

Country-level Business Performance and Policy Asymmetries in Great Britain

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Abstract:

HM Treasury identifies key ‘drivers’ of business performance and productivity differentials, which include skills, investment and competition. This paper presents an empirical investigation into the effects of these drivers on plant-level productivity per employee across England, Scotland and Wales in order to identify whether spatial differences in the influence of these drivers exists. Although the results offer support for the applicability of these key drivers the results also indicate that productivity differentials exist across Great Britain which require country-specific policy instruments.

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1. Introduction

In the UK, the emphasis on productivity both as a measure of business performance and as a target for microeconomic policy has been growing (see, for example, HM Treasury, 1998). Various authors have identified a ‘productivity gap’ where businesses in the UK have lagged behind other competing economies such as Germany and the USA. The sources of the UK labour productivity gap are found to differ across countries with capital per worker playing a larger part for France and Germany relative to the UK and with innovation being of more importance for the UK than for the USA (Crafts and O’Mahony, 2001). In spite of policy interventions and exhortations at the local, regional and national level (HM Treasury, 2001, 2003), there is a consensus in the literature which suggests that, while productivity in the UK has increased, relative to competing economies such as Germany and the USA, the productivity gap has not been closed (see, for example, Crafts and O’Mahoney, 2001).

The productivity gap also exists between the regions of the UK (Gardiner *et al.*, 2004) and the UK Treasury reports on productivity in the UK (HM Treasury, 2000, 2001) drew widely on the evidence base of existing academic and policy literature in order to identify both productivity differentials and those factors that might account for such differences in business performance. Amongst others, they emphasise the importance of skills, investment and competition. However, little research has been conducted to identify whether these factors vary in their importance across the countries of Great Britain.

Using business-level data, the aims of this paper are to a) ascertain whether productivity differences exist across the countries of Great Britain: England, Scotland and Wales, b) identify whether productivity per employee is enhanced by the specific policy drivers related to skills, investment and competition and c) explore whether the importance of these drivers varies across the three constituent countries. The findings are important as they contribute to the debate on the extent to which, in a context of devolved powers and policy instruments, different countries should shape their policy around the HM Treasury’s recommendations and whether each country should focus more or less on each specific policy area.

This paper has the following structure. In the next section some relevant academic literature and the HM Treasury’s key drivers are reviewed. The model and data are detailed in sections 3 and 4 respectively. The results are discussed in section 5 and the conclusions are presented in section 6.

2. Literature Review

Spatial differentials in business competitiveness and productivity have been a focus for academic and policy related concern on the grounds of improving efficiency, equity and social cohesion. The academic literature can be seen to focus on two distinct perspectives: reducing productivity differentials and/or enhancing productivity rates. These can be contradictory especially if particular policies are recommended or employed in order to generate different desired effects in different geographical areas. In the UK, the government has specifically emphasized the importance of the regional dimension to its central economic objectives (HM Treasury, 2001; HM Treasury, 2004; Department of Trade and Industry, 2004). This can be seen partly as a result of the current process of decentralising government to the level of the regions and partly as a response to economic inequalities expressed in debates such as those on the north-south divide, the urban-rural divide or the England-Wales-Scotland divide. Nevertheless the HM Treasury (2000, 2001) perspective is also relevant for other spatial classifications of the UK and it usefully outlines five key ‘drivers’ of

productivity and productivity differentials. Given data limitations, three of these key drivers (*skills*, *investment* and *competition*) are the subject of an empirical investigation here.

Skills can be seen as the outcome of individual potential, training and on the job experience. They are often seen as the most important slice of human capital, which the OECD (1998, p. 9) defines as “the knowledge, skills and competences and other attributes embodied in individuals that are relevant to economic activity”. Policy can be oriented to improve the human capital base of an economy’s labour force in two important ways: first, people can be encouraged in the purposeful accumulation of knowledge (by going to university for example) and secondly, the act of work itself can improve efficiency via the process of learning-by-doing (apprenticeships); both are seen as contributing to improvements in productivity (see Romer, 1986, 1990, and Lucas, 1988, respectively). Other studies go further when they emphasize skills are an important determinant of innovative capacity (Nelson and Phelps, 1966; Aghion and Howitt, 1998). The importance of both human and physical capital is also strongly embedded in the economic growth literature; see for example Mankiw *et al.* (1992) and Barro and Sala-i-Martin (1994).

