Regional growth and unemployment. The validity of Okun's law for the Finnish regions

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REGIONAL GROWTH AND UNEMPLOYMENT

The Validity of Okun's Law for the Finnish Regions

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Abstract:

This paper offers a concise critical overview of Okun's Law, with particular attention for its relevance in open economic systems of regions. Based on an extensive set of economic data for Finnish regions, the existence of cointegration is tested by using alternative statistical methods, viz. the residual-based test and the conditional error correction model. A novelty of the paper is to combine a method of hidden cointegrations with a method of removing cross-sectional dependence. After correcting for hidden cointegrations and cross-sectional dependence, both statistical methods used yield almost similar results and confirm cointegration for the relevant data on Finnish regions. This long-run relationship in Finland appears to be very similar to that found elsewhere in the literature.

Key words: Okun's Law, (hidden) cointegration, asymmetry, residual-based test, conditional error correction model, regional growth

1. Okun's Law Revisited

The seminal paper by Okun (1962) on the relationship between GDP growth and unemployment has prompted many scientific discussions over the past decades. 'Okun's Law' stipulates that this relationship is symmetric and that a three percent increase in real GDP is associated with a one percentage point decrease in unemployment, provided at least that the unemployment level is above the natural rate. Okun's Law presupposes essentially a macroeconomic correlation between the level of economic activity in the goods market and that in the labour market over the business cycle.

Okun's Law has obvious implications for macroeconomic policy, as it is often used as a benchmark for measuring the cost of unemployment rise (see e.g. Moosa 1997a). In addition, this law may be helpful in determining an optimal (or desirable) growth rate for the economy, which is needed as critical information for formulating monetary policy rules and other business cycle policies (Gordon 2010).

While there seems to be consensus on the negative correlation between unemployment and GDP movements, the order of magnitude of this correlation appears to show quite some variation in different studies. Various recent empirical studies point out that Okun's Law varies substantially across countries, over different time periods and over the phases of a business cycle in such a way that it seems plausible to model it as a non-linear relationship (see e.g. Altig 1997, IMF 2010, Daly and Hobijn 2010, Crespo-Cuaresma 2003, Silvapulle et al. 2004). These authors argue that the coefficient in Okun's Law varies according to recessions and expansions of the economy and that the effect of cyclical output on cyclical unemployment is significantly higher in case of a downturn in the economy.

Other features of Okun's Law, viz. its order of magnitude and its symmetry, have also met criticism. For example, by using a static framework and by imposing exogenously an asymmetry threshold on the unemployment variable, Lee (2000) tests the (a)symmetric behaviour of Okun's Law for yearly data on 16 OECD countries and finds significantly higher coefficients for various countries (e.g. Finland, Japan, the USA). Next, Mayes and Viren (2002) emphasize asymmetry in the behaviour of the labour market and demonstrate that rapid downturns in the economy have more than proportionate effects on unemployment, partly because of the mismatch between the relevant sectors and the regions where the jobs and

unemployment show up. Another explanation for the asymmetry in Okun's Law is given by Harris and Silverstone (2001), who emphasize the asymmetric responses among heterogeneous production sectors in terms of job creation and job destruction when faced with economic shocks.

The above mentioned observations question some basics of Okun's Law, in particular its linearity and its symmetry assumption. The limitations mostly highlighted in the literature are threefold: (i) the short-run analysis framework for linking output and unemployment gaps relative to their natural (equilibrium) level; these results are sensitive to the choice of the trend-cycle decomposition method and do not incorporate long-run feedback effects between goods and labour markets; (ii) the a priori assumed short-term exogeneity of unemployment and output in investigating the statistical correlation between these two variables; (iii) the statistical restriction to aggregate (macroeconomic) variables, without any consideration of region-specific characteristics in both the product and the labour markets and how different markets behave over the business cycle; (iv) under conditions of hysteresis and related factors – where fired workers tend to have re-employment difficulties after longer unemployment spells – a drop in GDP may produce a higher rise in unemployment rates relative to a case when GDP increases.

