Country-level Business Performance and Policy Asymmetries in Great Britain

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Abstract:

The 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 business-level productivity per employee across England, Scotland and Wales in order to identify whether spatial differences in the influence of these drivers exist.

We adopt the Cobb-Douglas production function approach and our results suggest that, after taking account of sector specific effects, productivity differentials do exist between businesses across Great Britain and that policy instruments do potentially enhance productivity. The results indicate that these key drivers are equally applicable across countries of Great Britain. However, there is evidence to suggest that scale effects for labour and capital do differ across England, Wales and Scotland and that policy makers should be aware of these asymmetries.

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Keywords: Productivity per employee; HM Treasury's key drivers; scale effects

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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, 2002, 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. By adopting the traditional Cobb-Douglas production function technique and employing firm-level data, we are also able to identify whether the importance of labour and capital scale effects vary across England, Scotland and Wales. Such identification would also be vital policy formation as it highlights whether firms use relatively more labour or capital in their production processes and whether further constituent country specific policies should be employed.

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 emphasis 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.

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. Furthermore, trip-distance is likely to be highly correlated with the degree of competition that the firm will face in the market.

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 travel time 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).

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 available. Pubic and private sector R&D expenditure is seen to have little explanatory power in accounting for firm 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 new firms is associated with new technologies, innovative working and increased competitive pressure on other firms. VAT registrations are often used to represent enterprise resulting in 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. It is difficult to see, however, how a relevant business-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 (see for example Gripaios *et al*., 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, of course 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 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:

$$Y = AK^{\beta 1}L^{\beta 2} \tag{1}$$

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:

$$\ln\left(\frac{y}{l}\right)_i = \alpha + \beta_1 \ln k_i + \beta_2 \ln l_i + \beta_3 s_i + \beta_4 hk_i + \beta_5 hk_a + \beta_6 pd_a + \beta_7 d_a + \beta_8 C + u_i \tag{2}$$

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 therefore conducive to policy formation: in addition to k_i and l_i which are the amount of capital and employment within the firm, hk_i is the ratio of full-time to part-time employees in the firm while hk_a is the skill-base in the local authority area, *a*, in which the firm is located, pd_a is the population density in the same area, d_a is the distance to the core of the market, an indicator of competition and peripherality, and *u* is an error term which we assume is normally distributed and well-behaved. *C* is a set of two dummy variables that are operative if the firm is located in either 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. To test whether this is the case, i.e. that $\beta_{England} = \beta_{Wales} = \beta_{Scotland}$ for each β, we initially estimate model (2) and then make two simultaneous changes: we exclude *C* and include compound variables that are comprised of *hk*, *pd* and *d* each with interaction dummy variables corresponding to either Wales or Scotland. Hence we estimate the following model:

$$\begin{aligned}
\ln\left(\frac{y}{l}\right)_i &= \alpha + \beta_{1a}\ln k_i + \beta_{1b}\ln k_i W + \beta_{1c}\ln k_i S \\
&+ \beta_{2a}\ln l_i + \beta_{2b}\ln l_i W + \beta_{2c}\ln l_i S \\
&+ \beta_{3a}s_i + \beta_{3b}s_i W + \beta_{3c}s_i S \\
&+ \beta_{4a}hk_i + \beta_{4b}hk_i W + \beta_{4c}hk_i S \\
&+ \beta_{5a}hk_a + \beta_{5b}hk_a W + \beta_{5c}hk_a S \\
&+ \beta_{6a}pd_a + \beta_{6b}pd_a W + \beta_{6c}pd_a S \\
&+ \beta_{7a}d_a + \beta_{7b}d_a W + \beta_{7c}d_a S + u_i
\end{aligned} \tag{4}$$

where *W* and *S* correspond to Welsh and Scottish dummies respectively and subscript *a*, *b* and *c* indicate that separate estimates of each β generated to correspond to each geographical area. 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 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 the establishment 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 distance observations and Census (2001) data for geographical areas.

One issue with the ARD is the level at which the data are collected: we use the establishment. However, 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. Firms 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 and district council level analyses). We use GVA per employee as the measure of productivity.

In addition to variables on the number of employees, labour characteristic variables need to be included in the estimations. This is done in two forms: first, the ratio of full-time to part-time employees (full-time ratio), and second, skill levels in the local authority district in which the business is located, often seen as a key target for policy intervention at local, regional or national level. In line with some other analyses (Boddy *et al*., 2005; Rice and Venables, 2004) we combine Census education data to create two classifications: *High Skills* (the proportion of the labour force with NVQ 4 and above) and *Medium Skills* (NVQ 1-3). These variables should be interpreted relative to the default grouping, which is the proportion of the population in the local authority district that has no formal qualifications. These variables are responsive to long term policy initiatives to improve educational attainment.

