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What accounts for the success of regions? Examining the factors associated with economic development

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Introduction

This paper aims to identify which variables are associated most strongly with regional economic development and prosperity. The data used in the analysis is taken from the World Competitiveness Index of Regions (WCIR), which covers a wide variety of regional economies based within differing national economies. The aim of this paper is to analyse the dataset to distinguish the underlying economic characteristics of both successful and less successful regions. In order to achieve this, the variables were grouped into measures of success – so called "output variables", and factors that were not desirable in themselves but might have contributed to success – "input variables". The former set of variables indicate economic success, while the latter variables are thought to be conducive to success but are not in themselves indicators of success.

The original dataset covers 546 regions, and 19 indicators (a further indicator, gross value added (GVA) per head, was added). The output variables consist of GVA per head, labour productivity, gross monthly wages, the rate of economic activity and the unemployment rate. The input group consists of the other fifteen variables: measures of the distribution of the labour force among different sectors, expenditures on education and on research and development, measures of internet connectivity etc. (see

Table 1: The determinants of regional success. Results of regression on the composite output variable (all regions)

	Standardized Coefficients (Beta)	t-value
Constant	244.390[a]	1.143
Employment in IT	0.081	3.356***
Employment in biotech	0.023	1.110
Employment in auto and mech eng	-0.011	-0.422
Employment in instrumentation	-0.042	-1.279
Employment in high-tech services	0.083	3.708***
Managers per 1,000 employees	0.075	3.361***
Govt. spending R&D	0.049	2.398**
Business spending R&D	0.175	5.707***
Patents per one million inhabitants	-0.031	-1.138
Per capita private equity investment	-0.089	-3.305***
Public expenditure primary and secondary education	0.379	10.295***
Public expenditure higher education	0.354	9.654***
Secure servers per one million inhabitants	0.044	1.147
Internet hosts per 1,000 inhabitants	-0.139	-4.889***
Broadband access per 1,000 inhabitants	0.219	6.220***

a: unstandardised coefficient
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

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column 1 of Table 1 for a complete list of variables). Based on this, the objective was to determine the relative importance of different input variables in contributing to regional success.

In terms of regional coverage, a total of 137 regions in the European Union are included. Due to the rapid development in the performance of the BRIC nations (Brazil, Russia, India, China), the WCIR gives the regions of these nations prominent coverage. In North America, 90 US regions are benchmarked along with 12 Canadian regions. In the case of Asia and Pacific regions, 164 regions are included and in the Middle East 35 regions. Finally, the WCIR covers regions from two South America nations: Brazil (27 regions) – as already mentioned - and Colombia (22 regions). For the current analysis 85 regions were dropped due to the outlying nature of their economies (principally oil and mineral dominated regions) or missing data.

Measuring Success

The first objective of the analysis is to characterise the output variables, in particular to identify the indicators that should be chosen as the dependent variable in regression analysis (which will then be 'explained' by the selected 'input factors'). GVA per head is a reasonable measure of the overall level of prosperity; monthly wages indicate how much of GVA goes to the workforce, so both are relevant. Economic activity rates indicate how much of the population is economically engaged and therefore likely to share in general prosperity. The simplest approach is to take GVA per head. Another approach is to construct a variable combining GVA, wages and activity.

A final approach was to undertake a principal components analysis on four of the output variables (unemployment statistics are not included on the grounds that they may be influenced by factors such as the rate and availability of unemployment benefit, and can add little to the analysis that is not already shown better by the activity rate). Overall, the analysis indicated two significant components: the first, accounting for some 71% of the total variance of the sample, was mostly an equal weighting of GVA per head, labour productivity and monthly wages; the second component, accounting for 25% of the variance, was essentially the economic activity variable. As economic activity contributes less to total variance than the other variables, it is probably a less important measure of welfare; moreover it is not possible to say *a priori* how much inactivity was voluntary and how much represented lack of opportunity. On this basis the combined loadings from the principal component analysis were used to reweight the output function. The output variable, O2, now becomes:

$$O2 = GVA^{0.3} * MGE^{0.3} * LP^{0.3} * Act^{0.1}$$

where MGE is mean gross monthly earnings, LP is Labour productivity and Act is the economic activity rate.