The current economic recession has recentely prompted a new debate on the association between GDP changes and unemployment, not only from a macroeconomic perspective, but also from a (multi-) regional perspective. A good illustration of this issue can be found in Finland, a country which – in contrast to its past prosperous development – faced in 2009 a drop of 8% in its GDP, while it may likely grow only 1 % in 2010 (Finnish Ministry of Finance 2010). These unfavourable growth prospects are a reason for deep concern on the future employment situation in this country and its regions. If Okun's Law would be strictly valid, Finland will encounter a problematic labour market development in the near future. Clearly, if a strict linear relationship does not hold, other determinants will impact on the future unemployment rate (see also Freeman 2001, Gordon 1984, Moosa 1997b, Knoester 1986). Therefore, the reliability of Okun's coefficients is not only of paramount importance for macroeconomic policy, but also for the regional distribution of unemployment rates in an open spatial system. Thus, a regional focus on Okun's Law is warranted. In addition, economic growth tends to exhibit more fluctuations at a regional scale than at a national scale due to spatial interdependencies and lower economic diversity of regions, so that also local public finances may show more variability and hence may

have more variations at a spatially disaggregated level. Furthermore, differences in regional economic structures – for instance, labour-intensive regional economies dominated by the public sector versus capital-intensive or export-oriented regions – may lead to different orders of magnitude of Okun's Law, so that economic fluctuations may have heterogeneous effects on regional (or local) tax bases and hence on public expenditures in case of a variety in regional economies within a national system (see also Machin and Van Reenen 1998, Moosa 1997b, Paldam 1987, Paley 1993). This issue is also related to endogenous regional economic growth analyses (see Stimson et al. 2010).

In order to potentially uncover geographical structural differences in the responsiveness of labor markets to changes in output and to benefit from the larger variation in output and unemployment at a regional level, some authors have recently tried to pay also attention to the regional aspects of Okun's Law (see e.g. Freeman 2000, Christopoulos 2004, Adanu 2005, Villaverde and Maza 2007). The present paper takes these arguments further and presents a new regional statistical analysis inspired by Okun's Law that allows for long-run asymmetries between output and unemployment in a multiregional system within a hidden cointegration framework, which does not need an a priori assumption on the exogeneity of either of these variables nor any trend-cycle decomposition procedure. Finally, the paper will take the cross-sectional dependence into account (in particular, whether a certain type of Okun correlation in one region will affect the Okun relationship in other regions). The new Okun model will be applied to 74 Finnish Labour market regions over the past 30 years.

In the light of the previous observations we aim to develop an amended statistical model representing Okun's Law that meets the following two conditions: (i) it should be able to identify or represent the existence of both linear and non-linear relationships between regional GDP and regional unemployment rates, and (ii) it should be able to take into consideration the extent to which Okun's relationship depends on the region's own characteristics and those of others (cross-sectional or spatial dependence). For this objective we combine a hidden conintegration approach by Gordon (2010) to accommodate asymmetries with a method by Pedroni (2004) to remove cross-sectional dependence. Our statistical analysis of time series of key variables will be based on a cointegration approach. The relationship is modelled utilising time series rather than cross-sectional variations in order to avoid taking a priori stances on the exogeneity of either

GDP or unemployment. However, in a system of small open regional economies, cross-sectional dependence is crucial to take into account as well.

2. Two Statistical Approaches and the Data

2.1 Hidden cointegrations

To model Okun's Law in case of asymmetry (with non-linear correlations) we will now present the following time series analysis of two I(1)-distributed variables, GDP_t and the unemployment rate UN_t (with a possible drift):

$$UN_t = UN_{t-1} + u_t = UN_0 + \sum_{i=1}^{t} u_i$$

and (1)

$$GDP_t = GDP_{t-1} + u_t = GDP_0 + \sum_{i=1}^{t} v_i,$$

where v_t and u_t are both white noise terms with zero means, meaning that u does not depend on UN and v is independent of GDP. Regardless of non-correlation within equations there can be correlations between them. If the association between these two time series variables was linear, we would define the following Engle and Granger (1987) linear cointegration formula (see also Attfield and Siverstone 1997, 1998, Granger and Yoon 2002, Pedroni 2000):

$$\sum_{i=1}^{t} u_i - \beta \sum_{i=1}^{t} v_i = 0, \quad (2)$$

meaning that the linear relationship between UN and GDP is stationary over time, although both variables have their own unit roots.

