Spatial Econometric Analysis of Rural Employment Change during the Recession: Full-time versus part-time

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Paper prepared for presentation at the 150th EAAE Seminar

"The spatial dimension in analysing the linkages between agriculture, rural development and the environment"

Jointly Organised between Scotland's Rural College (SRUC) and Teagasc

Scotland's Rural College, Edinburgh, Scotland
October 22-23, 2015

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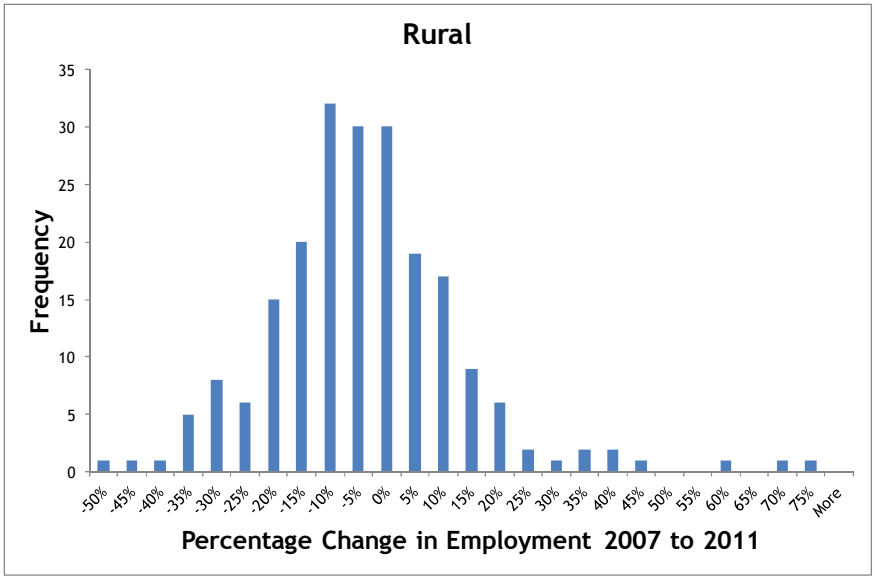
1. Introduction

The recent recession had a deep impact on the economy in Northern Ireland, with the Northern Ireland Composite Economic Index (a proxy for GDP) falling by 14 per cent between Q2 of 2007 and Q2 of 2012. The recession had a particularly negative impact on employment within rural areas during the early period of the recession (Patton and Xia, 2014). However, as shown in Figure 1 there was considerable variation in employment change within rural wards during this period. While the average percentage change in employment at the ward level between 2007 and 2011 was negative (minus 6 per cent), some wards displayed strong economic growth and others the opposite.

The analysis in this paper seeks to explain the variation in spatial employment in rural areas during this period. Why did some rural areas suffer more than others? This paper uses regression techniques based on the growth equilibrium model framework to examine the drivers of spatial variations in employment during the recession and provide a better understanding of why some rural areas are more resilient to the effects of the recession than

others. As full-time and part-time employment differ in terms of skills required, level of pay *etc*., the underlying factors driving their changes are rather dissimilar. The implications in terms of economic development of an area also differ. Therefore, total employment in rural areas is disaggregated into full-time and part-time employment.

Figure 1: Histogram displaying percentage change in rural ward total employment between 2007 and 2011



2. Methodology and Data

The growth equilibrium framework has been developed to examine the linkages between employment and population patterns and other exogenous determinants of spatial growth. This framework is based on the premise that population changes or migration flows not only reflect changes in employment but also contribute to such changes due to the availability of labour and demand for final goods (Kusmin, 1994). Within this framework, regional employment change is specified as a function of population change and other exogenous determinants of economic growth. At the same time, regional population change

is specified as a function of employment change and other theoretical drivers of population change. The two equations are estimated simultaneously. By allowing for interdependencies between population and employment growth, growth equilibrium models yield unbiased estimates for other explanatory variables.

