Drivers of Output Growth in UK Regions and Cities: Empirical Evidence Using Micro-Datasets

By

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Introduction

I would firstly like to thank the organisers of this Colloquium for the invitation to come and speak to you on this topic. As I believe is customary, this provides me with a licence to roam far and wide; and let my own predilections and biases take centre stage. I shall do all of these things; but on a more serious note, I also want to set out where I think particularly applied economists and economic geographers should at least in part concentrate some of their research efforts to provide a greater understanding of what indeed are the drivers of output growth at the spatial level. Or even if what I say is not seen by many as part of the research agenda, then in any event it is an agenda that I have been moving towards (and indeed working on) for a number of years now, as hopefully will become evident as I proceed.

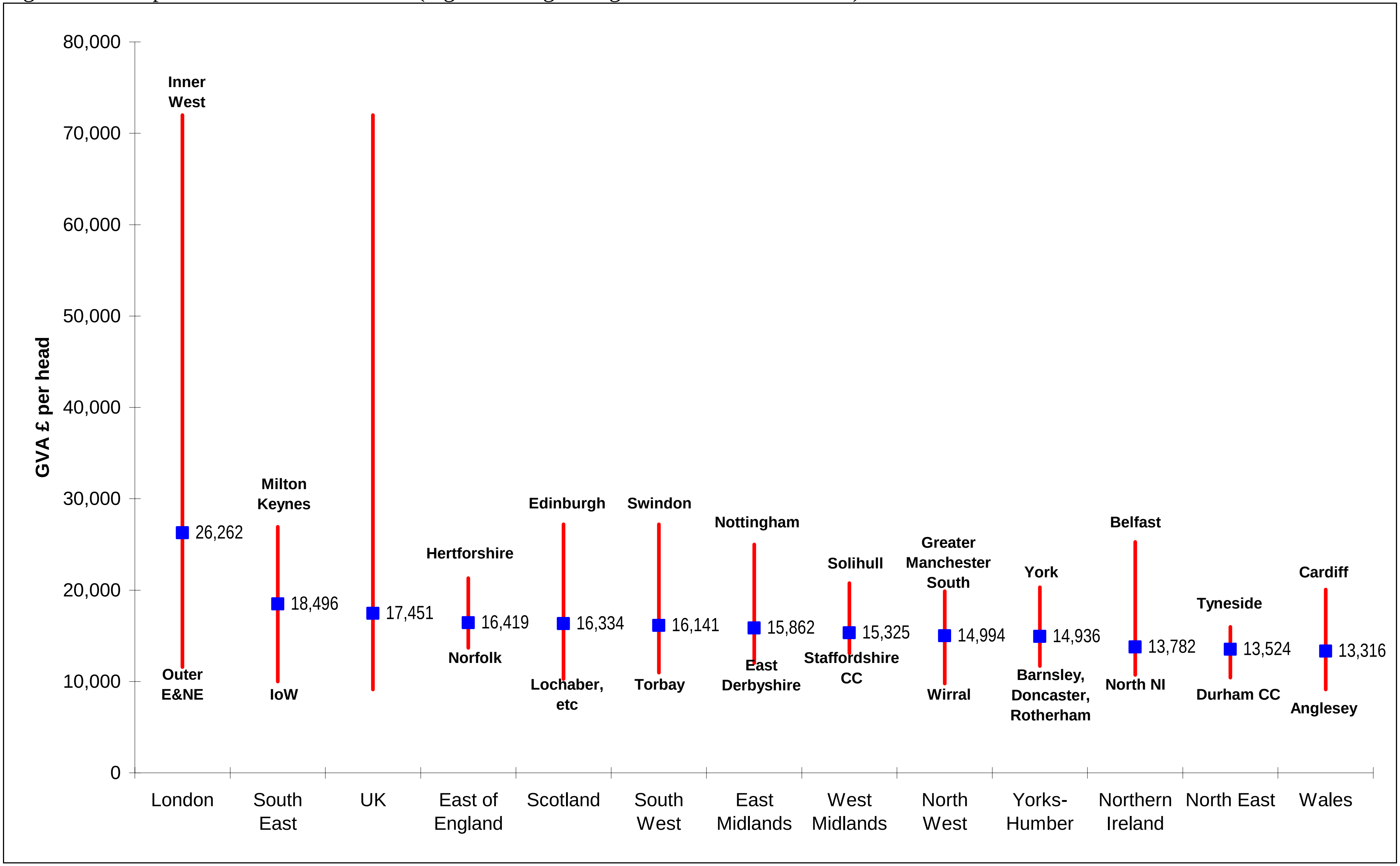
I shall start with a brief overview of spatial disparities in the UK before setting out some of the theoretical underpinning for this topic. This approach leads to a more rigorous framework within which can be placed the various elements or drivers of growth that ought to be considered as relevant candidates; it also makes explicit the structure of the model being considered, the complexity of the endogenous relationships involved, and the hypotheses to be tested. Overall, I think it is surprising that when the theory and empirical evidence is collated it appears that we know much less than we ought, particularly in terms of the relative importance of the demand- and supply-side drivers of growth.

Spatial Differentials in GVA and Productivity

The next few diagrams provide a quick overview of differences in regional and sub-regional GVA per head of population, with the expected patterns of significant spatial variations which tend to persist over time. Figure 1 presents data for 2004 by Government Office region, along with the range of GVA per head at the NUTS3 level. London has much the highest level of GVA per head (over 50% higher than the UK average), but this is significantly skewed because of GVA in the Inner West area of London. Indeed, the 'poorest' area identified for London (Outer East and North East) had a GVA per head level 34% below the UK average (slightly worse than the 'West and South of Northern Ireland' or 'East Merseyside'). Figure 1 also shows that within each region it is generally the major city that dominates in terms of GVA per head; for example, in 2004 Edinburgh ranks 3rd highest among all NUTS3 areas (at 56% above the national average), while Belfast ranked 6th (at 45% above the UK average).

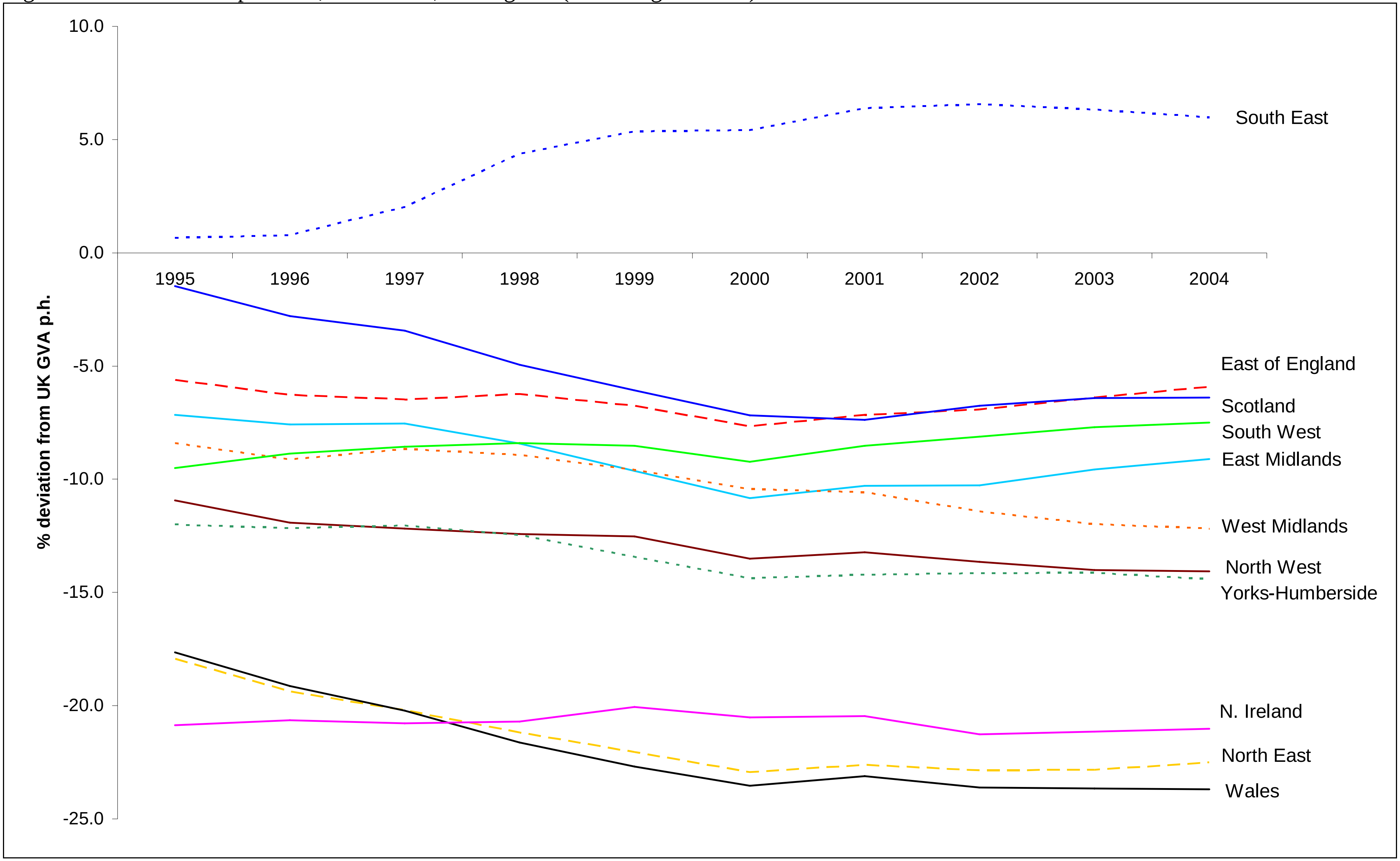
As to changes over time, Figure 2 presents GVA per head data for regions (relative to the UK), although it excludes London which on average was 48% higher than the national average during this period (and on an upward trend). As can be seen, apart from the South East there is evidence that all other regions were loosing ground although relative GVA per head steadied after 2000. Regions like Wales, the North East and Northern Ireland appear to be significantly adrift when compared to other regions (at around 21% below the UK average).