If it appears that the variables do not have a cointegration relationship, their sub-components may still have it (see Gordon 2010). In such a case the relationship is non-linear. In general, a hidden cointegration takes place among two variables, if their components are mutually cointegrated. To look for hidden cointegrations in the present case, let us decompose UN into two components:

$$u_i^+ = \max(u_i, d)$$

$$u_i^+ = \min(u_i, d) \tag{3}$$

where d is an a priori given threshold value. The same holds for v_i. Consequently, we have

$$u_i = u_i^+ + u_i^- - d$$
$$v_i = v_i^+ + v_i^- - d \tag{4}$$

On the basis of the expressions presented above and assuming d=0, we may now apply the following decomposition:

$$UN_t = UN_0 + u_t^+ + u_t^-$$
$$GDP_t = GDP_0 + v_t^+ + v_t^-, \tag{5}$$

where u_t^+ and v_t^+ are the cumulative sums of positive shocks in period t, while the negative counterparts are the cumulative sums of negative shocks on UN and GDP, respectively.

2.2 Database

The previous analysis framework has been used to analyse the existence and relevance of Okun's Law for the 74 travel-to-work areas, TTWAs, in Finland. Our data base covers annual time series information on GDP (value added) and the unemployment rate during the period 1976-2006.

The long run relationship between unemployment rate and GDP would be easy to estimate, if both series were stationary and stable in a sense that they would not have breaks in the data generating process. However, it appears that both aggregate series are highly non-stationary and non-stable (Figure 1). Therefore, a simple regression of unemployment on the log of GDP would yield highly unreliable results.

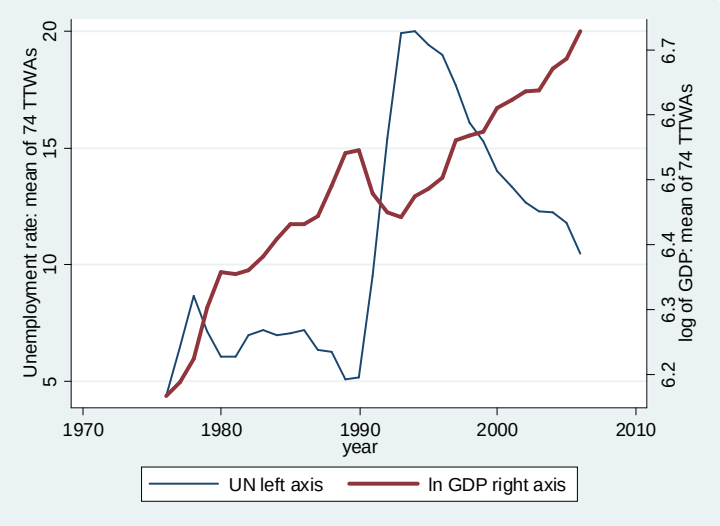

Figure 1. Time patterns of unemployment and GDP

It is noteworthy that a decomposed series appears to show a slightly better behaviour. However, there are still breaks in the positive UN series, u^+, and in the aggregate series, UN. While the negative component, u^- , appears to look much better, it also has a break in the early 1990s, when the series levels off for the years when the aggregate unemployment rises all over Finland (see Figure 2).

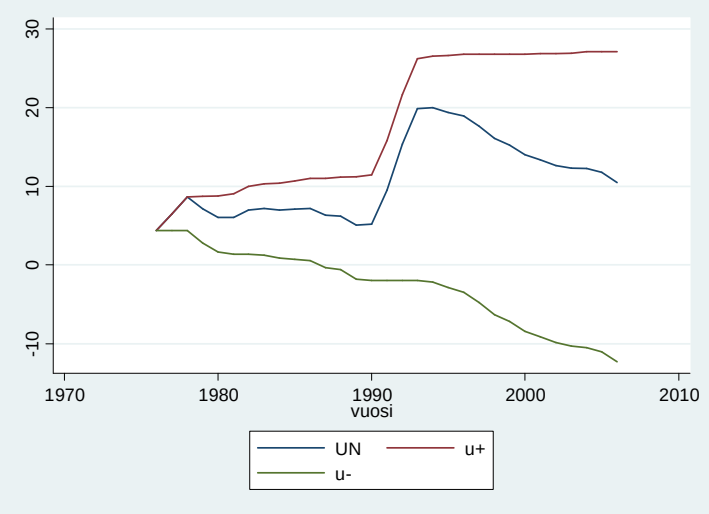

Figure 2. A decomposed mapping of unemployment

Next, we will offer a picture of the decomposed GDP series, v^+ and v^-. This time pattern appears to demonstrate a reasonably good behavior (see Figure 3).