Firm specific *investment* is typically undertaken to increase efficiency and/or output levels. It is axiomatic in conventional economic theory that increasing capital input with labour held constant, capital deepening, will increase labour productivity. Firm specific investment is also associated with innovation and a number of studies have considered the impact of ICT investment on productivity (see, for example, Oulton, 2002). In the micro-econometric literature, firm specific investment is typically measured by fixed capital formation although Oulton (2001) expresses some concern that this might be useful for balance sheet data analysis but less conducive to production function estimates and measurements of capacity utilisation.

Competition appears to be synonymous with competitiveness in much Treasury discussion, although the two factors have different relationships with firm productivity. Exposure to increased levels of competition will encourage firms to adopt measures to increase productivity and efficiency. Competition will also bring with it exposure to new ideas, especially competition from overseas and engagement in export markets. Distance to concentrations of population and business activity as measured by distance and population density variables will reflect the opportunity to participate in competitive markets. Peripherality, in the other hand, will tend to insulate firms from competition. Competitiveness can be attributed to a business or the economy of a geographical area (see Department of Trade and Industry, 2003).

In area based studies, infrastructure investment facilitates the movement of goods and people and helps to overcome the disadvantages of peripherality. It is likely to influence productivity (Button, 1998; Haughwout, 2002), but it is the result of long term policy initiatives and programmes designed to improve transport infrastructure.

The HM Treasury also highlight two other key drivers of productivity: the extent to which firms take part in *innovation* and *enterprise*. Considerable attention has been focussed on measuring innovation at the aggregate area level (see European Innovation Scoreboard, 2003). Aggregate level area analyses have had mixed results in using some of the area-specific variables. Public and private sector R&D expenditure is seen to have little explanatory power in accounting for plant level productivity differentials (Boddy *et al.*, 2005), as there are varying time lags before the benefits of expenditures accrue and because expenditure in one geographical area may result in implementation and spillovers elsewhere.

Enterprise is the other key driver identified by the Treasury. The growth of firms is associated with new technologies, innovative working and increased competitive pressure on other firms. VAT registrations are often used to represent enterprise resulting from business

start-ups, although this indicator is more precisely an indicator of businesses growing through a turnover threshold. Nevertheless, large differences in new business start-up rates at regional and sub-regional levels have been shown to persist, and indeed widen over time, with considerably higher rates in the economically more successful areas. However it is difficult to see how a relevant firm-specific variable reflecting ‘enterprise’ as such can be identified.

At the aggregate level, the metrics employed for productivity have been determined partly by the availability and quality of data. Some studies have employed output per capita. The denominator used ranges from the residential population, through the population of working age, the employed population, the workplace population, the total numbers of hours worked to total labour cost. Each of these can be justified on the basis of the objectives of the analysis. The use of output as a numerator fails to reflect value added and can lead to misleading area comparisons where, for example, low value added distribution activities dominate in one area and high value added financial services are disproportionately important in another. Aggregate gross value added (GVA) data is available in the UK and the EU at a geographically disaggregated level down to NUTS 3 areas (approximates of county and unitary authority areas in the UK). However, this data is the subject of some criticism, especially in econometric modelling (Gripaios and Bishop, 2003; Boddy *et al.*, 2005) in part because of the extensive use of estimation in the derivation of the data itself. As a result, in a number of studies, earnings have been used as a proxy for labour productivity. This makes the implicit assumption that labour markets are efficient and that the wage rates reflect marginal productivity. These problems in the use of aggregate level data have resulted in recent work using establishment and/or plant level data.

In the following empirical model we integrate the three key drivers into a Cobb-Douglas production function which is later employed as the basis for an empirical investigation into spatial differences of their impact on productivity across England, Wales and Scotland.