Figure 1: GVA per head in 2004 in the UK (region average + highest/lowest NUTS3 area)



Source: ONS Regional Accounts

Figure 2: Relative GVA per head, 1995-2004, UK regions (excluding London[a])



[a] GVA per head in London was on 48% higher than the UK average (and on a slight upward trend) Source: ONS Regional Accounts

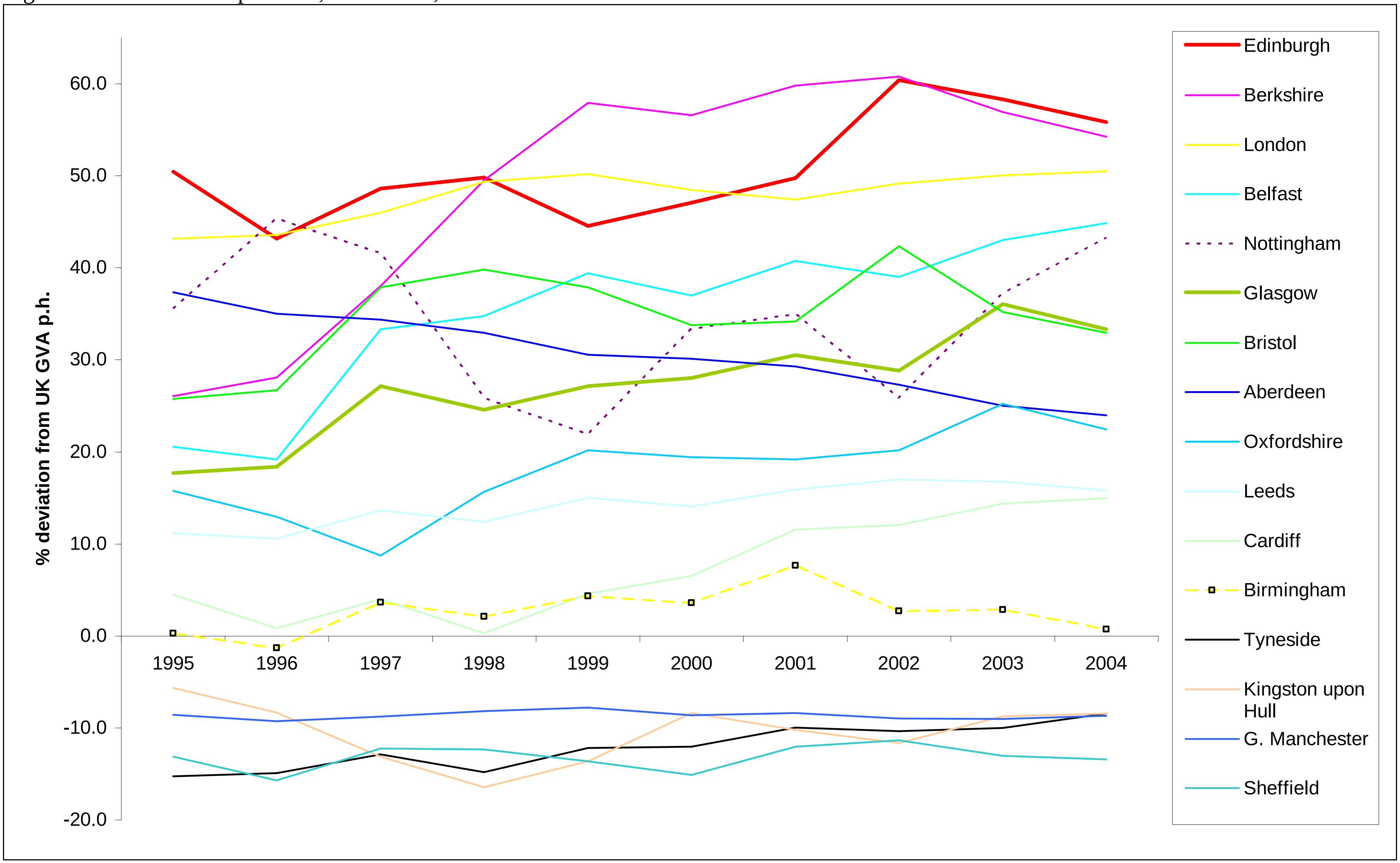
The picture is somewhat different if we consider relative GVA per head for (mostly) cities (Figure 3). Since 2000, Edinburgh has enjoyed a higher level than Greater London. Many of the cities identified are significantly above the UK average and there is evidence that overall they are tending to grow at a faster rate than the UK (a major exception being Aberdeen, presumably as the oil and gas sector contracts). In contrast, major cities of Northern England are not doing as well (e.g. Greater Manchester, Sheffield and Tyneside – although the latter has slowly moved towards the UK average from 15.3% below the UK average in 1995 to 8.4% below in 2004).

There are certain issues when comparing GVA per head figures, not least of which the estimates of GVA are workplace-based while population is residence-based and also includes the not economically active population. Thus, cities with high levels of cross-boundary commuting tend to have higher GVA per head estimates (the most obvious example being 'Inner London West').

A more accurate estimate of differences across sub-regional areas is to use the plant level data available in the ARD which is collected and administered by the ONS. Here the numerator is GVA at the workplace, while the denominator is the number of workers employed in that workplace. I have aggregated up this data for 2004 using the old NUTS3 sub-regions (i.e. the pre-1998 ONS areas which mostly referred to counties and metropolitan areas). At the same time, it is possible to apply the 'shift-share' technique and attribute labour productivity differences to the impact of the 'industry mix' of the sub-region (here I use some 56 2-digit industry groups), and that which is due to all other factors (which is labelled 'space' in Figure 4). As can be seen, the Grampian region (dominated by Aberdeen) comes out at the top of the rankings in Figure 4 (with productivity of some £40.3 thousand above the UK average), but this is due entirely to this area being dominated by the oil and gas industry which has very high levels of labour productivity. Most of the other sub-regions identified have differentials that are dominated by 'space' effects; such effects place areas like the metropolitan areas of Yorkshire, as well as Merseyside and Tyneside below the UK average. In comparison, Lothian (dominated by Edinburgh) and Buckinghamshire (with Milton Keynes) have large and positive 'space' effects that place their labour productivity levels some way above the UK average.