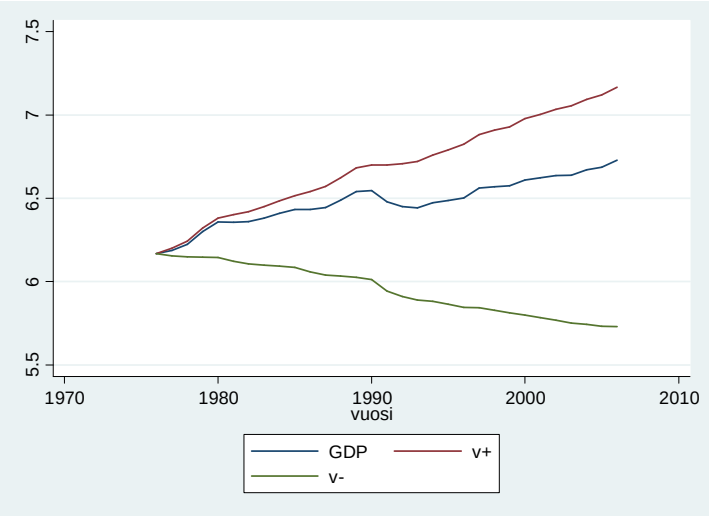

Figure 3. A decomposed mapping of GDP

It should be noted that even more non-reliability emerges from cross-sectional dependence. Beside time series dynamics, the Okun's Law relationship in an open regional economy may easily be affected by developments in other regional economies. Simple spatial correlations reveal that it is indeed important to take spatial dependencies into account. Using average values for each cross-sectional unit over the 30 years of investigation reveals a clear spatial correlation. For example, regions with a high unemployment rate tend to have adjacent neighbours with high unemployment and vice versa (see Figure 4).

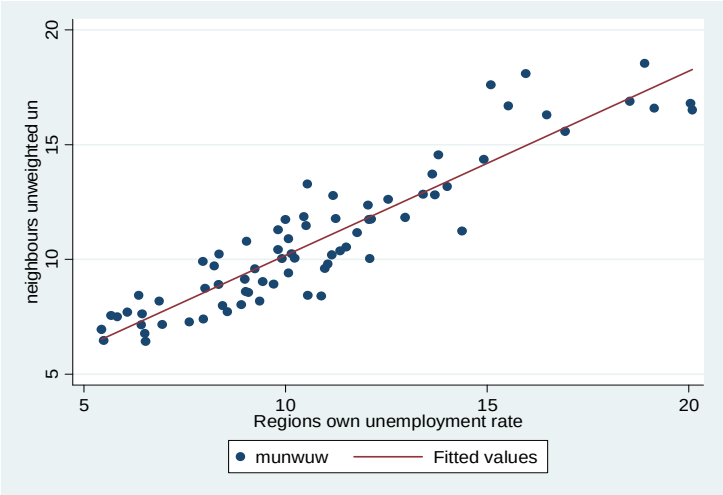

Figure 4. Spatial correlation in unemployment

2.3 Correcting for cross-sectional dependence

To account now for these correlations, we relate each variable to the annual country average, a procedure which is now common in econometrics panel data analysis with long time series and a high number of cross-sections. To do this, the threshold value d (introduced in (3) above) is no longer equal to 0, but equals the annual average across the cross-sectional (areal) units. As a consequence, the value of the positive unemployment rate series, u+, in 1977 is equal to that for 1976 plus the change in 1977, if the change in the region in question is higher than the average. Otherwise, the change is 0 and the value in 1977 equals that of 1976. The opposite applies to the negative series. If the change is lower than the average, the value is subtracted from the value in 1976, otherwise the change is 0. Using this logic the entire time series can be computed for each TTWA, obtaining variables uk^+, uk^-, vk^+ and vk^-, where k refers to the value relative to the country average. In other words, the method used combines the hidden cointegration framework with the Pedroni-style method to remove cross-sectional dependence.

Relating the variables to the country averages makes them look clearly non-stationary but stable (see Figures 5 and 6). Application of unit root tests (results available upon request) confirms this visual finding. As our time series is non-stationary, the long-run relationship is estimated using two alternative cointegration approaches.

