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THE RELATIONSHIP BETWEEN OUTPUT AND UNEMPLOYMENT IN SCOTLAND: A REGIONAL ANALYSIS

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ABSTRACT

The relationship between unemployment and growth (i.e., the so-called Okun's Law) has long standing in macroeconomics and regional economics. In this paper we estimate such a relationship for Scotland and at the Nomenclature of Territorial Units for Statistics (NUTS) level 3 regions using a panel dataset. The main motivations behind this interest are twofold: first, to test whether such a relationship exists in Scotland and how different these estimates are from those produced for the UK. Second, whether there exist regional differences in the estimates. The latter is particularly important in the context of the current budgetary cuts, which may affect both GDP growth and unemployment in different ways rural and urban areas. Results indicate that the Okun's coefficient for Scotland is slightly higher than the one computed for the UK (1.7 Scotland versus 1.39 and 1.45 for the UK), and although an Okun relationship seemed to be valid for most of the regions, there were no statistical differences between rural and urban areas. However, as regards the effect of economic growth on unemployment, the results indicate a different and stronger effect in urban areas than in rural areas.

KEYWORDS: Unemployment, Scotland, growth, panel data, cointegration.

1. Introduction

The UK public finances are going through a difficult period, which as stated in Atterton (2011) has its origins in the increasing structural deficit and the worldwide financial collapse in 2007 and 2008 which led to a significant reduction in taxes. As a reflection of this UK economic growth forecasts for 2008 and 2009 were dramatically reduced, the unemployment rate rose and public sector debt increased significantly.

Scotland's situation is not an exception, as the recession period (measured by the quarterly decrease in GVA and considering only the sample of this paper, 1995-2010) started during the first quarter of 2008 and lasted until the third quarter of 2009. This was accompanied by a decline in Scottish labour market conditions, a situation that did not improve even when the Scottish economy moved out of recession in the fourth quarter of 2009 (The Scottish Government 2010).

The austerity measures set by the Government to overcome the difficult public situation, particularly the budget cuts, are expected to have in Scotland a differentiated impact in urban and rural areas. Atterton (2011) advanced a number of reasons why the budget cuts may have a differentiated regional impact in Scotland. First, while urban areas have higher absolute numbers of jobs in the public sector, in relative terms the sector is an important employer in rural Scotland (20 per cent of employment in accessible rural areas and 18 per cent in remote rural areas). Second, the cost of service delivery in rural areas is higher than urban areas, which might tempt the Government to cut more in rural areas. Third, there have been concerns that some budgets, including rural and cultural spending, might be disproportionately affected as a result of the protection and ring-fencing of others, such as health and education. Fourth, the relatively small size of the private sector in rural areas and therefore it has limited ability to absorb jobs lost in the public sector. Fifth, the relatively faster ageing of the population and the associated demands on health and social care services, and sixth, the lower wages but higher prices faced by rural households for basic commodities such as transport and heating fuel and food. Furthermore, Atterton's report based on an index that incorporates a number of indicators (the proportion of all jobs in the public sector, the average earnings of local residents, the proportion of the population of working age and the proportion of the population receiving Job Seekers Allowance payments) illustrates the vulnerability of some local authorities to the effect of severe spending cuts and found that five of the top ten most vulnerable authorities are rural (the Western Isles, Argyll and Bute, Dumfries and Galloway, Moray and the Orkney Islands).

In the above context, the purpose of this paper is to explore whether there is a stable long term relationship between growth and unemployment, i.e., the so-called Okun's Law Okun(1962), for Scotland and particularly whether given the spatial differences in the country, that relationship differs between rural and urban areas. If such a relationship or relationships exist it can be useful for purposes of economic policy (e.g., for anticipating the effect of growth or lack of it on unemployment at a national or regional level) or for gaining further knowledge in terms the economic structure of Scotland and its regions.

The paper is structure as follows: it first presents a brief overview of the econometrics of Okun's Law, followed by a description of the data used in the analysis, the results from the econometric work (i.e., tests and estimation) and ends with conclusions.

2. Okun's law and econometrics

The relationship between labour market indicators and output indicators has long been an important component in macroeconomics and regional economics, examples of these are studies on aggregate production functions (e.g., Solow, 1957; O'Donnell and Swales, 1979) or the demand for factors of production (e.g., Brechling, 1965). Another macroeconomic relationship within this group of relationships is the so called Okun's Law (Okun, 1962), which measures the association between output growth and unemployment.