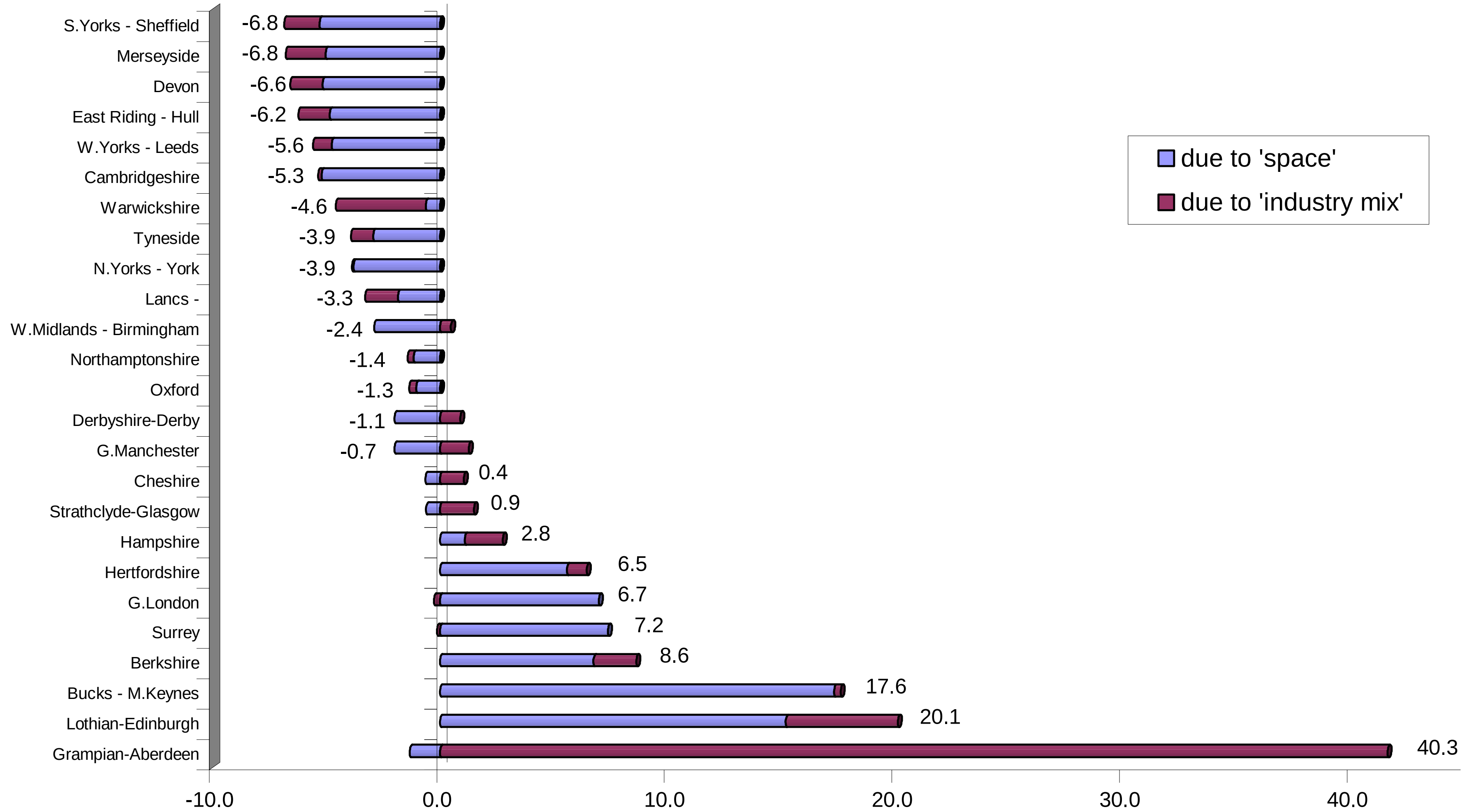
Given the differences between the results for GVA per head based on the ONS Regional Accounts data, and the estimates for workplace labour productivity produced by the ARD, it is possible to conclude that in order to compare and understand differences in output growth in UK regions and cities, the use of micro-based data from the ARD is preferable.

Figure 3: Relative GVA per head, 1995-2004, certain cities



Source: ONS Regional Accounts

Figure 4: £'000 difference in NUTS3[a] labour productivity compared to GB*, 2004



* Great Britain GVA per employee in 2004 was £31,750

[a] Pre-1997 definitions of NUTS3 areas (mostly equate to counties)

Source: special tabulation using the ARD

The Model

The basic model I'll use here is the Dixon and Thirlwall (1975) formalisation of Kaldor's (1970) model of regional growth. It contains both demand- and supply-side elements that we would want to include; it encapsulates disequilibrium models with increasing returns-to-scale, cumulative causation (and thus path dependency), as well as endogenous technological change. Thus the literature from Mydral, Hirschmann, Krugman and Romer are all, to some extent, taken onboard. Although the Kaldor-Dixon-Thirlwall approach emphasises the key role of the exogenous growth of demand as ultimately driving output growth and productivity, this is not to the exclusion of the supply-side. As with any theory, ultimately whether the demand- or supply-side dominates – if indeed one-side does dominate – is an empirical matter.

Since regional economies are very "open", the major source of exogenous demand is exports. With regard to Scotland, Table 1 shows how dependent is the region on external demand for goods and services:

Table 1: Final demand in Scotland, 1979 and 2003 (£m 2003 prices)

	2003		1979[a]	
	£m	%	£m	%
Consumption	54,893	69.9	33,481	64.7
Investment	12,426	15.8	11,653	22.5
Net Government spending	21,488	27.4	11,317	21.9
$Exports^{uk}$	29,778	37.9	23,396	45.2
$Exports^{w}$	15,338	19.5	18,898	36.5
$Imports^{uk}$	-35,927	-45.8	-34,278	-66.3
$Imports^{w}$	-19,492	-24.8	-12,751	-24.7
GVA (basic prices)	78,503	100.0	51,716	100.0

[a] Deflated using UK implied GDP deflator   Source: calculations based on Scottish I-O tables

Export-led growth is usually presented within the context of Harrod's foreign-trade multiplier, viz:

$$\frac{dY}{Y} = ka_x \frac{dX}{X} \qquad \Rightarrow \qquad \dot{y} = \gamma(\dot{x}) \tag{1}$$

where Y and X denote GDP and exports (in real terms), respectively, a_x is the share in total GDP of exports, and k is the export-base multiplier. If exports are a constant proportion of GDP, then ka_x can be replaced by $\gamma = 1$, the constant elasticity of output growth with respect to exports. Since there are other potentially important sources of autonomous demand (other than exports), Harrod's model is linked with Hick's (1950) super-multiplier which states that other autonomous expenditures in the region are subject to an "accelerator" effect through the growth of exports, so in the long-run the rate of growth of autonomous demand will adjust to the rate of growth of exports. Thirlwall (1980) later on modified this approach to include a balance-of-payments constraint to long-run regional growth; in effect an increase in exports will allow other autonomous expenditures to increase because it is the *only* element of demand that simultaneously relaxes the balance-of-payments constraint.

So what determines exports? The export demand function is written as:

$$X_t = P_{dt}^{\eta} \overline{P}_{ft}^{\delta} \overline{Z}_t^{\varepsilon} \qquad \text{or} \qquad \dot{x} = \eta(\dot{p}_d) + \delta(\dot{\overline{p}}_f) + \varepsilon(\dot{\overline{z}}) \tag{2}$$

where P_d is the domestic export price; P_f is the competitor's price; Z is the level of 'world' income'; and η,δ, and ε are the price, cross-price, and income elasticities of demand for exports, respectively. The 'bar' over a variable denotes it is taken to be exogenous to the region. In a 'world' of interdependent regions this is clearly a simplification.

The export pricing equation is set-out as:

$$P_{dt} = \left(\frac{\overline{W}}{R}\right)_t \overline{T}_t \qquad \text{or} \qquad \dot{p}_d = \dot{\overline{w}} - \dot{r} + \dot{\overline{\tau}} \tag{3}$$

where W is the level of money wages (which are assumed to be pegged to 'nationally' bargained rates); R is the average product of labour in the export sector (hence $\dot{r}$ is the growth of labour productivity); and T is 1 + % mark-up on unit labour costs (it being assumed that the mark-up is exogenously determined in a Cournot-type model of inter-firm dependencies).

Lastly, the model is closed via the Verdoorn relationship and assuming γ=1:

$$\dot{r} = \dot{\overline{r}}_a + \lambda(\dot{y}) \tag{4}$$

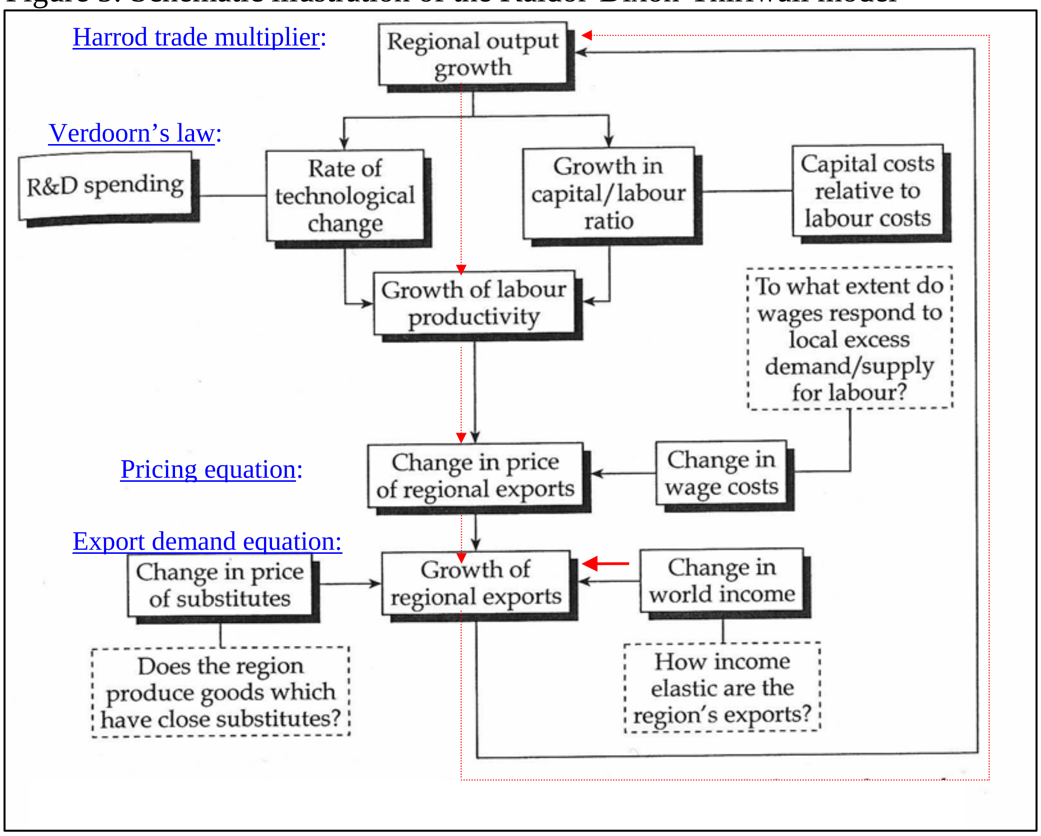
where labour productivity growth is determined by autonomous total factor productivity growth (i.e. technological change and efficiency gains); and the Verdoorn coefficient (λ>0) represents increasing returns-to-scale. There are a number of issues concerning the derivation and measurement of the Verdoorn equation (e.g., it is assumed that there is a constant capital-output ratio and thus the contribution of the capital stock to labour productivity growth is ignored – see McCombie, 2002; Harris and Lau, 1998), but these need not detain us here.