If the regions are ordered by O2, from highest to lowest, Wales is ranked at 208 of 461 regions, and for GVA per head it is ranked 222nd. This ordering of the data also suggested breaks in the sample, and some distinctive groups of regions, especially as arranged by O2, but also by GVA per capita. These observations are important, since it is not obvious that the characteristics that most separate a very poor region like Bihar in India from a middling region like Leningrad – or Wales – are the same as the ones that separate the latter from a very wealthy region like Luxembourg or the San Francisco area. Different features may be conducive to economic development at different stages of the development process. Therefore, a test is undertaken to determine whether the sample should be broken into different clusters for further analysis.

A two-step cluster analysis was run on the sample, clustering by O2. Only two significant clusters were found with 221 and 241 observations. This analysis showed that the clustering did

not depend at all on the economic activity variable. The mean value of that variable was identical for the two clusters. Labour productivity was the most important factor. Wales is in the wealthier cluster, albeit near the bottom ranked by O2 or GVA per head.

Having identified two clusters using the output variables, the next step is to determine which of the input variables are most clearly different between the two clusters, using a discriminant analysis.

The variables that most firmly distinguish the two clusters are identified as broadband access and public spending on education, both primary and secondary and higher education. Other variables are less influential, although the number of managers per 1,000 employees and the number of secure servers have some importance. If any conclusions are to be drawn from this, it is that educational expenditures and internet connectivity are the two elements most important for a region in the lower cluster aiming to get into the higher one.

Accounting for Success

The next step is to undertake a regression analysis to examine whether the same variables are associated with success (measured by O2) across the entire sample and then within each cluster.

Regression results for the full sample are shown in Table 1. The model fit is good (with an adjusted R^2 of 0.85). There are some substantial differences from the discriminant analysis. Significantly positive coefficients are now seen for employment in IT, employment in high-tech services, the number of managers per 1,000 employees, R&D spending by both businesses and government. Expenditure on all forms of education remains significant as does broadband access. There are, however, some counterintuitive results. For example, the number of internet hosts has a significantly negative coefficient, although this variable is correlated with broadband access. Moreover, private equity investment has a significantly negative effect.

For comparison, a regression with the same explanatory variables was run on GVA per head. Qualitatively the results are very similar. Education expenditures are the most important explanatory variables, followed by business R&D. The number of managers became insignificant as did private equity investment at the 5% significance level, although it retained a negative coefficient. The paradoxical opposite signs on broadband access and internet hosts remained. Also, the overall fit is slightly worse.

A remaining task is to run regressions on the two clusters separately. For cluster one - the wealthier regions - the results shown in Table 2 indicate that four variables dominate in terms of having a positive relationship with O2: expenditure on higher education, expenditure on primary and secondary education, R&D spending by businesses and employment in high tech services. Variables with some positive influence are patents, employment in IT and government R&D. There are significant negative coefficients on private equity investment and internet hosts per thousand inhabitants. Again, the last two results are counterintuitive and invite further re-examination of data.

The regression on cluster one has significantly worse fit than that across the sample as a whole, implying that the wealthier cluster is more internally diverse than the poorer cluster. The adjusted R^2 is down to 0.55, so almost half the variance cannot be explained by the explanatory variables. There are clearly some elements of competitiveness not included in this data set. Higher spending on education may be the result of higher GVA as well as, or even instead of, being a cause. For a country like Wales, which is eighth from the bottom of cluster one, the associations show that more successful regions have higher spending on education, more R&D spending by businesses and tend to specialise more in high tech services. It may not

Table 2: The determinants of regional success. Results of a regression analysis on the composite output variable (wealthier cluster of regions)

	Standardized coefficients (Beta)	t-value
Constant	4040.39[a]	6.48*
Employment in IT	0.085	1.53
Employment in biotech	0.038	0.77
Employment in auto and mech eng	-0.038	- 0.61
Employment in instrumentation	-0.015	- 0.17
Employment in hi-tech services	0.188	3.64***
Managers per 1000 employees	0.061	0.97
Govt spending on R&D	0.085	1.77*
Business spending on R&D	0.195	2.57**
Patents per million inhabitants	0.140	1.85*
Per capita private equity investment	-0.158	- 2.53**
Public spending on primary and secondary education	0.226	3.36***
Public spending on higher education	0.317	4.73***
Secure servers per million inhabitants	-0.025	- 0.37
Internet hosts per 1000 inhabitants	-0.234	-3.55***
Broadband access per 1000 inhabitants	0.035	0.39

a: unstandardised coefficient
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