This analysis uses ward level data.[1] Ward is the lowest level at which most of the socio-economic characteristics of an area are measured. There are 582 wards in Northern Ireland, with average area 23.8 km^2. As ward is a small spatial unit, it is essential to take into account spillover effects across wards. With regard to the employment and population interaction, the spillover effect is manifest by extensive commuting. That is, employment changes depend on population changes in surrounding areas. Similarly, population change in an area may depend upon employment opportunities within a wider area. This is captured by the inclusion of spatial cross-regressive terms (see the model specification for more details). In addition, employment change in a specific area may also be affected by employment changes in neighbouring units. This effect is captured using spatial autoregressive lags.[2]

In order to model the linkages between urban and rural areas the growth equilibrium model used in this study allows for differential urban, mixed and rural spillover effects.[3] This study extends the model framework set out in Patton and Feng (2014). The model specification within Patton and Feng (2014) provides a means to test the influence of *population* change in neighbouring wards, decomposed by urban/mixed/rural status, on employment change. Within this paper we are also interested in examining the influence of urban, mixed and rural spillover *employment* change on own-ward employment change. Following Fesser and Isserman (2006), this is achieved by decomposing the employment

[1] More descriptions of the data are provided later in the paper.
[2] Using more aggregated spatial units appears to be helpful to mitigate the methodology difficulties. However, given the limited total size of Northern Ireland, there are still substantial spillover effects among units of more aggregated level. Furthermore, economic growth at ward level varies considerably and more aggregated units will mask differences. The total number of district councils, which is the level of units above wards, is 26. Regression analysis is not feasible at this level (or above).
[3] Wards are classified as rural, urban or mixed using the settlement-based approach adopted by the Inter-Departmental Urban-Rural Definition Group (NISRA, 2005).

spillover effects into urban, mixed and rural effects. Thus, within the employment equation three separate spatial autoregressive terms are included for neighbouring employment growth with urban, rural and mixed wards. This leads to an augmented employment-population growth equilibrium model as follows:

(i) $\Delta E = \alpha_E + \beta_{1E}E_{t-1} + \gamma_{1E}\Delta P + \gamma_{2E}W_U\Delta P_U + \gamma_{3E}W_M\Delta P_M + \gamma_{4E}W_R\Delta P_R + \sum\delta_{iE}\Omega^E + \eta_{1E}M_U\Delta E_U + \eta_{2E}M_M\Delta E_M + \eta_{3E}M_R\Delta E_R + \mu$

(ii) $\Delta P = \alpha_P + \beta_{1P}P_{t-1} + \gamma_{1P}\Delta E + \gamma_{2P}W_U\Delta E_U + \gamma_{3P}W_M\Delta E_M + \gamma_{4P}W_R\Delta E_R + \sum\delta_{iP}\Omega^P + \eta_{1P}M_U\Delta P_U + \eta_{2P}M_M\Delta P_M + \eta_{3P}M_R\Delta P_R + \varepsilon$

where ΔE and ΔP are the changes in employment and population density in a particular rural ward in Northern Ireland between 2007 and 2011. I is an identity matrix and W and M are spatial weight matrices (with diagonal terms equal to zero), which define how geographic units of observation relate to their neighbours. Within the employment change equation [Equation (i)] $\gamma_{1E,}$ is the employment change in the own ward; while $\gamma_{2E,}$ γ_{3E} and γ_{4E} are coefficients for spatially weighted change in *population* in urban/mixed/rural areas (decomposed spatial cross regressive effects). The weight matrices for these variables are based on commuting data from the 2001 census. $\eta_{1E,}$ $\eta_{2E,}$ and η_{3E} are coefficients for spatially weighted change in *employment* in urban/mixed/rural areas (decomposed spatial autoregressive lags). The weight matrices for these spatial autoregressive terms are based on an inverse distance squared matrix, wherein geographic regions that are further away are weighted less heavily and hence, the spatial spillover effect diminishes with distance (distance decay). Within the population change equation [Equation (ii)] γ_{1P} is the population change in the own ward; while $\gamma_{2P,}$ γ_{3P} and γ_{4P} are coefficients for spatially weighted change in *employment* in urban/mixed/rural areas (decomposed spatial cross regressive effects). Again, the weight matrices for these variables are based on commuting data from the 2001 census. $\eta_{1P,}$ $\eta_{2P,}$ and η_{3P} are coefficients for spatially weighted change in *population* in urban/mixed/rural areas (decomposed spatial autoregressive lags). Again, the weight

matrices for these spatial autoregressive terms are based on an inverse distance squared matrix. Estimation is achieved using the GMM (General Method of Moment) procedure, which involves the use of instrumental variables. The exogenous explanatory variables form the basis of generating instrument variables.