Combining equations (1) to (4), it is possible to derive an equilibrium output growth rate for a region as:

$$\dot{y} = \frac{\gamma\left[\eta(\bar{\dot{w}} - \bar{\dot{r}}_a + \bar{\dot{\tau}}) + \varepsilon(\bar{\dot{z}}) + \delta(\bar{\dot{p}}_f)\right]}{1+\gamma\eta\lambda} \tag{5}$$

This shows that both demand- and supply-side factors determine the rate of growth of output, as shown in Figure 5 (which is taken from Armstrong and Taylor, 2000), although as stated it is presumed that autonomous demand (i.e. exports) ultimately determine long-run growth and hence cumulative growth is mostly affected by an increase in the growth of world income (the red solid line in Figure 5 resulting in the anti-clockwise red closed loop)

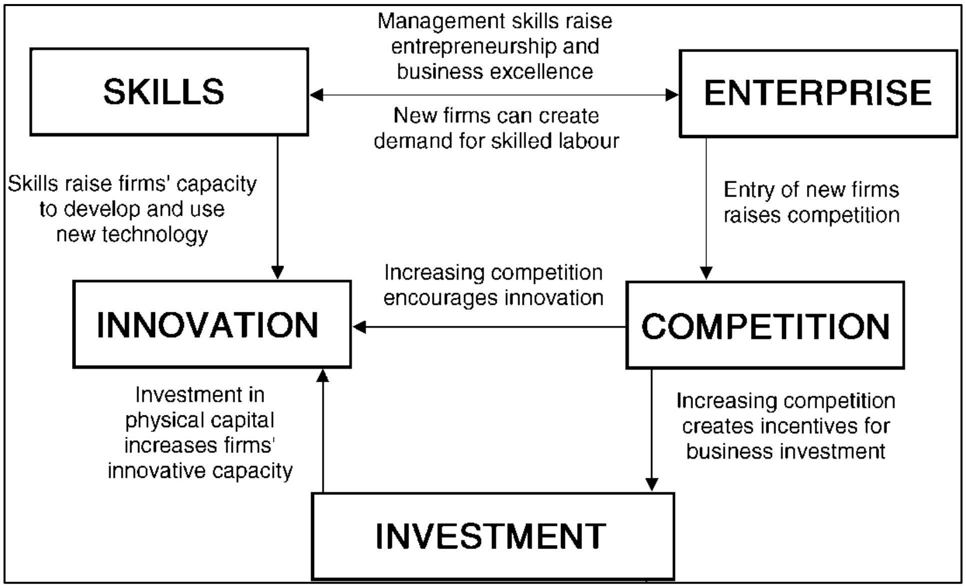
Figure 5: Schematic illustration of the Kaldor-Dixon-Thirlwall model



Source: Armstrong and Taylor (2000; Figures 4.1 and 4.2)

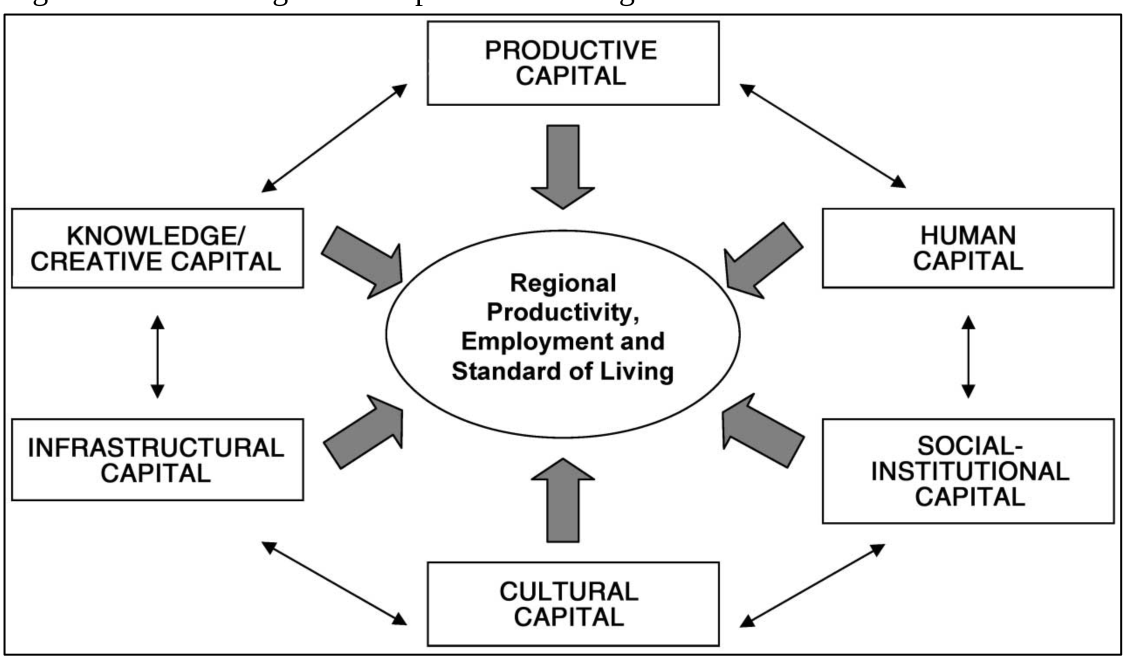
Contrast this model with say the drivers of regional productivity (and hence output growth) as set out by H.M. Treasury in 2004 (Figure 6), or the more general model as set out by Kitson *et. al*. (2004), which is reproduced as Figure 7.

Figure 6: Drivers of regional productivity



Source: H.M. Treasury (2004); diagram is reproduced from Kitson *et. al*. (2004, Figure 2)

Figure 7: Bases of regional competitive advantage



Source: Kitson *et. al*. (2004, Figure 1)

Figures 6 and 7 are essentially supply-side models of regional growth and productivity, and they compliment and extend the supply-side elements in the Kaldor-Dixon-Thirlwall approach. Indeed they introduce features that are not central to the Kaldor-Dixon-Thirlwall model, such as the role and importance of externalities, and they also explore more fully the determinants of total factor productivity (this is especially the case in Figure 7).