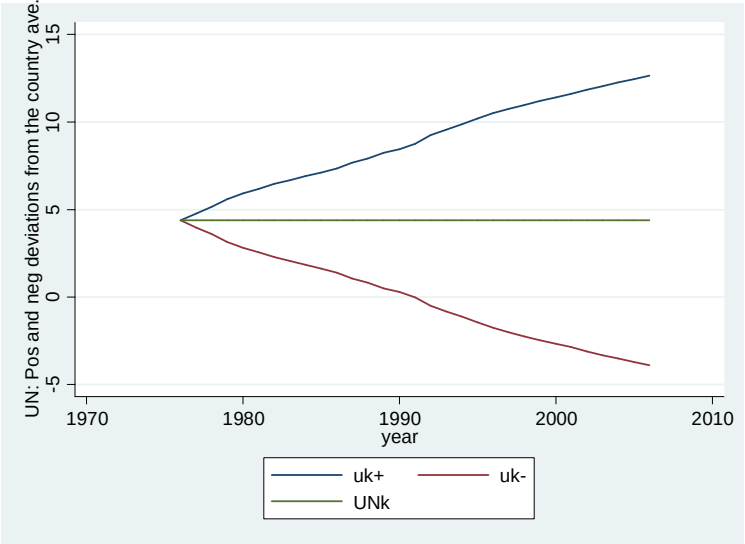

Figure 5. Positive and negative deviations from the annual country average of unemployment rate (average over TTWAs)

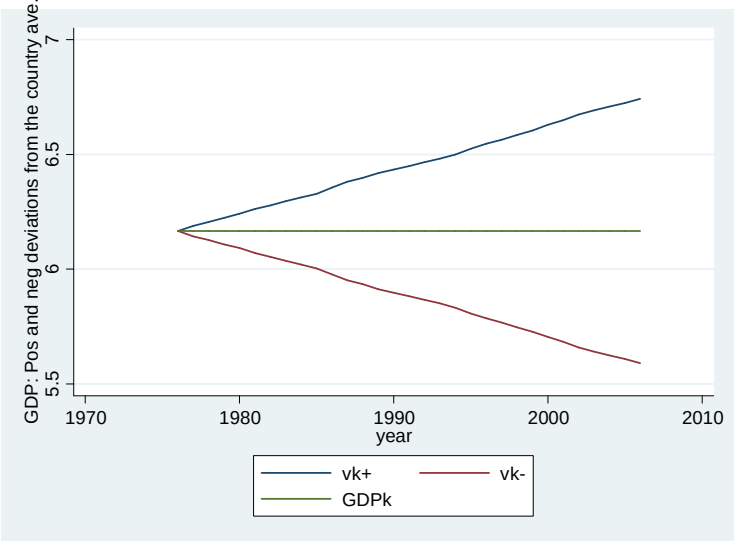

Figure 6. Positive and negative deviations from the annual country average of log(GDP), average over the TTWAs

3. Test Equations

The existence of cointegration will be tested now in two ways. First, the traditional residual-based test, based on Pedroni (2004), is used. According to this test, there is a long-run relationship between variables, if the residual is found stationary. For example, there is a long-run relationship between uk^{+} and vk^{-}, if the error term ε is stationary in the following OLS regression:

$$uk_{i,t}^{+} = \gamma_{0,i} + \beta_i vk_{i,t-1}^{-} + \varepsilon_{i,t-1}^{+} \qquad (6)$$

Second, a recently developed "structural" test will be applied, where a conditional error correction model for the variable of interest is designed (see Westerlund 2006). For example, there is a long-run relationship between uk^{+} and vk^{-}, if the coefficient γ in the error-correction representation (7) is less than zero. More precisely, the null hypothesis of no cointegration for cross-sectional unit i is implemented as a test of the null H0 : $\gamma_{1,i} = 0$ versus H1 : $\gamma_{1,i} < 0$.

$$\Delta uk_{i,t}^{+} = \gamma_{0,i} + \gamma_{1,i}(uk_{i,t-1}^{+} - \beta_i vk_{i,t-1}^{-}) + \Sigma_{l=1}^{L}\alpha_{u,i,l}\Delta uk_{i,t-l}^{+} + \Sigma_{l=1}^{L}\alpha_{v,i,l}\Delta vk_{i,t-l}^{-} + e_{i,t-1}^{+} \qquad (7)$$