By disaggregating employment into full-time and part-time employments, the specification used in this study becomes:

(iii) $\Delta E^f = \alpha_{Ef} + \beta_{1Ef}E^f_{t-1} + \gamma_{1Ef}\Delta P + \gamma_{2Ef}W_U\Delta P_U + \gamma_{3Ef}W_M\Delta P_M + \gamma_{4Ef}W_R\Delta P_R + \sum\delta_{iEf}\Omega^E + \eta_{1Ef}M_U\Delta E^f_U + \eta_{2Ef}M_M\Delta E^f_M + \eta_{3Ef}M_R\Delta E^f_R + \mu^f$

(iv) $\Delta E^p = \alpha_{Ep} + \beta_{1Ep}E^p_{t-1} + \gamma_{1Ep}\Delta P + \gamma_{2Ep}W_U\Delta P_U + \gamma_{3Ep}W_M\Delta P_M + \gamma_{4Ep}W_R\Delta P_R + \sum\delta_{iEp}\Omega^E + \eta_{1Ep}M_U\Delta E^p_U + \eta_{2Ep}M_M\Delta E^p_M + \eta_{3Ep}M_R\Delta E^p_R + \mu^p$

(v) $\Delta P = \alpha_P + \beta_{1P}P_{t-1} + \gamma_{1P}\Delta E + \gamma_{2P}W_U\Delta E_U + \gamma_{3P}W_M\Delta E_M + \gamma_{4P}W_R\Delta E_R + \sum\delta_{iP}\Omega^p + \eta_{1P}M_U\Delta P_U + \eta_{2P}M_M\Delta P_M + \eta_{3P}M_R\Delta P_R + \varepsilon$

where f and p denote full-time and part-time respectively. This specification is similar to Hoogstra (2013), which uses the growth equilibrium model to investigate the gender differences in the employment and population interaction. In Hoogstra (2013), the employment variable in the population equation is disaggregated into gender (gender is not used as a basis of disaggregation in this analysis). This is facilitated by the fact that the exogenous variables in the gender specific employment equations are different and therefore the availability of instrument variables is not an issue. However, as the exogenous variables in the full-time and part-time employment equations are the same within this analysis there are not enough instrument variables to separate different categories of employments in the population equation. Our specification is not to say that full-time and part-time employments have the same impacts on population changes. The data set does not allow us to test whether full-time and part-time employments have the same impacts on population changes.

Within the literature the contribution of these employment spillover effects may be either positive or negative, with the former indicating a spread effect and the latter a backwash effect. The spread effect arises when growth within nearby urban, rural or mixed areas has a positive impact on rural economic growth due to for example agglomeration

effects. In contrast, the backwash effect refers to the situation in which proximity to growing urban, rural or mixed areas is detrimental to economic growth within rural areas due to competition among regions. Since this employment spillover effect may be either positive or negative it must be determined empirically.

The analysis in this study is explicitly concerned with drivers of employment change during the recessionary period. This contrasts with the study by Patton and Feng (2014), which examined drivers of population and employment change prior to the downturn (2001 to 2007). It is possible that the underlying drivers of employment change differ during boom and downturn periods. In addition, the analysis in this study distinguishes between full-time and part-time employment. These employment types exhibited different trends following the outbreak of the recession and thus it is desirable to sub-divide these categories.

The following analysis is based on 2007 and 2011 Census of Employment data, using wards as the geographic unit of observation. Wards are classified as rural, urban or mixed using the settlement-based approach adopted by the Inter-Departmental Urban-Rural Definition Group (NISRA, 2005). For the purposes of undertaking regression analysis the employment and population data are defined in terms of density. Descriptive statistics for total/full-time/part-time employment and population density change between 2007 and 2011 for the rural wards are presented in Table 1. During this time period it is apparent from the descriptive statistics that although average total employment in rural areas decreased during this period, average population showed the opposite trend. In addition, underlying the decline in average total employment, full-time employment showed a more significant decline than part-time employment.