As pointed out by Knotek (2007), "Okun's law is not a tight relationship. There have been many exceptions to Okun's law, or instances where growth slowdowns have not coincided with rising unemployment. This is true when looking over both long and short time periods. This is a reminder that Okun's law—contrary to connotations of the word "law"—is only a rule of thumb, not a structural feature of the economy." (p. 93).
Due to its usefulness for policy, Okun's Law has been studied extensively and estimated for individual countries (e.g., USA as in the cited original work by Okun and re-estimated many times e.g., see Knotek (2007) for an overview), groups of countries (e.g., for OECD countries, Lee, 2000; for European countries, Tatoglu, 2011), and at a regional level (e.g., Blackley, 1991; Freeman, 2000; Apergis and Rizitis, 2003; Christopoulos, 2004; Bisping and Patron, 2005; Adanu, 2005; Connaughton and Madsen, 2009; Villaverde and Maza, 2009).

The econometrics of estimation of Okun's Law at a regional level, which is the focus of this paper, has evolved with the advances on dynamic panel data econometrics. As in the case of time series econometrics one needs to test, first, the stationarity of the used data before proceeding to the estimation; if this assumption is rejected, then the hypothesis of cointegration amongst the series needs to be tested before one can estimate a valid relationship (i.e., one that is not based on spurious correlations).

Under panel data the Okun's law equation (i.e., the long term equation) is given by (1) (Prachowny, 1993; Pedroni, 2000; Christopoulous, 2004):

$$(1) \qquad \begin{aligned} y_{it} &= \gamma_{1i} + \delta_i t + \beta_i x_{it} + \varepsilon_{it} \\ \Delta x_{it} &= \gamma_{2i} + \mu_{it} \end{aligned}$$

Where y_{it} is the logarithm of the real output in region i, in period t; t is a trend variable that takes the value of 1 in the first period; x_{it} is the unemployment rate. Note that if the real output series and unemployment are cointegrated then this implies causality in the sense of Granger in at least one direction. Therefore, if the causality is bi-directional, then it is possible to write the unemployment as a function of the real output, too.

As mentioned, in terms of the econometric procedure to estimate (1), first it is necessary to test for the stationarity of the series. The literature suggests that panel-based unit root tests have higher power than unit root tests based on individual time series. This is particularly important for the case in hands as the time series are relatively short.

Five panel unit root tests were considered for the analysis of unit roots in the data, namely Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-type tests using augmented Dickey-Fuller and Perron-Phillips (PP) tests (Maddala and Wu (1999) and Choi (2001)). The Levin, Lin and Chu and Breitung tests, which assume that there is a common unit root process that is identical across the cross-sections and consider the null hypothesis that the series have a unit root. The remaining tests consider that the unit root process can be different amongst the cross sections (i.e., a heterogeneous panel) and also consider the null hypothesis that the series have a unit root.

If the series are found integrated of order one (i.e., they have a unit root) then it is necessary to test whether they are cointegrated. In the case of panel data Pedroni (1999, 2004) extended the Engle-Granger framework for cointegration in time series to tests involving panel data.

Pedroni proposed several tests for cointegration that allow for heterogeneous intercepts and trend coefficients across cross-sections. The approach consists of obtaining the residuals from the equations (1) and then to test whether residuals have a unit root by running the auxiliary regressions (2) or (3):

$$(2) \qquad \varepsilon_{it} = \rho_i \varepsilon_{it-1} + u_{it}$$

$$(3) \qquad \varepsilon_{it} = \rho_i \varepsilon_{it-1} + \sum_{j=1}^{k} \psi_{ij} \varepsilon_{it-k} + \nu_{it}$$

Pedroni describes various methods of constructing statistics for testing for null hypothesis of no cointegration ($\rho_i = 1$). There are two alternative hypotheses: the homogenous alternative ($\rho_i = \rho < 1$), for all i (which, is called the "within-dimension" test or "panel statistics" test), and the heterogeneous alternative, $\rho_i < 1$ for all i (referred as the "between-dimension" or "group statistics" test).

Pedroni's panel eleven cointegration statistics are constructed from the residuals from either equations (2) or (3). These tests respond to different stochastic assumptions for the series; however, as shown by Pedroni (1999, 2004) once standardized, the statistics are asymptotically normally distributed.

Once the cointegration has been established two estimation procedures were followed: first, a dynamic panel data estimation of Okun's relationship at the aggregated level or considering specific groups of regions together (e.g., rural regions) using the Arellano-Bond Generalised Method of Moments (GMM) estimator (1991) and, second, the long term relationship between the real output and unemployment by region, i.e., β_i in equation (1), using Pedroni's fully modified ordinary least square (Pedroni, 2000).

As regards the aforementioned estimation at the aggregated level we consider an error correction model, which is given by equation (4). In the equation y_{it} is the log of the real GVA in region i at period t, x_{it} is the unemployment rate in region i at period t, t (as a variable) is a trend variable, Δ is the difference operator such that $\Delta x_{it} = x_{it} - x_{it-1}$ and $\alpha, \delta, \beta, \theta, \gamma$ are regression coefficients.

$$(4) \qquad \Delta Y_{it} = \alpha \Delta X_{it} + (\theta - 1)[Y_{it-1} - \gamma - \delta t_i - \beta X_{it-1}]$$

$$(5) \qquad Y_{it} = \gamma + \delta t + \beta X_{it}$$

The interesting aspect of this equation is that it indicates a dynamic relationship between the two variables: output and unemployment with adjustments that are not instantaneous. Furthermore, it indicates a short term adjustment (i.e., impact adjustment) measured by the coefficient (θ) in equation (1) and a correction every period from a disequilibrium towards what is the long term situation given by equation (5).