Table 2: Scottish Exports (£m) to the UK and abroad, 1979 and 2002

	1979	%	2002	%	2002[a]	%
Primary	569.1	5.9	5,045.0	11.0	729.3	4.2
Manufacturing	8,239.9	85.6	23,134.3	50.4	12,384.3	72.0
Distributive	590.1	6.1	4,846.7	10.6	1,755.1	10.2
Producer services	179.6	1.9	11,727.9	25.6	2,128.2	12.4
Social services	0.0	0.0	560.4	1.2	152.7	0.9
Personal services	49.9	0.5	571.4	1.2	51.7	0.3
Total	9,628.6		45,885.6		17,201.4	

[a] overseas only   Source: I-O tables for Scotland

In addition to extending the supply-side, we might also want to confront the Kaldor-Dixon-Thirlwall model with some further issues, such as:

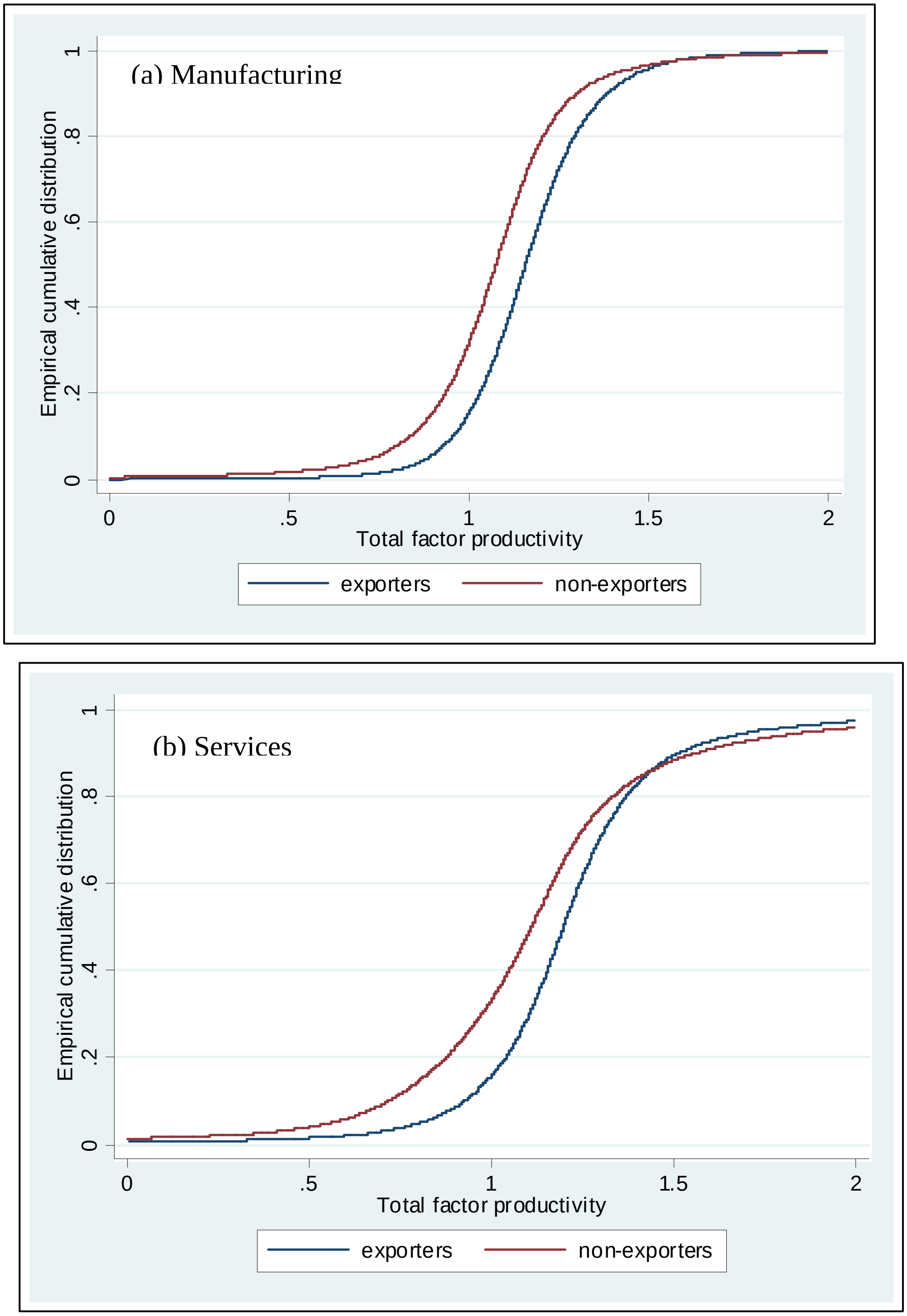
I. Given that exporting is the main autonomous source of demand, which firms should be included as part of the export-base? In past analysis, it has been presumed that exporting is mostly the domain of the manufacturing sector, but this is no longer the case (especially in a sub-national setting). Table 2 shows producer services (such as insurance, banking, finance, business services and leasing, and R&D) are now more tradeable than in the past. Thus most firms can export, and we need to know much more about how they overcome barriers to exporting? What makes them competitive enough to succeed in supplying non-local markets? In short, there has been a significant amount of more recent theoretical work that shows that exporters should have higher productivity (cf. Bernard et. al., 2003; Melitz, 2003), and the micro-based empirical literature is now beginning to provide the evidence that this indeed the case (e.g. Figure 8).

II. The Kaldor-Dixon-Thirlwall model puts the price of exports centre-stage in determining the growth of exports (in equation 2 the price of foreign goods and 'world' income are treated as exogenous), as increasing returns-to-scale induce higher labour productivity and thus downward pressure on export-prices. However, it might be presumed that rather than physical productivity (through efficiency gains) being the main link to the growth of exports, it will be the quality of differentiated goods and services that secure higher volumes of sales (and/or higher revenue productivity).[1] In the Kaldor-Dixon-Thirlwall model this would probably be picked-up through a high income elasticity of demand for the products produced

[1] The 2004 WERS survey shows that some 41% of employees work in plants that state that "demand depends heavily on superior quality" (37% in perhiperal regions and 44% in central and southern regions)

by firms in each region. Quality and differentiation of goods is more likely where firms are innovators, making significant use of their intangible assets.

Figure 8: TFP of exporters and non-exporters, 1996-2004



Source: based on *FAME* data – see Harris and Li (2007)

III. Lastly, the Kaldor-Dixon-Thirlwall model could be made more realistic by treating ‘word income’ in the export demand equation as an endogenous variable, or at least expanding the term to include intermediate as well as final goods, and thus allowing for interrelationships between regions that take account of spillovers and common shocks – in other words to allow for co-movement in the growth of output across different regions.

Extending the Kaldor-Dixon-Thirlwall model to include a more comprehensive role for the supply-side (including the role and importance of “untraded interdependences” within a region); as well as examining the determinants of exporting; the importance of quality linked to intangible assets; and trading interrelationships between regions, means that we need to focus more on: (i) the role of the plant/firm (i.e. a micro-based approach); and (ii) the importance and role of knowledge assets in determining competitiveness, productivity, and ultimately output growth. Thus I want to conclude this discussion of the theoretical side of regional growth by briefly looking at why intangible assets and the concept of absorptive capacity at the plant/firm level need to be emphasised.

The use of intangible assets (which can be defined as knowledge embodied in intellectual assets, such as R&D and proprietary know-how, intellectual property, workforce skills, world-class supply networks and brands) is recognized as a key (some say the key) driver of enterprise performance and thus ultimately aggregate productivity. A related concept that is closely linked to intangible assets is absorptive capacity (simply defined as the ability of enterprises to internalize and use external knowledge). This concept has also been the subject of much debate in terms of what it actually covers and how it can be measured.

Building IA requires that firms understand how to create new knowledge from the resources they possess. Thus to understand how firms create intangible assets requires us to look briefly at the ‘resource-based’ theory of the firm. The latter holds that a firm can generate higher “Ricardian” rents[2] from the utilisation of firm specific assets which cannot be replicated by other firms. The thrust of the argument is based on the established assumption (Hymer 1976) that ‘better’ firms possess non-tangible productive assets that they are able to exploit to give them a competitive advantage. Such a resource-based and organisational capabilities approach to the firm (e.g., Barney, 1991; Kogut and Zander, 1996; Teece *et. al.* 1997) is concerned with how resources, skills and capabilities (i.e. tangible and non-tangible assets) are generated, accumulated and deployed. The literature in this area concentrates on the firm defined as bundles of various assets (Penrose, 1959). But in addition to tangible assets which operate through relatively clearly defined markets, there are intangible assets (Griliches, 1981), or firm-specific capabilities (Teece and Pisano, 1998; Pavitt, 1984) which largely define the dynamic capabilities that then characterise the firm’s competitive advantage.

Essentially Teece argues that the firms’ dynamic capabilities are the sub-set of its competences and capabilities that allow the firm to create new products and processes and to respond to changing market conditions; they are the core of its competitiveness. Fundamentally, proponents of the resource-based view of the firm (like Teece) argue that such competencies and capabilities by their very nature cannot be bought; they can only be built by the firm – they therefore cannot easily be transferred or built-up outside the

[2] Defined as returns in excess of their opportunity costs, to distinguish them from monopolistic rents when firms restrict output.

firm.[3] This in part comes from the key role that learning plays both in enabling the firm to align its resources, competencies and capabilities, and in allowing the firm to internalise outside information into knowledge; and the way the firm learns is not acquired but it is determined by its unique 'routines', culture and its current position (stock of knowledge).

Thus, processes of knowledge generation and acquisition *within* the firm (i.e. internal knowledge generation) are essentially organisational learning processes (Reuber and Fisher, 1997; Autio, *et. al.*, 2000). Although firms could develop and acquire much of the knowledge internally (through their own resources and routines), few (and especially SMEs) virtually possess all the inputs required for successful and sustainable (technological) development. Therefore, the fulfilment of firms' knowledge requirements necessitates the use of external sources to acquire and internalise knowledge (Rosenkopf and Nerkar 2001; Almeida *et. al.*, 2003 set out the main *external* sources of knowledge available to firms).