3. The Model

We assume, as very commonly used, a Cobb-Douglas production function in the form:

$$Y = AK^{\beta_1}L^{\beta_2} \quad (1)$$

where K is capital stock, Y gross value added at factor cost (GVAFC) and L is labour force. We divide both sides by L , take natural logs and then augment the model to include our selection of important explanatory variables, such that:

$$\ln\left(\frac{y}{l}\right)_i = \alpha + \beta_1 \ln k_i + \beta_2 \ln l_i + \beta_3 s_i + \beta_4 hk_a + \beta_5 ep_a + \beta_6 o_i + \beta_7 C + u_i \quad (2)$$

where $\ln\left(\frac{y}{l}\right)_i$ is the output per employee for each firm, i , and s is the sector in which the firm operates. A selection of other variables is included in our model and these relate to the policy related literature outlined above. Several are specific to the firm while others are specific to the area in which the firm is located and are conducive to policy formation: in addition to k_i and l_i which are the amount of capital and employment within the firm hk_a is the skill-base in the local authority area, a , in which the firm is located, ep_a is the economic potential in the same area, o_i is an indicator of private ownership, and u is an error term which we assume is

normally distributed and well-behaved. C is a set of dummy variables that is operative if the firm is located in England, Wales or Scotland respectively.

One potentially interesting area of research is to test whether the importance of the explanatory variables varies between England, Wales and Scotland. Initial estimates of (2) indicated that these dummies were significant and so we make two simultaneous changes: we exclude C and include compound variables that are comprised of hk , pd and o each with interaction dummy variables corresponding to either England, Wales or Scotland. Hence we estimate the following model:

$$\ln\left(\frac{y}{l}\right)_i = \alpha + \beta_1 \ln k_i + \beta_2 \ln k_i C + \beta_3 \ln l_i + \beta_4 \ln l_i C + \beta_5 s_i + \beta_6 s_i C + \beta_7 hk_a + \beta_8 hk_a C + \beta_9 \ln ep_a + \beta_{10} \ln ep_a C + \beta_{11} o_i + \beta_{12} o_i C + u_i \quad (3)$$

and do this three times, one estimation for each country. If there is no difference in the importance of the parameter estimates for the full sample and for the country specific areas for each policy related variable then the parameters on the explanatory variables compounded with English, Welsh or Scottish dummy variables should be insignificantly different from zero. The sign and magnitudes of these compound variable coefficients can indicate whether the policy related variable is likely to have a smaller or a larger effect relative to the full sample. In order to estimate the model we need to identify appropriate data.

4. Data

Factors influencing productivity ultimately act by influencing the operational performance of firms. Analysing business performance at the firm level overcomes the shortcomings of working with aggregate data, in particular by providing an unambiguous association between output and the workforce responsible for generating it. In the analysis below we use 2004 plant level data held by the Office of National Statistics in the Annual Respondents Database (ARD) which brings together a wide range of data relating to individual business units (ONS, 2002) and then merge in data from two sources: author generated area-specific variables and Census (2001) data for geographical areas.

One issue with the ARD is the level at which the data are collected: we use the plant. Different establishments have different numbers of plants and to control for this we employ a variable called $llunit$ which is the log of the number of plants within the establishment. If the establishment is a single plant establishment then this is equal to one. Plants are identified by postcode in the ARD and this allows the flexibility to consider the productivity determinants at various geographical levels from national down to local level (see Boddy *et al.*, 2005, for regional analyses and Boddy *et al.*, 2006, for sub-regional analyses). We use GVA at factor cost per employee as the measure of productivity.

In addition to variables on the number of employees and on ownership (public/private), labour characteristic variables need to be included in the estimations. This is done by using data on skill levels in the local authority district in which the plant is located, often seen as a key target for policy intervention at local, regional or national level. In line with some other analyses we combine Census education data to create three classifications: *High Skills* (the proportion of the labour force with NVQ 4 and above), *Medium Skills* (NVQ 1-3) and *Low Skills* (the proportion of the labour force with no certifications). These variables are

comprehensive and each should be interpreted relative to the default grouping: in this case we use *Medium Skills*. These variables are responsive to long term policy initiatives to improve educational attainment.