In addition, these descriptive statistics indicate that the data set contains very large positive and negative changes with regards to both employment and population. These extreme observations may have undue influence on the estimated coefficients, leading to

inappropriate conclusions. As a result, regressions are estimated using the full data set and two other data sets in which the most extreme observations are excluded. This is achieved in a systematic fashion by removing (i) 0.5 per cent and (ii) 2.5 per cent of the observations in both tails of the distribution in question, *i.e.* total, full-time or part-time employment change and population[4].

Table 1: Descriptive Statistics

	Average	Standard Deviation	Minimum	Maximum
Full Data Set				
Total Employment Density Change 07 to 11	-1.87	9.38	-110.55	24.01
Full-Time Employment Density Change 07 to 11	-1.73	8.97	-110.67	20.52
Part-time Employment Density Change 07 to 11	-0.19	3.72	-48.21	5.27
Population Density Change 07 to 11	3.68	7.82	-20.26	86.86
Restricted Data Set (2.5% Percentile Removed)				
Total Employment Density Change 07 to 11	-1.02	2.62	-13.91	6.72
Full-Time Employment Density Change 07 to 11	-1.06	2.22	-12.61	5.38
Part-time Employment Density Change 07 to 11	0.10	0.96	-4.15	3.83
Population Density Change 07 to 11 (Total Emp. Equation)	3.02	3.14	-3.40	14.48
Population Density Change 07 to 11 (Full-Time Emp. Equation)	3.08	3.17	-3.40	14.48
Population Density Change 07 to 11 (Part-Time Emp Equation)	3.04	3.17	-3.40	14.59

3. Results

3.1 Employment Change

The estimation results for the full-time employment change, part-time employment change and population change are provided in Table 2. The estimations are implemented using the full data set and the restricted data sets in which the most extreme observations are removed.

[4] A further data set was used in which 1 per cent of the observations in both tails of the distribution were removed but is not presented for the purposes of brevity.

Full-Time Employment

Separate equations are estimated for full-time and part-time employment to determine whether the underlying drivers for these different categories of employment differ. Estimation using the full data set yielded some unexpected results. For example, the coefficient for population change within the own ward ('Self Pop Change') is significant and negative, indicating that an increase in population leads to a decline in employment. Similarly, population change within nearby urban wards has a statistically significant negative impact on employment. These results no longer apply when the most extreme observations are removed from the data set, i.e. none of these variables are significant using the data sets in which 0.5 per cent and 2.5 per cent of the observations are removed from the tails. This indicates that the results from the full-sample are driven by the most extreme observations. In light of these issues the following discussion refers to the results for the restricted data sets.

Focusing on the dataset in which 0.5 per cent of the sample at the tails is removed, none of the cross-regressive variables are statistically significant. This is not surprising given the opposing trends in average full-time employment and population change (decrease in full-time employment and increase in population, Table 1). Nevertheless, there is evidence of spillover effects for employment change. The statistically positive coefficient for the autoregressive variable 'Rural Employment Change' indicates the presence of a spread employment dynamic effect between rural areas. This implies that economic performance within proximate rural areas is complementary during a recessionary period. This result also applies to the restricted data set in which 2.5 per cent of the sample at the tails is removed. In addition, the results for the 2.5 per cent percentile removed data set also suggest that the diffusion of economic growth from urban to rural areas is positive and similarly from mixed to rural areas. This implies that the resilience of a rural area during this recessionary period