Table 3: The determinants of regional success. Results of a regression analysis on the composite output variable (poorer cluster of regions)

	Standardized coefficients (Beta)	t-value
Constant	609.28[a]	4.87***
Employment in IT	0.057	0.86
Employment in biotech	0.176	3.20***
Employment in auto and mech eng	-0.117	- 1.59
Employment in instrumentation	-0.066	- 0.89
Employment in hi-tech services	0.008	0.15
Managers per 1000 employees	0.180	4.33***
Govt spending on R&D	-0.036	- 0.62
Business spending on R&D	0.285	5.04***
Patents per million inhabitants	-0.313	-4.14***
Per capita private equity investment	0.196	3.34***
Public spending on primary and secondary education	0.433	9.45***
Public spending on higher education	0.086	1.58
Secure servers per million inhabitants	0.072	1.05
Internet hosts per 1000 inhabitants	-0.180	-2.64***
Broadband access per 1000 inhabitants	0.527	6.86***

a: unstandardised coefficient
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

follow that putting resources into these areas will result in gains in labour productivity, wages and GDP per head, but the association is at least suggestive of this.

The regressions for cluster 2 are shown in Table 3. The fit is better with an R^2 of 0.70. The results are indeed different, and for this cluster employment in biotechnology and chemicals is important while high tech services are insignificant. The number of managers per 1,000 employees is significant, unlike in cluster one. R&D spending by business remains significant. Per capita equity investment now makes a significant positive contribution, the reverse of the situation in cluster one. The number of patents now has a negative effect, again the reverse of cluster one. Spending on primary and secondary education remains by far the most significant and influential variable but, in a reversal from cluster one, it is now some five times as powerful as spending on higher education, which is not quite statistically significant. This seems to indicate clearly that for poorer regions the biggest pay-off in education spending is at the earlier age stages but this becomes less true as incomes and productivity rise.

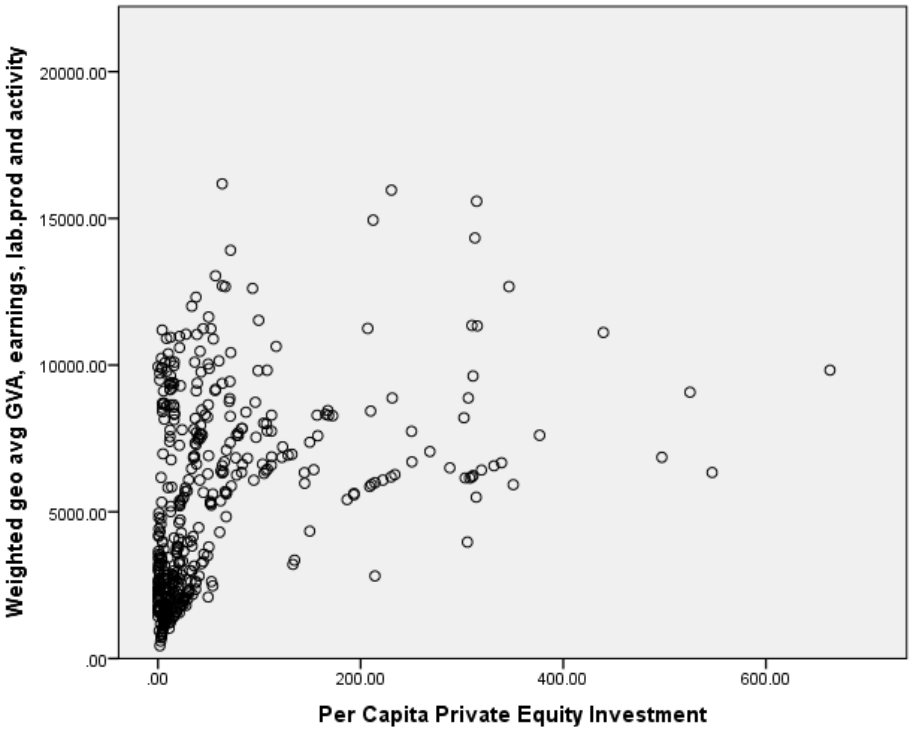
While the paradoxical result of a positive effect of broadband access combined with a negative effect from internet hosts persists, in cluster two the positive effect of broadband is three times the negative effect from hosts, and the coefficient is much better determined. This tends to support the result that internet connectivity is important for cluster two and underpins the result of discriminant analysis, which suggests it tends to discriminate regions in cluster one from cluster two. Based on these results, however, there is a threshold effect and once it is reached, higher connectivity numbers have little further effect on output and productivity.