Data on firm-specific capital stock is obtainable from the ONS and is matched with firm 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 two important area-specific variables: *population density* and *average time*. Infrastructure investments facilitate the movement of goods and people and help to overcome the disadvantages of peripherality. The distance in time to relevant urban centres is likely to influence productivity[1] and thus a location-specific variable (*average time*) is used which reflects the level of past infrastructure investment. This is the average travel time from the area in which the firm is located to central Birmingham, Manchester, Leeds, London, Bristol and Glasgow by road. Again, this variable is responsive to long term policy initiatives, in this case programmes to improve transport infrastructure. Clearly the longer the period of time it takes to move goods to the location of consumption or intermediate productive use then the greater will be the incurred transportation costs and the less competitive the firm will be in the market place.

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

Analyses involved maximisation of the likelihood function for each estimation by means of OLS estimation methods using STATA version 9.0 and all standard errors were corrected for heteroskedasticity using White's methodology. The regression results are reported in Table 1. In each regression the number of firms is equal to 29820.

The first set of results correspond to firms across all three countries within Great Britain: England, Scotland and Wales. The model is based on the traditional Cobb-Douglas

[1] In earlier analyses we did employ a distance-in-miles proxy, but this performed relatively poorly.

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 having more than one registered part of the production process, be it a plant in a different location or a different sub-section of the establishment which might be located on the same geographical site. The other important regressors which form the stem of the regression correspond to the industry in which the establishment operates: nine sector dummies are operational in each regression and the industry control variable corresponds to firms operating in all other sectors. We now turn to the results of the policy related variables.

The first thing to note is that all of the explanatory variables have the expected sign and are statistically significant at at least the 5% level. Firms with greater amounts of capital have higher rates of productivity per employee; firms with full-time ratios closer to 100% are also more productive. In part this simply reflects that fact that businesses with more full-time employees have higher levels of labour inputs and hence higher levels of output (other things equal). It may also reflect findings produced elsewhere that full-time employees are more efficient – producing more per hour worked than part-time employees. Businesses in areas with a higher proportion of the workforce with middle-range skills are more productive. Those in areas with a high proportion of high-level skills are even more productive. Firms located in areas which have greater population densities have higher rates of productivity per employee – suggesting that scale effects, proximity to markets and the positive benefits of clustering are positively correlated with business performance. The negative sign on *average time* is as we would expect: increasing distance to the core markets decreases the level of competitiveness for the firm whilst also insulating it from the effects of competition from firms located nearer the core of the market.

Of importance here are the coefficients for the dummy variables for Wales and Scotland. Once we have taken into account the number of employees in the firm, the amount of capital within the firm, the industry in which the firm operates, the number of plants in the firm and the other policy related variables, we find that the productivity per employee is lower in Wales by 6.6% and higher in Scotland by 12.3% (both relative to firms located in England). With this statistically significant difference in productivity per employee in mind, the regressions are reestimated in accordance with equation (2) in an attempt to identify whether policy relevant variables and labour and capital vary across firms located in England, Wales and Scotland. These results are presented in columns 2 and 3.

It is of immediate interest that the magnitude and the statistical significance of the policy related explanatory variables remain similar to those presented in column 1 after the inclusion of the compound variables. The compound variables (e.g. *Middle skills – Wales*) are all insignificantly different from zero thereby suggesting that the effects of policy in these areas are unlikely to have different effects across the three countries within Great Britain. Nevertheless, also of interest is the sum of the coefficients for each policy related variable as these would indicate if the effect could be smaller or larger for that area. Some of these are worthy of further comment. First, the coefficients for average time indicate that the greater the distance from the core of the market then the lower will be the productivity per employee, and that this effect might be greater for firms in Wales than for firms in England; firms in Scotland might suffer even more. Of course it might have been the case that the entrepreneur considered distance 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).

Second, if a Welsh firm is located in an area with workers with more *middle skills* then this doesn't benefit the firm. This conclusion can be made as the sum of the *middle skills* coefficient for the whole sample and for Wales is equal to zero. Note however that the effect of higher skills is likely to be positive for firms in Wales but that this effect is likely to be smaller than for firms in the rest of the sample. Further research is necessary to identify whether firms in Wales are constrained by a lack of availability of local skilled labour or whether commuting is affecting these results.

Third, in contrast if a Scottish firm is located in an area with workers with more middle and/or higher skills then this actually has a negative effect on employee productivity (a conclusion that can be made when we add the coefficients for the *middle skills* to that of *middle skills - Scotland*). This is an intriguing result. This might be because the spatial areas for Census data are much larger in Scotland than they are for England and Wales, and so the effect of locating in a middle- or high-skill area is likely to be diluted.

Finally, the effect of employment and capital on productivity per employee is also of interest as it can aid policy formation if interventions are contemplated which subsidise worker recruitment or capital deepening. In the results presented in column 1 it appears that Scottish firms are more productive, but this is likely to be because Scottish firms are smaller: as well as being smaller overall, Scottish firms appear to have a proportionally greater workforce and a proportionally smaller amount of capital. This is affecting the results and making the Scottish firms appear to be more productive. But is should be considered that labour deepening might have repercussions for future productivity gains and this should be a focus for policy makers.