The long term equation (i.e., equation 5) by region was estimated using Pedroni's fully modified ordinary least square (Pedroni, 2000), which is appropriate for heterogeneous cointegrated panels and addresses the coefficient bias generated by the estimation using ordinary least squares as it corrects the problems created by endogeneity and serial correlation in the errors. Pedroni's estimator ($\hat{\beta}_{FM}$) for a region i is given by (6):

$$(6) \qquad \hat{\beta}_{i,FM} = \frac{\sum_{t=1}^{T_i}\left(x_{i,t} - \bar{x}_{it}\right)y_{it}^{*} - T_i\hat{\gamma}_i}{\sum_{t=1}^{T_i}\left(x_{i,t} - \bar{x}_{it}\right)^2}$$

Where $y_{it}^{*} = y_{it} - \bar{y}_i - \frac{\hat{c}_{21i}}{\hat{c}_{22i}}\left(\Delta x_{it} - \overline{\Delta x_i}\right)$, $\hat{c}_{jki}$ is the j row k column Cholesky factor of Ω_i, which is the long-run covariance matrix of the vector error process from equation (1), i.e., $\eta_{it} = (\varepsilon_{it}, \mu_{it})'$. The Cholesky factors of Ω_i are given by $c_{11i} = \left(\Omega_{11i} - \Omega_{21i}^2 / \Omega_{22i}\right)^{1/2}$, $c_{12i} = 0$, $c_{21i} = \left(\Omega_{21i} / \Omega_{22i}^{1/2}\right)$, $c_{22i} = \Omega_{22i}^{1/2}$. As shown by Pedroni (2000) the long-run covariance matrix can be decomposed as $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i$, where Ω_i^0 is the contemporaneous covariance and Γ_i is a weighted sum of autocovariances. The term $\hat{\gamma}_i$ is given by $\hat{\gamma}_i = \Gamma_{21i} + \Omega_{21i}^0 - \left(\Gamma_{22i} + \Omega_{22i}^0\right) \cdot c_{21i} / c_{22i}$. Finally, the standard error of the estimator is given by (7):

$$(7) \qquad \sigma_{i,FM} = \frac{c_{11i}}{\sum_{t=1}^{T_i}\left(x_{i,t} - \bar{x}_{it}\right)^2}$$

3. Data used in the analysis

The estimation of Okun's relationship at a regional level requires data for real output and for unemployment. The data are not readily available and this section explains it construction.

For Scotland, the most regionally disaggregated information for output, is the nominal gross value added (GVA) estimated at the Nomenclature of Territorial Units for Statistics (NUTS) level 3 regions by the Office for National Statistics, which is available for the period 1995-2009 and includes information for 23 regions. However, these series have no price deflators to transform them into real terms. Due to this, UK level deflators were used.

As regards the regional unemployment rates for Scotland, these are estimated by the Office for National Statistics at the local authority level (32 local authorities) for the period 2004 to 2010. The series were extended to 1995 (first period available for the output data) using the fact that that the unemployment data is highly correlated with the Claimant Count statistics[1], which are available since 1983. Employment levels data at the local authority, required to compute the unemployment rate, were available from the Annual Business Inquiry (1998 to 2008) and from the Business Register Employment Survey (2008 to 2010). For the period 1995 to 1997 employment levels were estimated using a fixed effects panel data regression between employment levels and claimant counts for the period 1998 to 2010.

The unemployment and employment levels at local authority were transformed to NUTS3 levels. In general, this is a straightforward operation except for the NUTS3 regions of 'Caithness & Sutherland and Ross & Cromarty' and 'Inverness & Nairn and Moray, Badenoch & Strathspey' areas which do not have an easy correlate with local authority areas. Therefore, an aggregated region was created "Highland and Moray", which at the output level is the sum of the two aforementioned NUTS3 regions and for the unemployment and employment it was the adding up of the Highland and Moray local authorities.

Table 1 presents the descriptive statistics of the data and also whether they are classification as "predominantly rural areas", "predominantly urban areas" and "intermediate areas" according to the European Commission Urban-Rural typology (EC, 2012). According to this typology a "predominantly urban region" is one where the rural population is less than 20 per cent of the total population; a "intermediate region" has a rural population between 20 per cent and 50 per cent of the total population and predominantly rural region is one where the rural population is 50 per cent or more of the total population.

