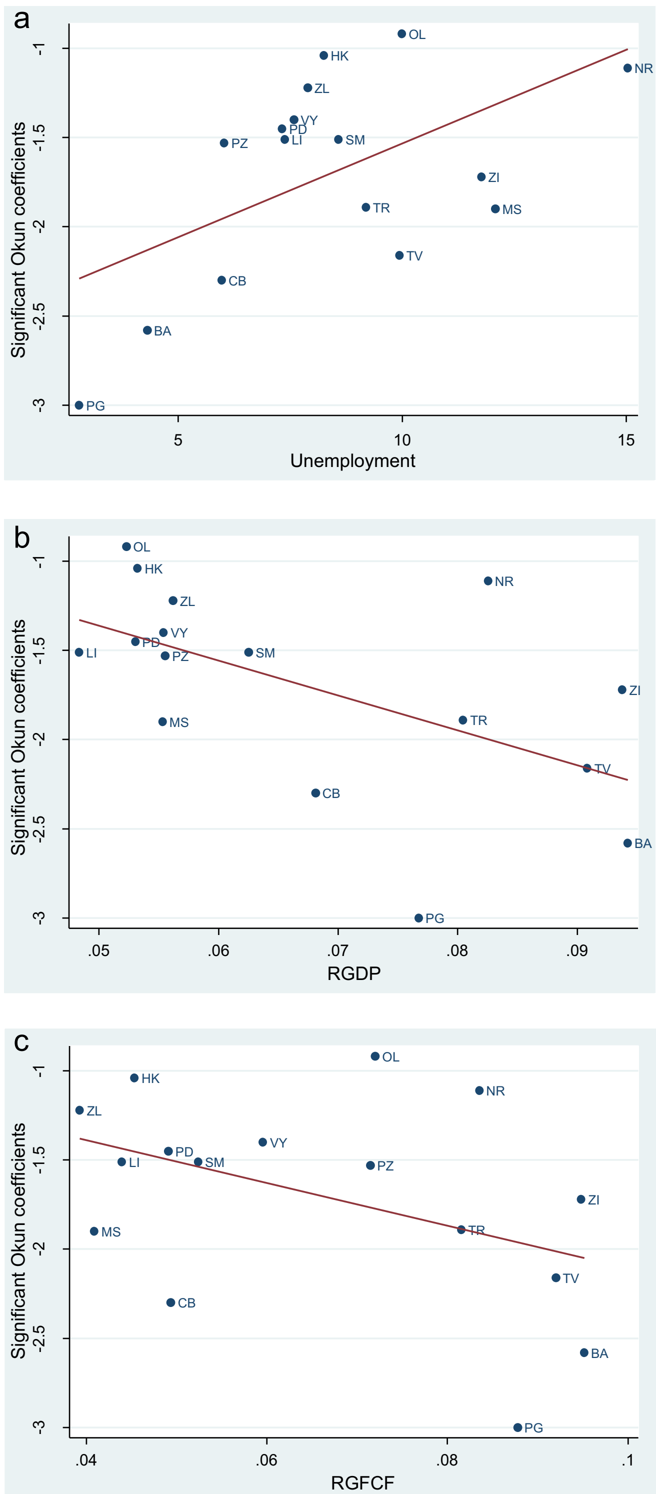

Fig. 3. a. The magnitude of regional Okun coefficients: the role of unemployment. b. The magnitude of regional Okun coefficients: the role of economic growth. c. The magnitude of regional Okun coefficients: the role of the GFCF.

regions, policymakers concerned with reducing unemployment should provide facilities for attracting FDI in such affected regions.[22] One way to do so is to focus on large public investment plans in regional infrastructure (such as highways or other rapid roads).[23] Failing to do so might result in persistent unemployment rates, and even regional underemployment traps, in the Czech and Slovak regions associated with different convergence speeds compared to other EU/CEEC regions. From this perspective, EU funds designed for fostering convergence across the area can play the role of a key vector in accompanying the Czech and Slovak transition (and convergence to the advanced EU countries) process, by driving regional development and reducing regional unemployment.

[22] One successful example is the Moravian Silesian region in the Czech Republic: despite high unemployment rates following the restructuring process in industry, the region attracted domestic and foreign investments (in particular by building industrial parks) that generated sizable macroeconomic effects in reducing unemployment.

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[23] The role of local infrastructure for reducing regional unemployment is similarly outlined by Christopoulos (2004) for Greece or Binet and Facchini (2013) for France.

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