Knowledge and learning can be expected to have a fundamental impact on growth in that firms must apprehend, share, and assimilate new knowledge in order to compete and grow in markets in which they have little or no previous experience (Autio, *et. al.* 2000). Prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends. These abilities collectively constitute what we call a firm's "*absorptive capacity*".[4]

Given the problems with measuring IA (definitional and data limitations), there have been few studies that have provided estimates of the impact of IA on firm performance. Most approaches, certainly at the enterprise-level, that seek to estimate the size of the impact of intangibles on output growth are usually limited to a consideration of whether the possession of R&D and/or ICT capital (i.e. covering mostly computer hardware and software) leads to higher growth. However, R&D and/or ICT capital are only a part of the IA stock, and perhaps more fundamentally this type of approach does not show directly how intangible resources are "…effectively internalised and/or appropriated by (an) organisation." (RICARDIS, 2005). In essence, we need to understand the way that knowledge is obtained, and from whom, and how this then leads to R&D and/or ICT spending, and from this the subsequent impact on productivity and growth. Put differently, investments in R&D and ICT are (at least in part) outcomes from the firm already having (and acquiring more) knowledge (although there is a reinforcing feed-back from the stocks of these assets to further knowledge acquisition activities[5]).

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[3] As if to emphasise the point about dynamic capabilities, Teece (1996) sets out what he considers the fundamental characteristics of technological development: its uncertainty, path dependency, cumulative nature, irreversibility, technological interrelatedness (with the complementary assets), tacitness of knowledge (organisational routines), and inappropriability (which means that firms' cannot necessarily obtain full property rights over their technology). All of this points to the outcome that technological 'know-how' is 'locked-in' to the firm and future alternatives are path dependent.

[4] Note, absorptive capacity was developed by Cohen and Levinthal (1989) in the context of innovation for which outside sources of knowledge are critical. However the usefulness of the concept extends to all questions relating to the identification, assimilation and application of new, external information (Bessant *et. al.* 2005)

[5] As pointed out in MERITUM (2002), intellectual capital can be both the product of R&D activities and the enabler for creating greater value from R&D.

This suggests to me that a more direct measure(s) that is linked to the sources of knowledge (i.e. absorptive capacity) is a useful way to understand the role of intangible assets in terms of their impact on performance. This is also important when looking at the potential impact of knowledge-sharing across firms with others in the region, and in other regions (include internationally). Specifically, I would content that unless firms have sufficient absorptive capacity, they will not be able to fully internalise the benefits of any spillovers, agglomeration economies, or benefit from technology transfers.

All of this suggests that more research is needed at the micro-level that considers the role of intangible assets (operationalised through measuring absorptive capacity), as part of the way knowledge is utilised to provide competitive advantage and thus achieve higher growth paths. A start in this direction would be to use existing micro-level data for the UK (and indeed other EU regions) to

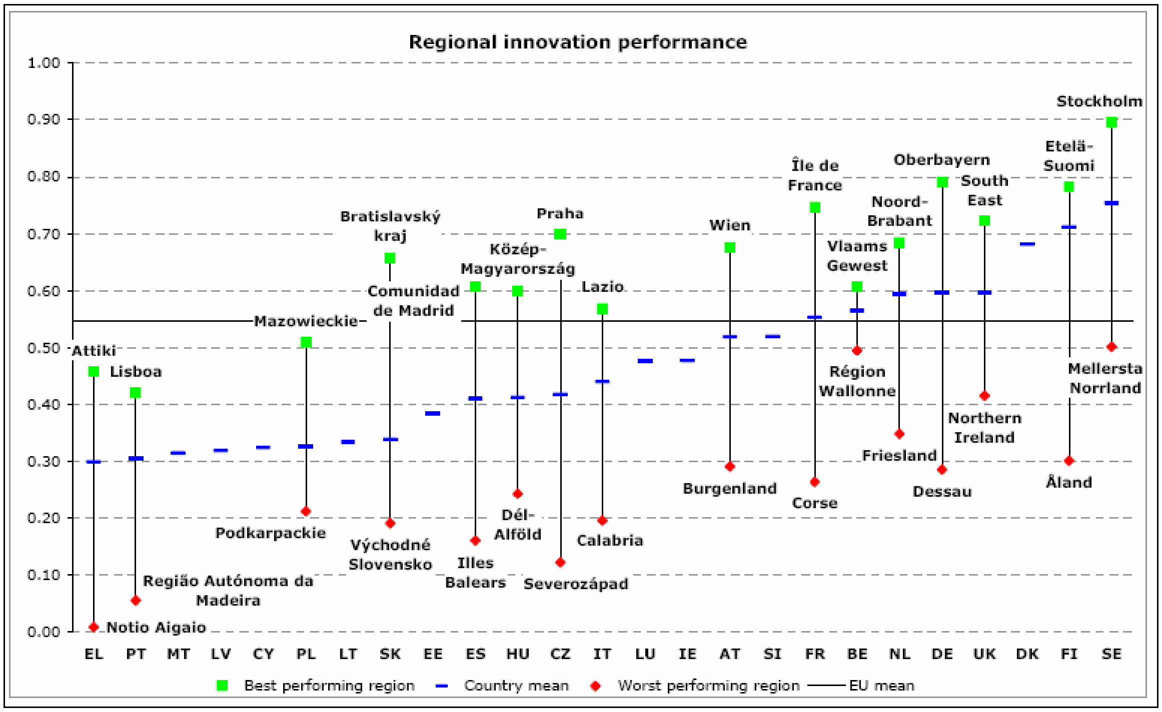
- Consider the impact of absorptive capacity on R&D spending, whether an enterprise exports, and also whether the enterprise innovates (or not), ranking the importance of absorptive capacity against a set of other determinants of exporting, R&D and innovation that have been identified by previous studies;
- Consider the impact of absorptive capacity on enterprise-level productivity, both directly and through the impact of exporting, R&D and innovation on productivity performance;
- Construct a more transparent link between intangible assets and absorptive capacity, to highlight their roles in determining firm performance, and to move towards a better understanding of what these concepts measure and how they can be measured.

Some Evidence

I confine myself here to looking at (mostly the UK) evidence on differences in R&D and innovation performance across regions. In essence, I am concentrating on the importance of this aspect of intangible assets as *the* key driver of productivity and growth, mostly because this is where we have most evidence, but also because if I have to pick the most important driver say from the Treasury list (Figure 7) then innovation takes precedence.

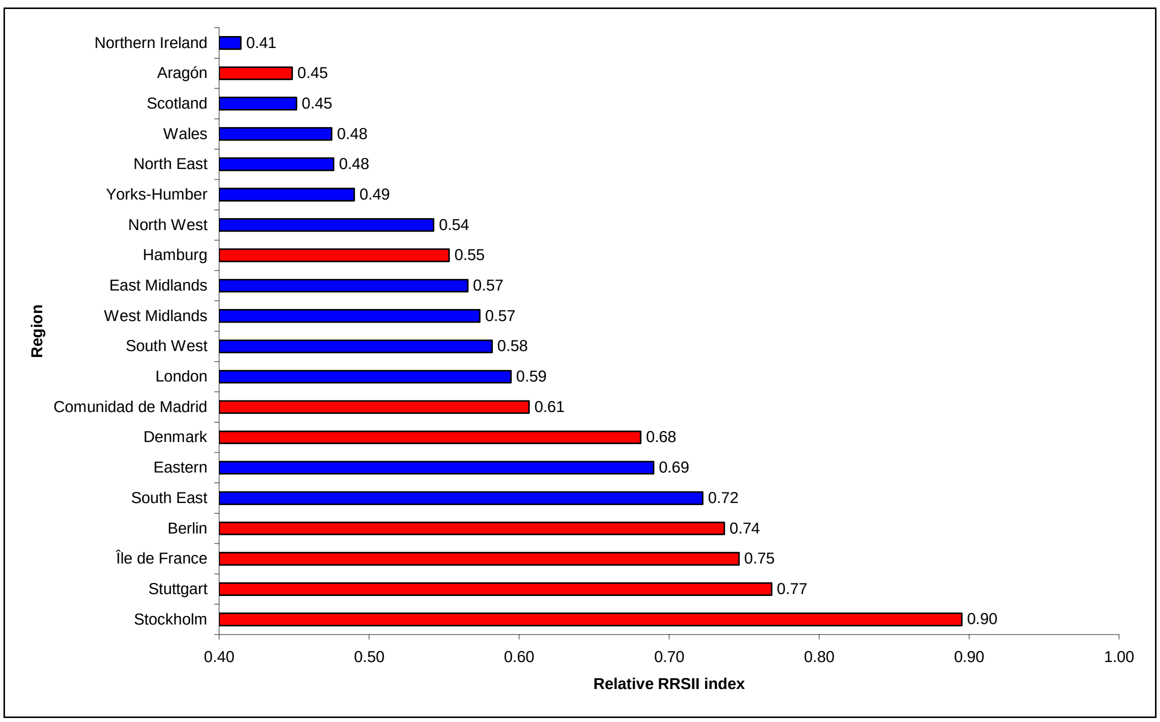
I start by placing the UK regions within the EU hierarchy of innovation performance. Figure 9 takes information from the 2006 European Regional Innovation Scoreboard (RIS, 2006), which takes a range of data covering public and business R&D spending, plus other HR characteristics and employment structures across sectors. As can be seen, the UK is placed 4th (about 9% higher than the EU average), with Greece last and Sweden top. Clearly there are significant differences between EU countries, and wide variations within each country. Figure 10 picks out the regions within the UK (showing the expected pattern of dominance by the 'south' – e.g. the South East has an index that is 76% higher than the value for Northern Ireland), but also includes some of the best EU performers (with Stockholm having the highest EU score – 25% better than that obtained by the best UK region).