[1] The Claimant Count is a measure of unemployment, which reports the number of people who claim unemployment benefits, but actively seeking work.

Table 1: Data summary statistics 1995-2009

	Real GVA				Unemployment rate			
	Mean	St. Dev	Min	Max	Mean	St. Dev	Min	Max
Intermediate areas								
Aberdeen City and Aberdeenshire	10,749.0	1,112.1	9,563.7	12,844.0	0.05	0.02	0.03	0.10
Clackmannanshire and Fife	5,121.6	434.3	4,400.1	5,889.2	0.07	0.02	0.06	0.11
East Ayrshire and North Ayrshire Mainland	2,977.7	154.6	2,777.1	3,281.2	0.09	0.02	0.06	0.14
East Lothian and Midlothian	1,980.0	291.1	1,562.3	2,417.5	0.06	0.03	0.04	0.12
Perth & Kinross and Stirling	3,555.6	487.8	2,792.9	4,249.5	0.06	0.02	0.04	0.10
South Ayrshire	1,803.7	136.0	1,521.8	2,039.0	0.08	0.03	0.05	0.13
Predominantly rural areas								
Dumfries & Galloway	1,998.7	147.9	1,795.7	2,303.3	0.06	0.02	0.04	0.11
Eilean Siar (Western Isles)	346.8	46.2	285.5	420.7	0.10	0.07	0.04	0.25
Highland and Moray 3/	3,643.2	558.6	2,791.3	4,416.1	0.06	0.03	0.03	0.12
Lochaber, Skye & Lochalsh, Arran & Cumbrae and Argyll & Bute	1,255.5	117.8	1,101.1	1,446.1	0.06	0.03	0.04	0.12
Orkney Islands	272.3	27.3	226.3	308.0	0.05	0.03	0.03	0.14
Scottish Borders	1,319.4	106.0	1,137.8	1,513.5	0.05	0.01	0.03	0.08
Shetland Islands	386.1	37.2	334.1	448.2	0.05	0.03	0.02	0.11
Predominantly urban areas								
Angus and Dundee City	4,033.9	256.3	3,716.3	4,456.0	0.09	0.03	0.06	0.16
East Dunbartonshire, West Dunbartonshire and Helensburgh & Lomond	2,566.0	242.9	2,191.4	2,961.7	0.07	0.03	0.05	0.13
Edinburgh, City of	13,579.8	2,324.8	10,253.9	16,555.9	0.07	0.03	0.04	0.14
Falkirk	2,171.7	317.0	1,738.6	2,622.2	0.07	0.02	0.04	0.11
Glasgow City	14,946.4	1,960.3	11,765.4	17,582.0	0.11	0.04	0.07	0.19
Inverclyde, East Renfrewshire and Renfrewshire	5,160.1	143.7	4,968.3	5,389.0	0.07	0.02	0.05	0.11
North Lanarkshire	4,089.4	731.5	3,084.0	5,286.7	0.08	0.02	0.05	0.13
South Lanarkshire	4,377.5	531.2	3,535.6	5,132.5	0.07	0.02	0.04	0.11
West Lothian	2,964.6	328.6	2,225.0	3,461.0	0.06	0.02	0.04	0.10
Scotland	89,298.9	10,004.6	75,303.8	103,804.3	0.07	0.03	0.05	0.13

Source: Own estimations based on the Office for National Statistics data.

4. Results

Table 2 presents the unit root tests for both series: the logarithm of the real GVA and the unemployment rate. The results indicate that the hypothesis of unit root cannot be rejected for the variables in levels and these are stationary in first differences.

Table 2: Panel data unit root tests 1/

	Log(real GVA)				Unemployment rate			
	Statistic	Prob. 2/	Cross-sections	Obs.	Statistic	Prob.2/	Cross-sections	Obs.
Tests for the variables in levels								
Null hypothesis: Unit root (assumes common unit root process)								
Levin, Lin and Chu t*	0.19	0.58	22	297	0.11	0.54	22	310
Breitung t-stat	-0.78	0.22	22	275	7.71	1.00	22	288
Null hypthesis: Unit root (assumes individual unit root process)								
Im, Pesaran and Shin W-stat	-0.28	0.39	22	297	7.54	1.00	22	310
ADF - Fisher Chi-square	55.84	0.11	22	297	12.64	1.00	22	310
PP - Fisher Chi-square	66.09	0.02	22	308	25.87	0.99	22	330
Tests for the variables in differences								
Null hypothesis: Unit root (assumes common unit root process)								
Levin, Lin and Chu t*	-12.11	0.00	22	281	-15.09	0.00	22	294
Breitung t-stat	-2.14	0.02	22	259	-4.52	0.00	22	272
Null hypthesis: Unit root (assumes individual unit root process)								
Im, Pesaran and Shin W-stat	-6.71	0.00	22	281	-11.28	0.00	22	294
ADF - Fisher Chi-square	119.85	0.00	22	281	186.55	0.00	22	294
PP - Fisher Chi-square	138.06	0.00	22	286	259.61	0.00	22	308

Notes:
1/ All the unit root tests consider deterministic intercept and trend.
2/ Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 3 presents the cointegration tests between real GVA and the unemployment rate using the Pedroni's cointegration tests (1999, 2004). Except the case of rho-statistics, all the others indicate that the two series are cointegrated. This indicates that there is causation in the sense of Granger in at least one direction, although based on economic theory one would expect the relationship to be bidirectional, i.e., unemployment affecting the growth of the GVA and the other way around.