Data on plant-specific capital stock is obtainable from the ONS and is matched with plant specific data within the ARD. Although this is not identical to the Treasury investment productivity driver, it represents the result of past investment and is appropriate in modelling based on the Cobb-Douglas production function. Competition is proxied in our estimations by economic potential: *gravity*. This measures the potential interaction between one area and every other area in the set of areas, defined for each area, i , as the average (for all other areas) of $p_i * p_j / d_{ij}^2$, where p_i is the population at area i , p_j , that at area j , and d_{ij} is the distance between area i and area j . Population (p_i) is measured at the level of the administrative area in which each establishment is located; p_j is the population of every other administrative area in Great Britain; d_{ij} is represented by the straight-line distance between the centroids of each administrative area. This provides an index of economic potential for each administrative area, which is then linked to plants.

In this paper, the factors influencing productivity in England, Scotland and Wales are considered. This level of spatial aggregation is large enough to avoid distraction by regional diversity but small enough to be a realistic target for intervention.

5. Results

The results were generated using maximisation of the likelihood function by means of OLS estimation methods using STATA version 9.0 while the standard errors were adjusted for heteroskedasticity using White's methodology. Table 1 presents six columns of results; each column contains the explanatory regressors, a country dummy (which is equal to one if a plant is located in that country) and compound variables that seek to identify whether the explanatory variables have statistically different effects on the plants located in the respective countries. The estimation procedure is repeated using England, Wales and Scotland dummies respectively. Columns 1-3 are for the full sample; the results are re-estimated for a sub-sample of only single plant firms and these results are presented in columns 4-6. The purpose of this stability check is to identify whether there are any scale effects which could bias the results; qualitatively similar results are observable.

{Table 1 about here}

The model is based on the traditional Cobb-Douglas production function whereby output per employee is driven by employment and capital. In addition we include two important regressors: the first is *llunit* and corresponds to the number of units within the establishment. This is in accordance with much of the literature that employs this data set and it captures the effects of the establishment having more than one registered plant (local unit). The other important regressors which form the stem of the regressions correspond to the industry in which the establishment operates: seven sector dummies are operational in each regression plus an industry control variable which corresponds to plants operating in all other sectors.

It is of immediate interest that the magnitude and sign of many of the policy related explanatory variables remain similar across columns. All of the explanatory variables have the expected sign and some are statistically significant at least at the 5% level. Plants with greater amounts of capital have higher rates of productivity per employee. Plants in areas with a large proportion of the workforce with high-range skills are more productive than those

located in areas with larger proportions of medium skills. Those plants in areas with a large proportion of low-level skills are less productive. Plants located in areas which have greater economic potential have higher rates of productivity per employee – suggesting that population scale effects, proximity to markets and the positive benefits of clustering are positively correlated with business performance. Privately owned plants are more productive than non-privately owned plants.

Plants operating in the *Hotel and catering* sector have the lowest level of productivity per employee while plants operating in the *construction* sector have the highest level of productivity per employee once all other effects have been taken into account. *Real estate* plants also have quite high productivity per employee.

In summary, these results suggest that policy should be geared around increasing the plants' capita stocks, raising the educational background of the local labour force (enhancing the skill levels of the workers with medium skills to high skills as well as educating those workers with no qualifications), stimulating greater agglomeration and encouraging private ownership. Of course it might have been the case that the entrepreneur considered economic potential when the decision was made on the location for production, in which case it is entirely possible that the producer solved the logistics-cost location production problem (McCann, 1993). With respect to the size of the plants work force, it should be considered that labour deepening might have repercussions for future productivity gains and this should be a focus for policy makers. Many of these are in line with the recommendations by the HM Treasury as discussed above.

On particular interest in this paper, however, is whether the enhancing effect of such policy would differ across the countries of Britain. To facilitate this analysis compound variables (e.g. *High skills – Wales*) are included in the statistical analysis, as outlined in section 3. In this part of the analysis we follow each country individually. It is the sum of the coefficients for each policy related variable that indicate if the effect could be smaller or larger for that area. The LR test for collective variable deletion of the composite variables are all statistically significant suggesting that collectively they significantly improve the model, indicating that there may well be important differences between these economies which should be the target of appropriate policy formation.

According to Table 1, greater levels of plant-specific capital stock have a larger effect on productivity per employee in England than for plants located in Wales and Scotland. This may well be due to the industrial structure of England. These results also indicate that *wholesale and retail* plants located in England are more productive than the average plant, a similar effect is observable for plants in Wales. However, it appears that plants in English areas may suffer from high proportions of the local population with no qualifications; this effect is not identified for either Wales or Scotland.