In this case there is an economic interpretation for the long-run relationship presented in the parentheses of (7). Moreover, Westerlund (2006) has shown that these two methods for testing cointegration are complementary, and that the power and size characteristics of the tests depend on how well the case at hand fits to the assumptions behind the tests. The power of the residual-based test is the higher, the closer the $\gamma$of the region in question is to the respective α's (in equation (7)). If these long- and short- run coefficients differ markedly, the power of the test collapses yielding a wrong inference. On the other hand, the crucial assumption in the 'structural' test is that vk should be exogenous or weakly endogenous. In the present case the assumption of weak endogeneity is plausible. Since vk may not be endogenous, uk (unemployment) should not affect GDP in this period, but it may affect it in the subsequent period. It seems plausible that unemployment does not affect GDP immediately, since recently laid-off workers are usually well employable. However, over a longer period of time decreasing human capital and skill levels may reduce employability resulting in lower GDP growth. In a phase of an economic upturn, unemployment may affect GDP growth immediately only if there is a shortage of labour (i.e. very low unemployment). However, there have been only two very brief cases in the Finnish economic history where the average unemployment rate was very low (the mid 1970s and late 1980s). In other periods, there has always been ample unemployment somewhere in Finland, which has acted as a pool of potential labour for other regions. In conclusion, it seems that the 'structural' test has some appealing indulging assumptions for our case.

If there are long-run relationships between components, the aggregate series may also be cointegrated. However, this is only the case in one particular situation, as can be seen by distinguishing and comparing four possible cointegration cases:

1. None of the two components is cointegrated. Then, GDP and UN are not cointegrated; they may experience positive and negative shocks, but will exhibit their own independent trends.
2. Only one of the two components is cointegrated, but not both. In that case, GDP an dUN may have common opposite shocks, but they are still not cointegrated, although they share a more common structure than in case 1.

3. Both components have different cointegration vectors. Yet, GDP and UN are not coitegrated, even though they have common shocks.
4. Both components have the same cointegration vector. In this case, GDP and UN are cointegrated and there is only one common shock.

In conclusion, for GDP and UN to be fully cointegrated, their components should be mutually cointegrated with the same cointegrating vectors.[1]

4. Empirical Results

4.1 Base-line model

Relating the aggregate time-series for economic indicators by region to the country average removes the trend from the variables. Therefore, there is no point using cointegration methods to the aggregate series UNk and lnGDPk. Instead, a simple regression model can be run, which leads to the following result:

$UNk_{i,t}$ = 0.12 – 0.0126*$lnGDPk_{i,t}$ + TTWA fixed effects (8)
(***) (***),

where *** indicates statistical significance at the 1 percent level.

In other words, we find that the β coefficient in an empirical equation is one tenth of the typical value found in the literature (Moosa 1997a; Knotek 2007). Next, we will proceed by analyzing the component of both series by the above described cointegration methods (8).

4.2 Residual-based tests

Empirical results obtained with the Pedroni-testing procedure are presented in Table 1 while the Westerlund methodology leads to the results shown in Table 2.

For the linear case (aggregate variables) with or without a correction for cross-sectional dependence, the panel ρ-test statistics indicates that unemployment and GDP are not related in a

[1] Since virtually always unemployment and GDP are negatively correlated, neither (uk_t^+ and vk_t^+) nor (uk_t^- and vk_t^-) can be cointegrated. Thus, we concentrate here on the long-run relationship between component (uk_t^+ and vk_t^-) and component (uk_t^- and vk_t^+).

statistical sense (ρ > -2.0). This is as expected due to the stationarity of the series (there is actually no point in running this test for stationary series, but it is done here, however, for the case of comparison). Also, the long-run β-coefficient is very similar to the one found above in an OLS regression with fixed effects and thus small relative to the value found in the literature. In contrast, when the Pedroni test is computed for the decomposed variables (that have been de-meaned from the average growth rates) the test statistics is well beyond the limit of -2.0. Furthermore, the long-term coefficients are now of the same order of magnitude as those found elsewhere. They are also close to each other, as is implied by the figures above and the use of the national average growth rates as the threshold, which makes such series symmetric by construction.

Table 1. Residual-based tests and long-run coefficient

	Panel ρ	β, Panel FM[(a)]	β, Panel DOLS[(a)]
Linear (aggregate), no correction for cs dependence : $UN = \alpha + \beta.\ln GDP$	-0.71	-1.539***	-2.221***
correction for cs dependence : $UNk = \alpha + \beta.\ln GDPk$	-1.90	-0.016***	-0.015***
Contractions : $uk^{+} = \alpha + \beta.vk^{-}$	-5.18***	-0.134***	-0.136***
Expansions : : $uk^{-} = \alpha + \beta.vk^{+}$	-3.44***	-0.118***	-0.121***

(a) The full sample estimates of β-coefficients are computed by taking a weighted average of the individual estimates. Each individual β is weighted by the diagonal matrix formed by taking the square root of the precision matrix of the estimates for that individual. With such a weighting procedure, the coefficients and covariance matrix reproduce the average *t*-statistic so that the averaging done in calculating the *t*-statistics and the average β-coefficients match.