Table 3: Pedroni residual cointegration tests between real GVA and the unemployment rate 1/

	Log(real GVA) and unemployment rate			
Alternative hypothesis: common autoregressive coefficients (within-dimension)				
	Unweighted		Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	2.69	0.00	2.33	0.01
Panel rho-Statistic	-0.12	0.45	-0.30	0.38
Panel PP-Statistic	-3.57	0.00	-4.37	0.00
Panel ADF-Statistic	-5.43	0.00	-5.99	0.00
Alternative hypothesis: individual autoregressive coefficients (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	1.88	0.97		
Group PP-Statistic	-3.17	0.00		
Group ADF-Statistic	-4.92	0.00		

Notes:
1/ The tests' null hypotheses is no cointegration. All the tests include deterministic intercept and trend.

Table 4 presents the results of four error correction estimations (one in each panel) using the Arellano-Bond estimator. Horizontally two relationships are presented: first, the equation of log of real GVA with respect to the unemployment rate and second, the unemployment rate with respect to the log of the real GVA. Vertically, the table presents two situations: first, no difference between predominantly rural sectors and second, the difference between them.

The relationship between economic growth and the unemployment rate in Scotland indicate that an increase in 1 percent-points in the unemployment rate is reflected in a decrease in 1.7 per cent in the real GVA growth in the short run (impact), without difference between areas and a long term effect of also 1.7. The value of the coefficient is slightly higher than the ones estimated for the UK, which are in the range of 1.30 to 1.45 (Lee, 2000). It should be noted that although the coefficients for rural and non rural areas are statistically significant (i.e., different from zero) they are not statistically different.

In terms of the impact of the real GVA growth on the unemployment rate, the estimation indicates a difference between predominantly rural areas and the other areas. Thus, in the long term an increase by 1 per cent in the real GVA in predominantly rural areas decreases the unemployment rate by 0.33 percent-points, whilst in the other areas the decrease is by 0.65 percent- points.

Table 4: Relationship between real GVA and employment variables

Variable	All areas together				Rural/non-rural			
	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
Dependent variable: log(real GVA)								
Lagged dependent	0.564	0.053	10.596	0.000	0.583	0.092	6.345	0.000
Trend	0.008	0.001	6.260	0.000	0.008	0.001	5.979	0.000
Unemployment rate								
Predominantly rural					-1.924	0.595	-3.232	0.001
Predominantly urban and intermediate					-1.614	0.290	-5.560	0.000
All areas together	-1.695	0.211	-8.029	0.000				
Lagged unemployment rate	0.964	0.273	3.526	0.001	0.963	0.293	3.283	0.001
Derived results 1/								
Adjustment towards long run solution (θ-1)	-0.436	0.053	-8.202	0.000	-0.417	0.092	-4.543	0.000
Short run effect of unemployment rate (α)								
Predominantly rural					-1.924	0.595	-3.232	0.001
Predominantly urban and intermediate					-1.614	0.290	-5.560	0.000
All the areas	-1.695	0.211	-8.029	0.000				
Long run effect of unemployment rate (β)								
Predominantly rural					-2.303	1.605	2.060	0.152
Predominantly urban and intermediate					-1.561	0.511	9.314	0.003
All areas together	-1.676	0.358	21.975	0.000				
Dependent variable: unemployment rate 1/								
Lagged dependent	0.874	0.009	98.522	0.000	0.869	0.015	57.886	0.000
Trend	0.002	0.000	21.311	0.000	0.003	0.000	33.530	0.000
Log(real GVA)								
Predominantly rural					-0.084	0.008	-9.961	0.000
Predominantly urban and intermediate					-0.126	0.013	-9.530	0.000
All the areas	-0.100	0.005	-20.792	0.000				
Lagged log(real GVA)	0.036	0.008	4.663	0.000	0.041	0.009	4.416	0.000
Derived results								
Adjustment towards long run solution (θ-1)	-0.126	0.009	-14.140	0.000	-0.131	0.015	-8.733	0.000
Short run effect of real GVA (α)								
Predominantly rural					-0.084	0.008	-9.961	0.000
Predominantly urban and intermediate					-0.126	0.013	-9.530	0.000
All the areas	-0.100	0.005	-20.792	0.000				
Long run effect of real GVA (β)								
Predominantly rural					-0.332	0.073	20.454	0.000
Predominantly urban and intermediate					-0.648	0.057	129.660	0.000
All the areas	-0.509	0.020	649.975	0.000				

Notes
1/ The test for the coefficient significance is a chi-square test.