Figure 9: Regional innovation performance



Source: RIS (2006)

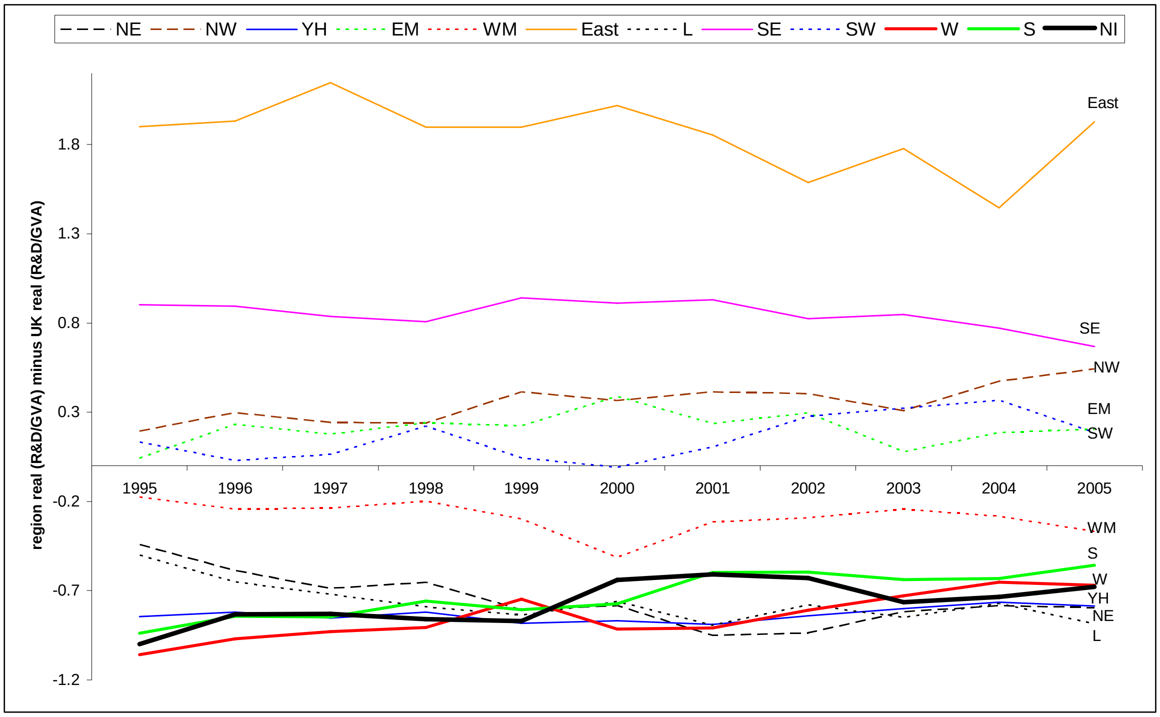
Figure 10: Regional innovation performance in UK regions (plus some others)



Source: RIS (2006)

These EU data suggest very different levels of knowledge creation assets across the regions of Europe. Turning in more detail to the UK, Figure 11 presents the most up-to-date information on business R&D intensity for regions of the UK, again showing wide variations at the sub-national scale (with the more peripheral regions like Scotland, Wales, Northern Ireland and the North East located at the bottom of the R&D intensity league table). The diagram also shows that rankings are relatively stable, and there is little if any evidence of convergence from just considering the ‘raw’ data.

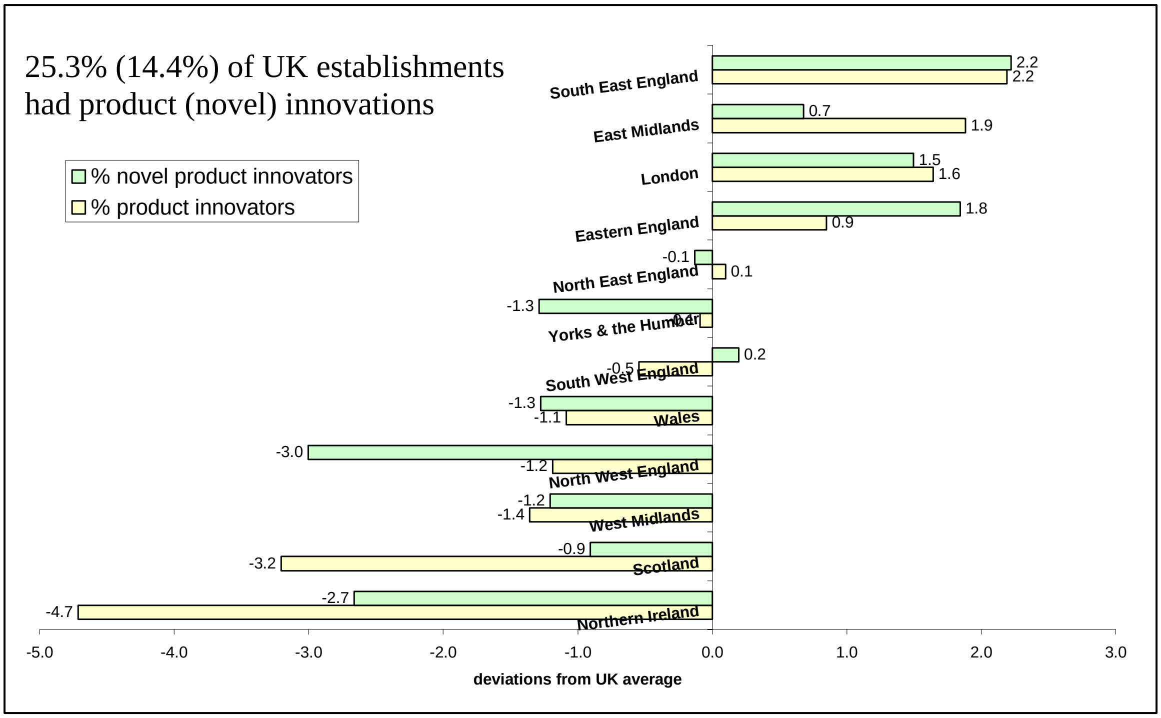
Figure 11: Ratio of (real) R&D spending to (real) GVA in UK regions



Source: BERD (updated 2007)