The conditional error correction model produces similar results. The linear model without correction for cross-sectional dependence is not cointegrated. While the linear model with correction for cross-sectional dependence is cointegrated, its long-run estimate does not have a transparent economic interpretation. In contrast, when the data series is split in positive and

negative components, both equations are cointegrated and the long-run β-coefficient is very close to those obtained elsewhere in the literature.

Table 2. Results of conditional error correction model.

	Cointegration. relationship			Error Correction Model	
	γ_1	constant	β_1	Sum of coeff. On lags of Δu	Sum of coeff. On lags of Δv
Linear, no correction for cs dependence: $UN = \alpha + \beta.\ln GDP$	-0.12	-0.30***	+1.80	+0.54***	-0.09**
correction for cs dependence: $UNk = \alpha + \beta.\ln GDPk$	-0.30***	.000	+0.08*	+0.16**	-0.03***
Contractions: $uk^+ = \alpha + \beta.vk^-$	-0.21***	0.17	-0.194***	+0.00	+0.01
Expansions: $uk^- = \alpha + \beta.vk^+$	-0.19***	0.20	-0.165***	+0.07**	+0.07***

Both the Pedroni and the Westerlund testing strategies tell us that the hidden cointegration relationships between uk^+ and vk^- on the one hand between uk^- and vk^+ on the other hand are significant at a 5% significance level. This means that regions having different GDP growth rates from the average across regions, also have persistently different unemployment rates relative to the average unemployment.

5. Conclusion

This paper aimed to test the existence of the Okun's Law in the case of small open regional economies. Using alternative statistical methods, viz. the residual-based test and the conditional error correction model, the main finding is that the Okun's coefficient in the present case is -0.2, which is very similar to that found elsewhere. A novelty of the paper is to combine a method of hidden cointegrations with a method of removing cross-sectional dependence. Statistical tests reject the long run relationship between the regional aggregate unemployment

and output series. However, after correcting for hidden cointegrations and cross-sectional dependence, both statistical methods used yield almost similar results and confirm cointegration for the relevant data on Finnish regions.

The presence of hidden cointegration may be considered as a clue for the presence of a long-run link between regional to national ratios of GDP and unemployment. More precisely, while the traditional Okun's Law relationship concerns the short-run correlation between unemployment and GDP transitory movements, our result clearly shows that this correlation also holds in the long-run at the decentralized level of regions. Various potential explanations such as insider/outsider models, human capital or regional mobility may be found in the literature for this long-run response of regional unemployment to regional GDP shocks.

Moreover, empirical estimates of the β-coefficients obtained with the Panel FM and the Panel DOLS estimators (Table 1) or with the Westerlund ECM estimation (Table 2) reveal that the impact of GDP expansions on unemployment is smaller in absolute value than the impact of GDP contractions. While the Panel FM and Panel DOLS estimators are smaller in absolute terms that those obtained with the Westerlund estimator, they all point to the presence of an asymmetric effect of GDP movements on unemployment with a larger responsiveness of unemployment in case of negative output variations. These results are fully consistent with those already observed in earlier studies by Crespo (2003) or Silvapulle et al. (2004) for specific countries. Taken as a whole, our results indicate that when regional GDP growth is larger (respectively smaller) than the national GDP growth by 1 percentage point, the gap between regional and national unemployment rate decreases (respectively increases) by an amount falling in between 0.12 and 0.17 percentage points (respectively 0.13 and 0.19 percentage points).

These effects are all quantitatively smaller than the traditional Okun's Law coefficients obtained in the literature for the case of countries; to interpret these differences, we have to keep in mind two main points. First, the traditional version of the Okun's Law concerns a short run temporal horizon when the labor market and the nominal wages are predominantly rigid so that there is no major regulation of unemployment and GDP movements through labor market adjustments. In this case, the labor market cannot adjust. The presence of hidden cointegration relationships indicates that our results typically concern a long-run time horizon. As a consequence, they tend to indicate that regional labor market adjustment mechanisms are not able to fully incorporate the variations of unemployment rates induced by large regional GDP

shocks. However, the initial impacts of GDP shocks on unemployment are partly dampened by labor market and real wages adjustments in the medium term, while only a fraction of the initial impact can remain in the long run.