The results of the estimation are presented in Table 5 allows us to explore the long- term relationship between real GVA and unemployment at a regional level. Note that all the coefficients are strongly significant, with the exception of Orkney's coefficient measuring the effect of unemployment on real GVA (however, the coefficient on the opposite direction is highly significant).

It is important to note that the coefficients for the urban, rural and intermediate areas are somewhat different than those long term coefficients obtained with the Arellano-Bond estimators (which assume the presence time dummies). One difference between them is that in the Pedroni's case, the coefficients for those areas are computed as the simple average of the corresponding regions.

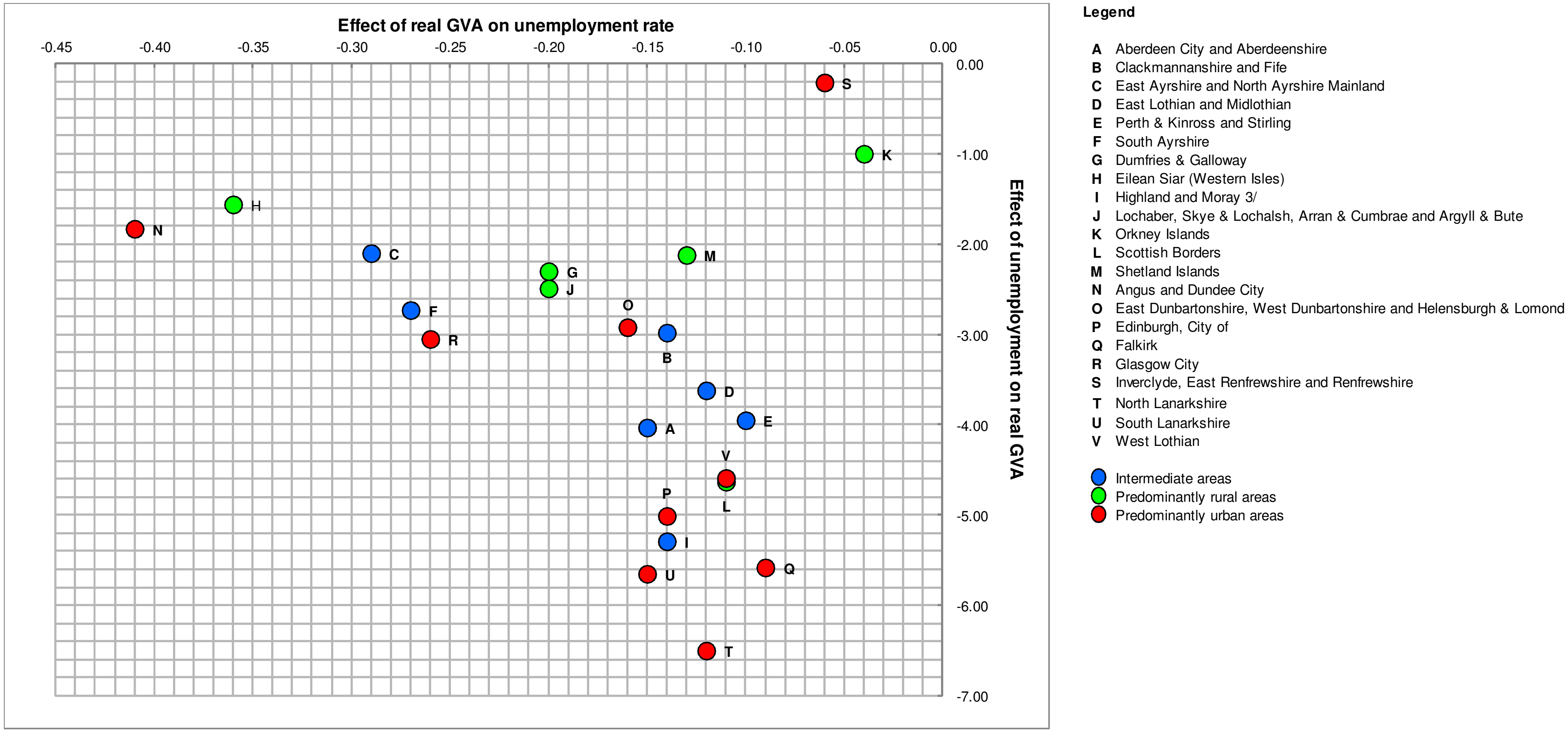
The value of the coefficients indicate a great deal of heterogeneity in the panel as measured by the different coefficients ranging from -0.21 for Inverclyde, East Renfrewshire and Renfrewshire to -6.5 in North Lanarkshire, and similar dispersion for the effect of the GVA on unemployment, which ranges from -0.06 in Inverclyde, East Renfrewshire and Renfrewshire to -0.41 in Angus and Dundee City.