Taken at face value, the results also suggest that levels of private equity investment per capita are important at lower levels of GVA per head, but lose significance and indeed become counterproductive at higher levels. However this seems to be a spurious result driven by a few data outliers. As illustrated by Figure 1, the bulk of the points in the scatter diagram of O2 on private equity imply a positive association, especially at low values of both variables (accounting for the cluster 2 result). At higher values, however, the association weakens considerably.

The value of O2 at the cluster break is around 6,000. Most observations above that are in cluster 1, where the association looks much weaker but the negative coefficient in the regression is due to a handful of outlying observations.

A robust conclusion is that private equity investment is associated with progress at lower levels of success and the association is much less

Figure 1: Private equity investment and the composite output variable



clear at higher levels. Similar graphical analysis confirms that broadband access has a clearer positive association in cluster two but none in cluster one. Even internet hosts appear to be positively associated with O2 in cluster two, the negative coefficient presumably stemming from collinearity with broadband access. There is no clear association in cluster one. This implies that connectivity does indeed have a threshold quality.

Comparing Wales with other regions

As already noted, in the wealthier cluster of 218 regions, Wales ranks at number 208 on the composite output variable. Tables 4 and 5 compare Wales with the three wealthiest regions in the cluster - Bridgeport Connecticut, Luxemburg and San Jose California - and the three poorest - Puglia, Calabria and Brandenburg, Germany. In terms of per capita income and productivity, the three top regions are roughly three times better off than Wales, which is not very different from the regions just below it. The Italian regions have higher productivity, but much lower activity rates leaving

Table 4: Comparing the output performance of Wales with selected regions

	GDP/Head (US$)	Mean Gross Monthly Earnings (US$)	Economic Activity Rate (US$)	Labour Productivity (US$)
Bridgeport-Stamford-Norwalk, CT Metropolitan Statistical Area, US	87,444	8,773	69.9%	157,344
Luxembourg, Luxembourg	83,646	8,212	56.6%	180,337
San Jose-Sunnyvale-Santa Clara, CA Metropolitan Statistical Area, US	80,105	8,984	67.6%	149,680
Wales, United Kingdom	*24,908*	*2,558*	*58.2%*	*52,418*
Puglia, Italy	21,503	2,549	40.9%	61,926
Brandenburg, Germany	26,475	2,278	62.2%	48,188
Calabria, Italy	21,128	2,466	38.5%	64,195

Table 5: Comparing the employment structure of Wales with selected regions

	Employment Automotive and Mech. Eng. per 1,000 employees	Employment in Instrumentation and Electrical Machinery per 1,000 employees	Employment in High-Tech Services per 1,000 employees	Number of Managers per 1,000 employees
Bridgeport-Stamford-Norwalk, CT Metropolitan Statistical Area, US	10.7	13.0	31.5	79.3
Luxembourg, Luxembourg	2.9	26.4	55.4	47.0
San Jose-Sunnyvale-Santa Clara, CA Metropolitan Statistical Area, US	9.3	21.2	83.6	81.9
Wales, United Kingdom	*43.3*	*23.1*	*23.0*	*164.2*
Puglia, Italy	26.1	12.0	17.0	100.6
Brandenburg, Germany	28.2	13.2	8.0	69.3
Calabria, Italy	7.6	5.8	19.1	107.0

them lagging Wales slightly in GVA per head (Table 4).