Plants located in Wales appear to be significantly less adversely affected by the lack of *capital stock*; this does not suggest that plants in Wales would not have higher levels of labour productivity – they would – but this effect is smaller for plants in Wales than for plants in England or Scotland. These results suggest that there may be asymmetries in the decision to invest in capital across countries and that policy should reflect these issues. Such results have ramifications for supply-side policy associated with labour migration, investments in labour forces, capital market imperfections, and research and development.

This results stand even after the industrial composition has been taken into account. However the industrial structure appears be significantly different in Wales than in the rest of Britain. More *manufacturing* firms would actually increase the average level of labour productivity in Wales, an effect that is not observed for England or Scotland. The same observation can be made for *transport*. For Wales, the enhancing effect of *real estate* plants

on average productivity per employee is much larger while the diminishing effect of plants in the *hotel and catering* sector is smaller.

Scotland based plants would benefit from policies to enhance labour force skill backgrounds, workforce size (in terms of employees) and agglomeration in the same way as plants located in England and Wales. However, it appears that plants operating in the *transport, manufacturing* and *wholesale and retail* sectors reduce the observable labour productivity for Scotland; at the same time the enhancing effect of plants operating in the *real estate* sector is smaller.

Of interest here are the coefficients for the dummy variables representing the geographical areas of England, Wales and Scotland. We find that the productivity per employee across plants in England is lower than in the rest of Great Britain; something similar cannot be said for plants in Wales and Scotland with a high level of statistical confidence. The reason for this is worthy of further research but it may be due to the much larger economy of England relative to Scotland and Wales.

6. Conclusion

The purpose of this paper was to investigate whether a) productivity differences exist across the constituent countries of Great Britain, b) productivity per employee is enhanced by the specific policy drivers related to skills, investment and competition and c) the importance of these drivers varies across the three countries. The findings were emphasised as being important because they can contribute to the debate on the extent to which different countries should shape their policies around the HM Treasury's productivity drivers and whether each country should focus more or less on each specific policy area.

The results suggest that, in general, these variables have similar effects across the three countries. However, there is tentative evidence to suggest that the effect of certain policies is likely to be greater in one country than in another. The results have ramifications for supply-side policy associated with labour migration, investments in labour forces, capital market imperfections, and research and development.