The second point concerns the fact that our sample includes regional data. As mobility is much more important across regions than across countries, regional unemployment rates movements are also partly influenced by regional mobility. This mobility may thus also contribute to explain why our β-coefficients are smaller than those obtained with national data.

References

Adanu, K. (2005). A cross-province comparison of Okun's coefficient for Canada. *Applied Economics* 37: 561-570.

Altig D., Fitzgerald T. and Rupert P. (1997). Okus's Law Revisited: Should We Worry about Low Unemployment? Research commentary, Federal Reserve Bank of Cleveland.

Attfield C. and Silverstone B. (1998). Okun's law. cointegration and gap variables. *Journal of Macroeconomics* 20: 626-637

Attfield C.L.F. and Silverstone B. (1997). Okun's coefficient: a comment. *Review of Economics and Statistics* 79: 326-329.

Christopoulos D. (2004). The relationship between output and unemployment: Evidence from Greek regions. *Papers in Regional Science* 83: 611-620.

Crespo-Cuaresma J. (2003). Revisiting Okun's law: a piecewise-linear approach. *Oxford Bulletin of Economics and Statistics* 65: 439_451.

Daly, M. and Hobijn B. (2010). Okun's Law and the unemployment surprise of 2009. FRBSF Economic Letter, March 2010.

Freeman D. (2000). A regional test of Okun's Law. *International Advances in Economic Research* 6: 557-570.

Freeman D.G. (2001). Panel tests of Okun's law for ten industrial countries. *Economic Inquiry* 39: 511–523.

Gordon R.J. (1984). Unemployment and potential output in the 1980s. *Brookings Papers on Economic Activity* 2: 537-586.

Gordon R. (2010). Okun's law, productivity innovations, and conundrums in business cycle dating. Paper presented at the ASSA meeting, Atlanta, January 4, 2010.

Granger C.W. and Yoon G. (2002). Hidden cointegration . Working Paper, Department of Economics. University of California. San Diego.

Harris R. and Silverstone B. (2001). Testing for asymmetry in Okun's law: A cross-country comparison. *Economic Bulletin* 5: 1-13

IMF (2010). Unemployment dynamics during recessions and recoveries: Okun's law and beyond. Report April 2010.

Knoester A. (1986). Okun's law revisited. *Weltwirtschaftliches Archiv* 122: 657-666.

Knotek E. (2007). How usesul is Okun's law? C*ity economic review (Federal reserve bank of Kansas)* 4: 73-103.

Lee J. (2000). The robustness of Okun's law: Evidence from OECD countries. *Journal of Macroeconomics* 22: 331-356

Machin S. and Van Reenen J. (1998). Technology and changes in skill structure: evidence from seven OECD countries. *Quarterly Journal of Economics* 113: 1215-1244.

Mayes. D. and Viren M. (2002). Asymmetry and the problem of aggregation in the euro area. *Empirica* 29: 47-73.

Moosa I.A. (1997a). On the costs of inflation and unemployment. *Journal of Post Keynesian Economics* 19: 651-66

Moosa I.A. (1997b). A cross-country comparison of Okun's coefficient. *Journal of Comparative Economics* 24: 335-–356.

Okun A. (1962). Potential GNP: its measurement and significance. American Statistical Association. Proceedings of the Business and Economic Statistics Section, pp. 98-104.

Paldam M. (1987). How much does one percent of growth change the unemployment rate? *European Economic Review* 31: 306-313.
Palley T.I. (1993). Okun's law and the asymmetric and changing cyclical behaviour of the USA economy. *International Review of Applied Economics* 7: 144-62.
Pedroni P. (2000). Fully modified OLS for heterogeneous cointegrated panels. Non-Stationary Panels. *Panel Cointegration and Dynamic Panels* 15: 93-130.
Pedroni P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 20: 597-625.
Silvapulle P., Moosa I.A. and Silvapulle M.J. (2004). Asymmetry in Okun's law. *Canadian Journal of Economics* 37: 353-374.
Villaverde J. and Maza A. (2007). Okun's law in the Spanish regions. *Economics Bulletin* 18 (5): 1-11
Westerlund J. (2006). Testing for error correction in panel data. METEOR working papers, RM/06/056.

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