Table 5: Fully modified OLS estimation of long term coefficients for real GVA and unemployment rate

	Dependent variable					
	Real GVA			Unemployment rate		
	Coefficient	t-stat.	Sig. 1/	Coefficient	t-stat.	Sig. 1/
Intermediate areas						
Aberdeen City and Aberdeenshire	-4.03	-4.09	**	-0.15	-28.23	**
Clackmannanshire and Fife	-2.98	-3.16	**	-0.14	-24.23	**
East Ayrshire and North Ayrshire Mainland	-2.10	-5.71	**	-0.29	-17.44	**
East Lothian and Midlothian	-3.62	-2.78	**	-0.12	-34.56	**
Perth & Kinross and Stirling	-3.95	-2.87	**	-0.10	-34.83	**
South Ayrshire	-2.73	-7.79	**	-0.27	-28.89	**
Panel Results						
Without time dummies	-3.24	-10.78	**	-0.18	-68.67	**
With time dummies	-1.45	-2.60	**	-0.03	-96.81	**
Predominantly rural areas						
Dumfries & Galloway	-2.30	-4.07	**	-0.20	-23.41	**
Eilean Siar (Western Isles)	-1.56	-4.96	**	-0.36	-14.83	**
Highland and Moray 2/	-5.29	-7.73	**	-0.14	-63.02	**
Lochaber, Skye & Lochalsh, Arran & Cumbrae and Argyll & Bute	-2.49	-3.89	**	-0.20	-23.07	**
Orkney Islands	-1.00	-1.30		-0.04	-14.58	**
Scottish Borders	-4.63	-3.72	**	-0.11	-35.90	**
Shetland Islands	-2.12	-2.58	**	-0.13	-17.22	**
Panel Results						
Without time dummies	-2.77	-10.68	**	-0.17	-72.58	**
With time dummies	-1.22	-4.48	**	-0.11	-83.06	**
Predominantly urban areas						
Angus and Dundee City	-1.83	-8.06	**	-0.41	-20.01	**
East Dunbartonshire, West Dunbartonshire and Helensburgh & Lomond	-2.92	-3.90	**	-0.16	-26.03	**
Edinburgh, City of	-5.01	-5.17	**	-0.14	-49.28	**
Falkirk	-5.58	-3.48	**	-0.09	-40.68	**
Glasgow City	-3.05	-7.86	**	-0.26	-36.95	**
Inverclyde, East Renfrewshire and Renfrewshire	-0.21	-2.02	*	-0.06	-6.20	**
North Lanarkshire	-6.50	-6.07	**	-0.12	-59.36	**
South Lanarkshire	-5.65	-9.05	**	-0.15	-65.54	**
West Lothian	-4.59	-3.56	**	-0.11	-35.51	**
Panel Results						
Without time dummies	-3.93	-16.39	**	-0.17	-113.19	**
With time dummies	-3.25	-7.45	**	-0.07	-146.88	**
All the areas together						
Without time dummies	-3.37	-22.13	**	-0.17	-149.19	**
With time dummies	-1.32	-8.65	**	-0.07	-191.35	**

Notes:
1/ ** indicates significant at 1 per cent and * at 5 per cent.
2/ Include the NUTS3 areas of Caithness & Sutherland and Ross and Cromarty and Inverness & Nairn and Moray, Badenoch & Strathspey.

Figure 1: Long term effect of unemployment rate on real gross value added (GVA) and vice versa by region



In order to capture a better idea of the dispersion, Figure 1 plots the results differentiating by predominantly urban, rural and intermediate areas. Figure 1 shows that in comparison with urban and intermediate areas, in rural areas the effect of the unemployment rate on the real GVA is smaller. However, on the effect of the real GVA on unemployment, rural areas show some dispersion from very low reaction (Orkney Islands) to somewhat high reaction (Western Islands).

5. Conclusions

The relationship between economic growth and the unemployment rate in Scotland indicates that an increase of 1 percentage point in the unemployment rate is reflected in a decrease of 1.7 per cent in the real GVA growth in the short run (impact), without a difference between areas and a long term effect of also 1.7. It should be noted that although the coefficients for rural and non rural areas are statistically significant (i.e., different from zero) they are not statistically different from each other.

In terms of the impact of real GVA growth on the unemployment rate, the estimation indicates a difference between predominantly rural areas and the other areas. Thus, in the long term an increase by 1 per cent in the real GVA in predominantly rural areas decreases the unemployment rate by 0.33 percentage-points, whilst in the other areas the decrease is by 0.65 percentage points.