In terms of structure of the economy, the poorer regions generally have more people employed in the automotive or mechanical engineering sector and Wales is most specialised in that sector. The wealthier regions are specialised in high-tech services, and while Wales has slightly more employment in that sector than the poorer regions it lags well behind the top three (Table 5). There is no correlation within the cluster between number of managers per 1,000 employees and the output variables like GVA per head. If anything the weaker regions tend to have more and Wales has by far the most in this group.

Of the remaining variables found to be associated with success, the difference is stark between the top regions and the bottom ones, including Wales. Per capita expenditures by business on R&D are higher in Wales than the other poorer regions, but less than a fifth of any of the top three regions. Expenditure on higher education per capita tells a similar story, with Wales spending less than half than Luxemburg and less than a third of San Jose, California. It also spends less than Brandenburg. Wales does well relative to the poorer countries in spending on primary and secondary education, but still significantly less than any of the top three.

For variables that are less clearly correlated with success Wales does very poorly on R&D spending by government and patents registered. It scores well on secure servers per million inhabitants and fairly well on per capita equity investment. These are the variables, however, that appear to show diminishing returns. At low levels of income they are associated with success but the effect diminishes and disappears as incomes rise.

Recall that this regression accounts for just over half the variation in the composite output variable across the sample. There are other factors accounting for GVA and productivity, which raises the question: how do the omitted variables bear on Wales performance? Given the observed variables for Wales, is its performance on the composite output variable better or worse than expected? It turns out that the actual value for Wales on the composite output index, explaining its lowly position of 208, is 5,415 but the value predicted from the cross-cluster regression is 7,794. If Wales' performance in other respects – in the unknown omitted variables – were typical of the set of regions it would be 30% better off and rank 112 not 208. According to the analysis in this paper, if expenditure on higher education more than doubled in Wales, the composite output variable would be just 9% higher. While this analysis points to spending by business on R&D and to government on higher education as areas where Wales could usefully increase its efforts, it also shows that these investments are no panacea. Welsh output and productivity lag other regions for other reasons not identified in the analysis.

Conclusion

In undertaking this analysis, one result stands out. Education expenditures are strongly associated with regional success. For lower GVA and productivity regions, the most important element is expenditure on primary and secondary education. At higher levels of the GVA and productivity scale, however, spending on higher education becomes more important.

Business expenditure on research and development is generally associated with success. Among more competitive regions, there is also a weak association between government spending on R&D and productivity, which tends not to be the case among poorer regions. The sectoral specialisations that seem to go along with higher output per head also differ with the productivity level of the region. Among wealthier regions there is a clear association between success and specialisation in high-tech services, but this

association is absent among poorer regions.

A number of variables show clear threshold or plateau effect whereby they are clearly associated with progress among poorer regions, but above a certain level of output per head and productivity there is no clear association with further progress. These variables include the number of managers per thousand workers, per capita levels of private equity investment and various measures of internet connectivity. It seems that rates of broadband access are very important in enabling poorer regions to advance, but increases beyond a certain point have no significant effect on productivity in wealthier regions.

A general conclusion is that it is easier to chart the progress from poorer to middling regions. The variables explored appear to explain some 70% of the variation in output per head, productivity and economic activity rates among poorer regions. Among richer regions, however, there seems to be greater diversity and the same variables explain no more than 55% of the differences in success.

Finally, Wales is a particular case where the analysis in this paper leaves a substantial unexplained element, and although Wales suffers from relatively low spending on higher education and low spending by business on R&D, there are clearly other factors beyond this analysis pulling down its relative performance.

One factor that has been found to be influential is agglomeration; productivity is higher in large cities. Wales lacks a large city by international standards and population density is fairly low, which could help to explain relatively low productivity.

Another factor is the influence on each region of institutions determined at national level. For example the degree of regional autonomy within the nation state may be a significant variable, or the nature of the national legal system, corporate law and the financial system. UK productivity levels tend to lag those of other advanced states in Europe and North America and this could be owing to factors that extend to Wales. Some macroeconomic variables could also have long-run effects, like the savings rate, which determines how much investment can take place without borrowing. The Welsh savings rate, like that of the UK as a whole but to an even greater degree, is low by international standards. Unfortunately these types of factors lie outside the control of the Welsh government. As well as seeking to quantify these effects, further research must hunt for factors that can be changed in Wales itself.