We also have evidence of diminishing economies of scale of for the whole sample (0.974). Diminishing economies to scale also exist for Wales (0.970), although the effect is smaller for the labour input into the production process and greater for the capital input when compared to Scottish firms. Welsh firms are also more labour intensive and less capital intensive than the average firm; Scottish firms are even more extreme with respect to labour and capital when compared to their English counterparts.

There are diminishing economies to scale which are stronger for Scotland (0.951), although again this is less so for the labour input and much more so for the capital input into the productive process. Hence capital diseconomies are having a greater effect on employee productivity, suggesting capital is less effective in Scotland. This could be because there are not enough skilled workers to use capital effectively, which points towards a policy of investing more in education or a policy to discourage the out-migration of skilled workers from Scotland.

These results suggest that there may be asymmetries in the decision to invest in either capital or labour and that policy should reflect these issues. Scottish firms appear to be constrained in their ability to grow because of a lack of capital and effective labour force. Such results have ramifications for supply-side policy associated with labour migration, investments in labour forces, capital market imperfections, and research and development.

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 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.

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. Of particular interest are the observations that the enhancing effect of education might be smaller in Wales and Scotland and that differences in the diminishing economies to scale might also exist across firms across England, Scotland and Wales.

These results are found to be driven by differences in the importance of labour and capital across England, Welsh and Scottish firms. The results suggest that asymmetries in policy formation are of significance in policy terms. This is particularly the case in Wales, where the results suggest that although policy should encourage firms to be more capital intensive the negative effect of having too much labour in the production process is less of a problem. In contrast, in Scotland policy should encourage firms to be more capital intensive. These 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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	1 *(pooling all firms)*	2 *(includes Wales dummies)*	3 *(includes Scotland dummies)*
Wales	-0.066 (0.016)**	–	–
Scotland	0.123 (0.057)*	–	–
Employment	-0.320 (0.006)**	-0.323 (0.006)**	-0.321 (0.006)**
Employment – Wales	–	0.043 (0.022)*	–
Employment – Scotland	–	–	0.052 (0.057)
Capital	0.294 (0.005)**	0.297 (0.005)**	0.295 (0.005)**
Capital – Wales	–	-0.047 (0.014)**	–
Capital – Scotland	–	–	-0.085 (0.042)*
Full time ratio	0.350 (0.010)**	0.349 (0.011)**	0.349 (0.010)**
Full time ratio – Wales	–	0.023 (0.027)	–
Full time ratio – Scotland	–	–	0.173 (0.123)
Middle skills	0.239 (0.053)**	0.259 (0.054)**	0.279 (0.051)**
Middle skills – Wales	–	-0.280 (0.285)	–
Middle skills – Scotland	–	–	-1.406 (2.398)
High skills	0.140 (0.015)**	0.150 (0.016)**	0.137 (0.015)**
High skills – Wales	–	-0.056 (0.070)	–
High skills – Scotland	–	–	-0.616 (0.458)
Population Density	0.015 (0.004)**	0.014 (0.004)**	0.017 (0.004)**
Population Density – Wales	–	-0.004 (0.013)	–
Population Density – Scotland	–	–	0.368 (0.324)
Average time	-0.075 (0.008)**	-0.072 (0.008)**	-0.084 (0.008)**
Average time – Wales	–	-0.043 (0.039)	–
Average time – Scotland	–	–	-0.144 (0.258)
Llunit	-0.003 (0.006)	-0.004 (0.006)	-0.001 (0.006)
Construction	0.675 (0.035)**	0.675 (0.035)**	0.674 (0.035)**
Wholesale/Retail	0.573 (0.032)**	0.575 (0.032)**	0.573 (0.032)**
Catering	-0.216 (0.036)**	-0.212 (0.036)**	-0.223 (0.036)**
Transport	0.404 (0.036)**	0.406 (0.036)**	0.401 (0.036)**
Real Estate	0.560 (0.032)**	0.561 (0.032)**	0.557 (0.032)**
Social Work	0.161 (0.036)**	0.156 (0.036)**	0.151 (0.035)**
Community	0.227 (0.037)**	0.228 (0.037)**	0.225 (0.037)**
Mining and Power	0.380 (0.075)**	0.382 (0.075)**	0.385 (0.075)**
Manufacturing	0.312 (0.032)**	0.315 (0.032)**	0.312 (0.032)**
Ramsey Reset	42.54**	40.35**	40.37**
R^2	0.365	0.365	0.365
F test	704.22**	565.88**	553.17**

Notes: In all cases, the dependent variable is *lgvapc*. All regressions have robust standard errors and 29820 observations. Values in parentheses are standard errors. * and ** signify significance at the 5% and 1% level respectively. Constants omitted as per ONS requirements. Source: ONS.