Our statistical analysis highlights that differences in the composition of the economy of rural and urban areas lead to a stronger relationship between growth and employment in urban areas. This has implications for policies targeting growth to reduce unemployment. At one level it suggests that urban areas should be targeted, on another level it suggests that we need to understand more fully the relationship in rural areas so that growth which leads to greater rates of employment can be encouraged.

References

Adanu K. (2005). A Cross-province Comparison of Okun’s Coefficient for Canada. Applied Economics, 37(5): 561–570

Apergis N. and Rezitis A. (2003) An examination of Okun’s law: evidence from regional areas in Greece. Applied Economics, 35:1147–1151

Arellano, M., and S. R. Bond (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, Review of Economic Studies, 58, 277–297.

Atterton, J. (2011). The Implications of Changing Public Sector Budgets for Rural Scotland. Rural Policy Centre Research Report, April. Available online at: http://www.sac.ac.uk/mainrep/pdfs/publicsectorbudgets.pdf

Bisping, T. O. and Patron, H. (2005). Output Shocks and Unemployment: New Evidence on Regional Disparities. International Journal of Applied Economics, 2(1): 79-89.

Blackley, P. R. (1991). The measurement and determination of Okun's Law: Evidence from state economies. Journal of Macroeconomics, 13(4): 641–656.

Brechling, F. P. R. (1965). The Relationship Between Output and Employment in British Manufacturing Industries. The Review of Economic Studies, 32(3): 187-216.

Breitung, Jörg (2000). “The Local Power of Some Unit Root Tests for Panel Data,” in B. Baltagi (ed.), Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Amsterdam: JAI Press, p. 161–178.

Chamberlin, G. (2011). Okun’s Law revisited. Economic & Labour Market Review, 5(2): 104-32.

Choi, I. (2001). “Unit Root Tests for Panel Data,” Journal of International Money and Finance, 20: 249–272.

Christopoulos, D. (2004). The Relationship between Output and Unemployment: Evidence from Greek Regions. Papers in Regional Science, 83(3): 611-620.

Connaughton, J. E. and Madsen, R. A. (2009). Regional implications of the 2001 recession. Annals of Regional Science. 43(2): 491-507.

European Commission (EC) (2012). Urban-rural typology. Available online at: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Urban-rural_typology

Freeman D.G. (2000) Regional tests of Okun’s law. International Advances of Economic Research 6(3): 557–569.

Im, K. S., M. H. Pesaran, and Y. Shin (2003). Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics, 115, 53–74.

Knotek, E. S., (2007) How Useful is Okun’s Law?. Economic Review, 4th quarter, Federal Reserve Bank of Kansas City. Available online at: www.KansasCityFed.org.

Lee, J. (2000). The Robustness of Okun's Law: Evidence from OECD Countries. Journal of Macroeconomics, 22(2): 331-56.

Levin, A., C. F. Lin, and C. Chu (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties, Journal of Econometrics, 108, 1–24.

Maddala, G. S. and Shaowen Wu (1999). “A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test,” Oxford Bulletin of Economics and Statistics, 61, 631-652.

Okun, A. (1962). Potential GNP: Its Measurement and Significance, American Statistical Association, Proceedings of the Business and Economics Statistics Section, pp. 98–104.

O'Donnell, A. T. and Swales, J. K. (1979). Factor Substitution, the C.E.S. Production Function and U.K. Regional Economics, Oxford Economic Papers, 31(3): 460-76.

Pedroni, P. (1999) Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics 61(special issue): 653-670.

Pedroni, P. (2000). Fully-Modified OLS for Heterogeneous Cointegrated Panels. Advances in Econometrics 15: 93-130.

Pedroni, P. (2001). Purchasing Power Parity Tests in Cointegrated Panels. The Review of Economics and Statistics, 83(4): 727–731.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP. Econometric Theory, 20(3): 597-625.

Prachowny, M.F.J. (1993). Okun's Law: Theoretical Foundations and Revised Estimates. The Review of Economics and Statistics, 75(2): 331-336.

Revoredo-Giha, C., Renwick, A., Williams, F. and Lamprinopoulou, C. (2010). How resilient is the rural economy to the current economic crisis? In: Skerratt, S. et al. Rural Scotland in Focus Report 2010. Scottish Agricultural College (SAC).

Solow, R. M. (1957), Technical Change and the Aggregate Production Function. Review of Economics and Statistics, 39: 312-320.

Tatoglu, F. Y. (2011). The long and short run effects between unemployment and economic growth in Europe. Doğuş Üniversitesi Dergisi, 12 (1): 99-113.

The Scottish Government (2010) The Scottish Economic Recovery Plan: Accelerating Recovery. The Scottish Government Economic Strategy Directorate: Edinburgh.

Villaverde, J. and Maza, A. (2009) The robustness of Okun's law in Spain, 1980–2004, Journal of Policy Modeling 31(2): 289–297.