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Table 1: Regression results

	Full Sample			Single plant firms only		
	1 – England	2 – Wales	3 – Scotland	4 – England	5 – Wales	6 – Scotland
England	-0.994** (0.485)	–	–	-0.369 (0.569)	–	–
Wales	–	-0.010 (0.911)	–	–	-0.983 (1.031)	–
Scotland	–	–	0.816 (0.603)	–	–	0.340 (0.704)
Employment	-0.524 (0.016)***	-0.513 (0.007)***	-0.512 (0.007)***	-0.347 (0.019)***	-0.338 (0.010)***	-0.334 (0.010)***
Employment * Country	0.012 (0.017)	-0.012 (0.022)	-0.008 (0.022)	0.013 (0.022)	0.015 (0.028)	-0.015 (0.027)
Capital	0.439 (0.013)***	0.465 (0.006)***	0.463 (0.006)***	0.317 (0.017)***	0.349 (0.008)***	0.348 (0.008)***
Capital * Country	0.027 (0.015)*	-0.046 (0.018)**	-0.020 (0.019)	0.034 (0.019)*	-0.057 (0.022)***	-0.026 (0.024)
High skills	0.235 (0.119)**	0.108 (0.043)**	0.035 (0.049)	0.127 (0.138)	0.135 (0.051)***	0.064 (0.059)
High skills * Country	-0.196 (0.130)	-0.061 (0.238)	0.144 (0.173)	-0.037 (0.152)	-0.272 (0.271)	-0.008 (0.197)
Medium skills	<i>Control Variable</i>					
Low skills	0.152 (0.185)	-0.145 (0.061)**	-0.258 (0.070)***	0.038 (0.217)	-0.179 (0.073)**	-0.303 (0.084)***
Low skills * Country	-0.408 (0.200)**	0.202 (0.357)	0.267 (0.253)	-0.307 (0.236)	-0.019 (0.413)	0.204 (0.293)
Gravity	0.046 (0.021)**	0.036 (0.009)***	0.047 (0.010)***	0.050 (0.025)**	0.033 (0.011)***	0.047 (0.012)***
Gravity * Country	-0.001 (0.024)	0.041 (0.047)	-0.001 (0.026)	-0.009 (0.028)	0.065 (0.052)	0.001 (0.031)
Private	0.527 (0.086)***	0.476 (0.040)***	0.464 (0.040)***	0.973 (0.119)***	0.584 (0.053)***	0.563 (0.054)***
Private * Country	-0.061 (0.096)	-0.012 (0.123)	0.087 (0.127)	-0.443 (0.132)***	0.270 (0.175)	0.423 (0.175)**
Manufacturing	-0.215 (0.062)***	-0.209 (0.029)***	-0.154 (0.030)***	-0.257 (0.073)***	-0.179 (0.034)***	-0.113 (0.035)***
Manufacturing * Country	0.040 (0.070)	0.347 (0.096)***	-0.247 (0.085)***	0.125 (0.082)	0.288 (0.121)**	-0.314 (0.097)***
Construction	0.235 (0.067)***	0.210 (0.031)***	0.208 (0.032)***	0.100 (0.074)	0.232 (0.035)***	0.257 (0.036)***
Construction * Country	-0.027 (0.075)	0.054 (0.112)	0.034 (0.089)	0.163 (0.083)**	-0.022 (0.131)	-0.142 (0.096)
Wholesale and Retail	-0.154 (0.063)**	-0.023 (0.028)	0.030 (0.029)	-0.272 (0.074)***	0.007 (0.034)	0.084 (0.035)**
Wholesale and Retail * Country	0.173 (0.070)**	0.191 (0.098)*	-0.331 (0.085)***	0.352 (0.083)***	0.146 (0.126)*	-0.518 (0.097)***
Hotels and Catering	-1.150 (0.069)***	-1.148 (0.035)***	-1.113 (0.035)***	-1.156 (0.079)***	-1.001 (0.041)***	-0.947 (0.040)***
Hotels and Catering * Country	0.023 (0.079)	0.259 (0.103)**	-0.141 (0.102)	0.210 (0.090)**	0.163 (0.124)	-0.323 (0.115)***
Transport	-0.169 (0.071)**	-0.224 (0.039)***	-0.162 (0.040)***	-0.292 (0.081)***	-0.195 (0.046)***	-0.122 (0.047)***
Transport * Country	-0.028 (0.083)	0.462 (0.107)***	-0.216 (0.103)**	0.148 (0.095)	0.321 (0.127)**	-0.352 (0.117)***
Real Estate	0.179 (0.064)***	0.220 (0.030)***	0.267 (0.030)***	0.009 (0.076)	0.172 (0.036)***	0.227 (0.036)***
Real Estate * Country	0.072 (0.071)	0.253 (0.097)***	-0.237 (0.090)***	0.214 (0.085)**	0.116 (0.125)	-0.338 (0.103)***
Social Work	-0.381 (0.067)***	-0.411 (0.043)***	-0.353 (0.037)***	-0.560 (0.072)***	-0.431 (0.053)***	-0.370 (0.044)***
Social Work * Country	-0.007 (0.080)	0.292 (0.099)***	-0.142 (0.186)	0.178 (0.090)**	0.171 (0.123)	-0.363 (0.157)**
Other sectors	<i>Control variable</i>					
Llunit	0.678 (0.023)***	0.614 (0.009)***	0.610 (0.009)***	–	–	–
Llunit * Country	-0.072 (0.025)***	0.050 (0.029)*	0.080 (0.035)**	–	–	–
R ²	0.685	0.685	0.685	0.252	0.251	0.252
F test	1688.71***	1704.36***	1690.66***	154.22***	156.27***	148.60***
LR test for collective variable deletion of composite variables	2.58***	3.09**	3.37***	3.58***	2.98***	4.04***

Notes: In all cases, the dependent variable is *labprod* and regressions have robust standard errors. The full sample regressions contain 24060 observations while the single plant firm regressions have 16510 observations. Values in parentheses are standard errors. *, ** and *** signify significance at the 10%, 5% and 1% level respectively. Constants omitted. Source: ONS.