Table 2: Employment Change

			Full Sample		0.5% Percentile Removed		2.5% Percentile Removed	
			Coeff.	**P- value**	**Coeff.**	**P- value**	**Coeff.**	**P- value**
Full Time Employment	Constant		3.652	**0.00**	0.140	0.82	1.354	**0.02**
	Lagged FT Emp		-0.070	**0.00**	-0.128	**0.00**	-0.139	**0.00**
	Self Pop Change		-0.608	**0.00**	0.059	0.18	-0.050	0.30
	Cross regressive Pop	Urban	-0.018	**0.01**	-0.003	0.46	-0.002	0.43
		Rural	0.521	**0.00**	-0.015	0.76	0.010	0.77
		Mixed	0.000	0.99	-0.013	0.12	0.004	0.53
	% Emp in Construction		-0.051	**0.07**	-0.029	**0.09**	-0.045	**0.00**
	Distance to Key Corridor		0.000	0.58	0.000	0.18	0.000	**0.07**
	Autoregressive Emp	Urban	-0.004	0.78	-0.007	0.31	0.013	**0.00**
		Rural	0.846	**0.00**	0.186	**0.00**	0.084	**0.04**
		Mixed	0.002	0.98	0.011	0.61	0.029	**0.03**
	% Emp with High Qual		-0.023	0.56	0.037	**0.05**	0.041	**0.01**
	Claimant Count		-0.385	**0.03**	0.117	0.25	-0.052	0.56
Part Time Employment	Constant		0.429	0.43	1.454	**0.00**	0.948	**0.00**
	Lagged PT Emp		-0.093	**0.00**	-0.018	**0.00**	-0.065	**0.00**
	Self Pop. Change		0.091	**0.00**	0.000	0.99	0.094	**0.00**
	Cross regressive Pop	Urban	-0.001	0.70	0.003	**0.05**	-0.001	0.48
		Rural	-0.017	0.58	-0.013	0.50	0.028	0.10
		Mixed	-0.008	0.11	-0.001	0.85	-0.006	**0.05**
	% Work Pop in Construction		-0.001	0.91	-0.011	0.12	-0.027	**0.00**
	Distance to Key Corridor		0.000	0.11	0.000	0.25	0.000	**0.05**
	Autoregressive Emp	Urban	-0.019	**0.00**	-0.005	**0.03**	-0.004	**0.02**
		Rural	0.230	**0.01**	0.043	0.25	0.089	**0.01**
		Mixed	-0.025	0.32	0.041	**0.03**	-0.008	0.67
	% Work Pop with High Qual		-0.010	0.58	-0.045	**0.00**	-0.032	**0.00**
	Claimant Count		0.109	0.12	-0.247	**0.00**	-0.039	0.33
Population	Constant		-4.848	0.24	-12.063	**0.00**	-5.215	**0.02**
	Lagged Pop		-0.001	0.69	0.018	**0.00**	0.031	**0.00**
	Self Emp (Total) Change		-0.417	**0.00**	0.033	0.71	0.111	0.22
	Cross regressive Emp	Urban	-0.001	0.62	0.003	**0.08**	-0.002	0.18
		Rural	0.175	**0.00**	-0.012	0.67	-0.037	**0.08**
		Mixed	-0.013	0.38	0.016	0.30	-0.007	0.55
	% Ag		-0.030	0.29	0.020	0.30	-0.017	0.32
	% 25To44		0.316	**0.00**	0.287	**0.00**	0.142	**0.00**
	Distance to School		0.000	**0.07**	0.000	0.44	0.000	0.33
	Income		0.000	**0.10**	0.000	0.41	0.000	0.72
	Distance to Key Corridor		0.000	0.17	0.000	0.48	0.000	**0.07**
	Autoregressive Pop	Urban	0.028	**0.03**	0.026	**0.00**	-0.002	0.80
		Rural	0.899	**0.00**	0.408	**0.00**	0.430	**0.00**
		Mixed	-0.035	0.35	0.082	**0.00**	0.104	**0.00**
	Claimant Count		0.278	**0.10**	0.005	0.97	-0.068	0.57

was partly determined by the performance of urban/mixed areas in close proximity. Rural areas located nearby declining urban/mixed areas suffered to a greater extent in terms of employment change compared to other rural areas.

Returning to the dataset in which 0.5 per cent of the sample at the tails is removed, the exogenous variables '% of Employment in Construction' and '% of Population with High Qualifications' are statistically significant. The coefficient for '% of Employment in Construction' is negative and reflects the disproportionate impact of the recession on the construction sector. All other things equal, rural wards with a high mix of employment in this sector suffered to a greater extent than elsewhere. On the other hand, as indicated by the positive coefficient for '% of Population with High Qualifications'[5], rural areas with a superior skills mix were more resilient to the effects of the recession in terms of full-time employment.

Part-Time Employment

In light of the results for full-time employment, unless otherwise stated, the following discussion for part-time employment refers to the restricted sample in which 0.5 per cent of the sample at the tails is removed.

Estimation of the part-time employment equation yielded a statistically significant positive coefficient for population change within nearby urban wards (cross-regressive urban population variable). Note, however, this result does not hold for the 2.5 per cent percentile removed sample and thus should be treated with caution.

As demonstrated by the autoregressive urban term, urban part-time employment growth exerts a statistically significant negative influence on nearby rural employment growth. This suggests that the diffusion from urban to rural areas is backwash in nature with

[5] High qualifications are defined as NVQ level 4 qualifications and above.

regards to part-time employment, *i.e.* an increase in employment within an urban area has a negative impact on employment in rural areas, or conversely a decrease in employment within an urban area has a diminished employment impact or even results in an increase in rural areas. This result holds using the data set in which 2.5 per cent of the sample at the tails is removed. There is some uncertainty concerning the impact of the autoregressive rural term. While this is not significant within the restricted 0.5 percentile removed sample, it is significant within the 2.5 percentile removed sample. The sample with more extreme observations removed suggests that the spatial spillover of part-time employment has opposing effects depending upon whether the spillover is from urban or rural areas.

Within the part-time employment equation, the exogenous variable '% of Population with High Qualifications' is statistically significant. In contrast to the full-time employment equation, the coefficient is negative within the part-time employment equation. During the period 2007 to 2011 the change in part-time employment was negligible, while full-time employment showed a marked decline. The negative relationship between '% of Population with High Qualifications' and 'Part-Time Employment' most likely reflects the lower requirement for high qualifications for part-time employment.

3.2 Population Change

While the main focus of this paper is on explaining spatial variations in employment, since the employment and population equations are estimated simultaneously, the results for the latter are presented for the purposes of completeness. Again, unless otherwise stated the following discussion focuses on the restricted sample in which 0.5 per cent of the sample at the tails is removed.

The only significant cross-regressive variable that is statistically significant is 'Urban Employment Change'. Note, however, that this variable is not significant within the other

data sets. The variables capturing neighbouring population change in urban, mixed and rural wards (*i.e.* the autoregressive variables 'Urban Population Change', 'Mixed Population Change' and 'Rural Population Change') are all statistically significant and positive. This indicates that during the recession period population growth (decline) from urban, rural and mixed areas spread to other rural areas. It should be noted that the urban population autoregressive variable is not significant within the restricted sample in which 2.5 per cent of the sample at the tails is removed.

In terms of the exogenous variables, the only variable that is statistically significant when the restricted data set is used is '% 25 to 44 Age Group'. The results should be interpreted within the context that the recession had a significant disruptive effect on the housing market in Northern Ireland, which limited population movements. Nonetheless, it is important to control for population change when modelling changes in regional employment to ensure the robustness of the findings.

4. Conclusions

This study examined regional variations in employment in Northern Ireland between 2007 and 2011 using a growth equilibrium model. The modelling framework provides a means to obtain a better understanding of the factors underlying regional variations in the performance of rural areas during the recession. The analysis confirms that different explanatory factors contribute to variations in full-time and part-time employment. Using aggregated data (total employment which consists of both full-time and part-time employment) would mask some important differences between these sub-groups.

In terms of full-time employment, there is some evidence of employment spillover effects from neighbouring areas. Within the sample in which most the extreme observations

have been removed, these employment spillover effects are diffused from both rural and urban areas. The finding that the performance of urban areas influences rural prosperity implies that rural development strategies should take into account the potential to incorporate urban areas with strong linkages to surrounding rural communities. In particular, rural development programs should not be too narrowly focused on purely rural areas but should incorporate market towns within predominately rural areas. Moreover, rural development strategies should aim to establish, strengthen and leverage urban-rural linkages. However, these positive spillover effects did not apply for part-time employment during this recessionary period.

The analysis also confirmed that rural areas with a superior skills mix were more resilient to the effects of the recession for full-time employment. However, the opposite applies for part-time employment. These subtitles need to be taken into consideration in investing in education for rural development purposes.

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