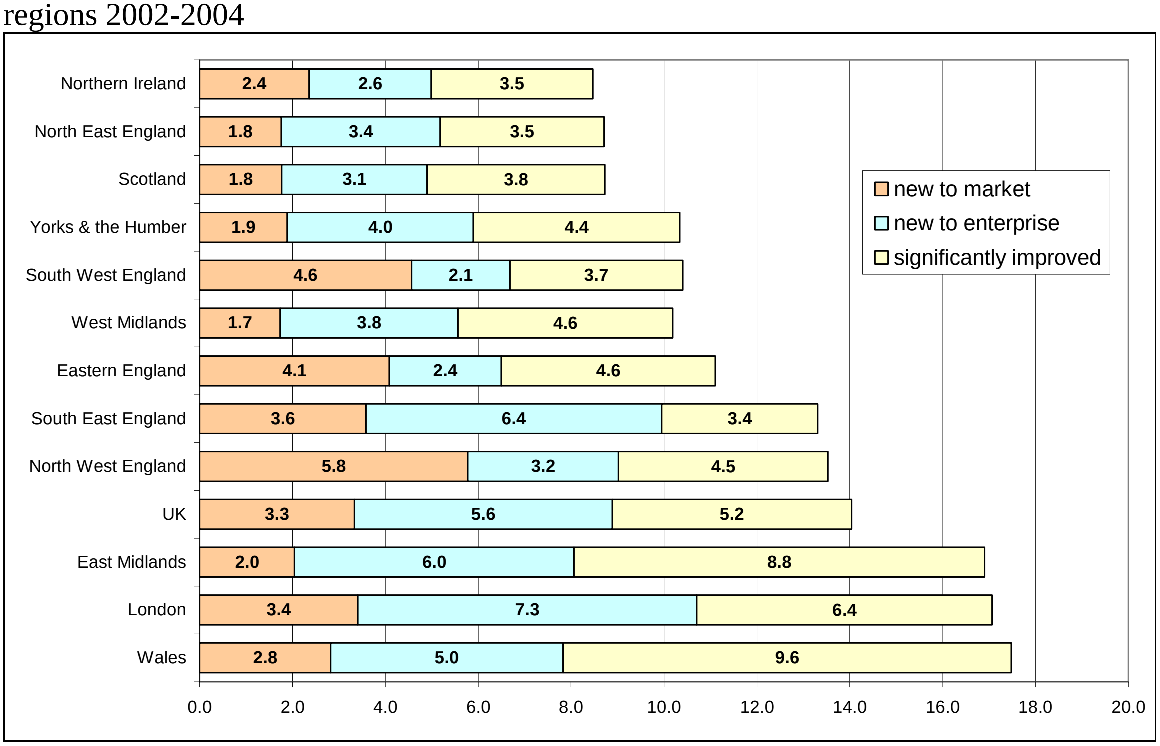
Turning to one of the expected outcomes from spending on R&D, Figure 12 shows the percentage of UK establishments that produced product innovations during 2002-2004, expressed as deviations from the UK average. Again, we see a similar ranking of regions that has featured in the earlier diagrams, e.g., the ‘south’ has more of its establishments producing (novel) product innovations. Since, the proportion of establishments innovating is only one aspect of the overall impact of new product development, Figure 13 provides information on the percentage of total turnover in each region in 2004 that is accounted for by product innovations. The regional rankings are now a little different, with Wales having some 17.5% of sales in 2004 attributed to new or improved products (compared to only 8.5% in Northern Ireland). However, the position of Wales is significantly lower when regions are ranked on the basis of turnover due to ‘new to market’ innovations; the Principality ranks below the UK average of 3.3% with the South West, Eastern England, the South East and London ranked above it. Indeed when we rank regions on the basis of ‘new to market’ plus ‘new to the enterprise’, London followed by the South East come top and Wales is ranked 5th in such a table.

Figure 12: Percentage of UK establishments with product innovations 2002-2004 (by GOR)



Source: weighted CIS4

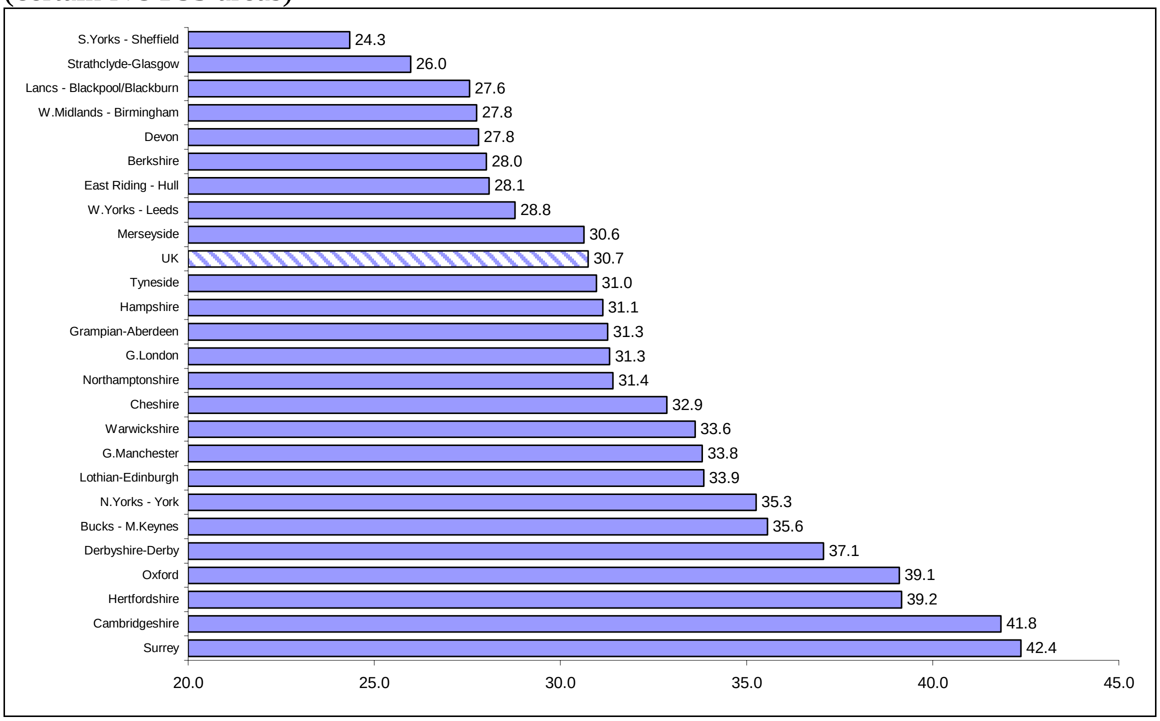
Figure13: Percentage of turnover (2004) due to product innovations introduced in UK regions 2002-2004



Source: weighted CIS4

The comparable picture using more disaggregated spatial boundaries are presented in Figures 14-16 (using the old NUTS3 regions which mostly equated to counties and metropolitan areas). In terms of the percentage of establishments undertaking R&D, Figure 14 shows that southern counties had significantly more enterprises investing in R&D. Surrey had nearly 12% more establishments engaged compared to the UK average, and over 18% more than in the Sheffield area. There are also some significant differences between counties that are in the same region or close by; for example North and South Yorkshire (dominated by the cities of York and Sheffield), and Strathclyde and Lothian (i.e. Edinburgh and Glasgow).

Figure 14: Percentage of establishments in UK undertaking R&D, 2002-2004
(certain NUTS3 areas)

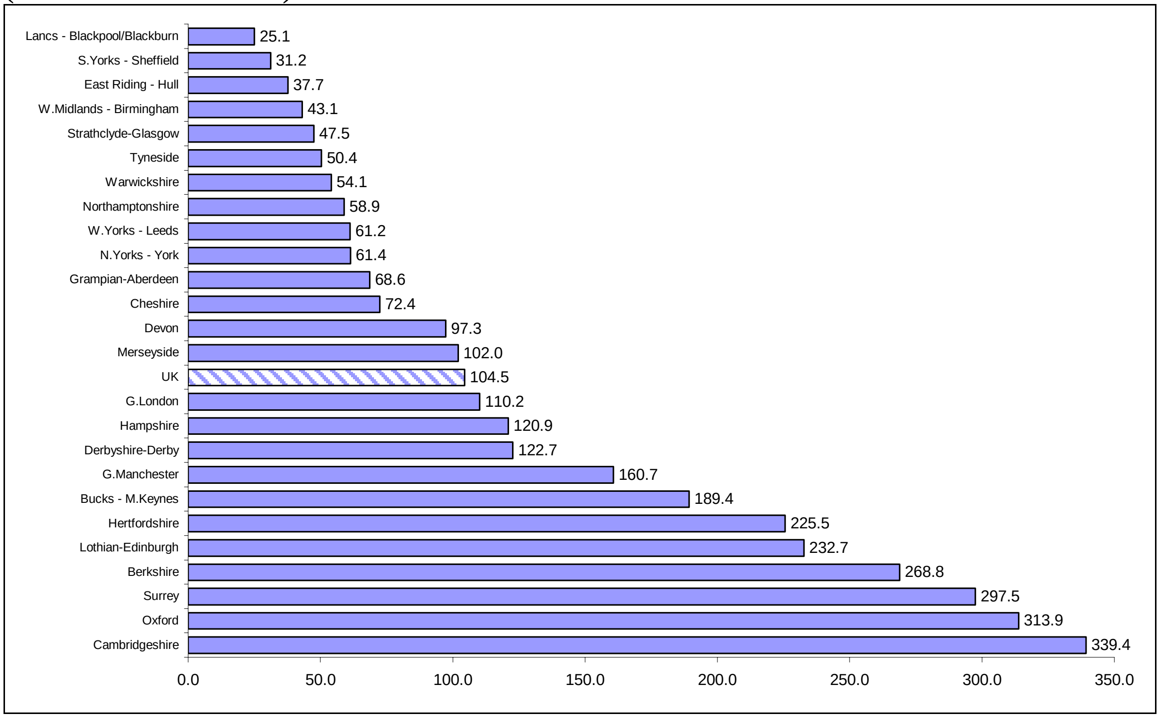


Source: weighted CIS4

Figure 15 produces figures on R&D spend per employee; the correlation between the figures in this diagram and the previous is 0.74 showing that areas have a similar ranking whichever way R&D intensity is measured.

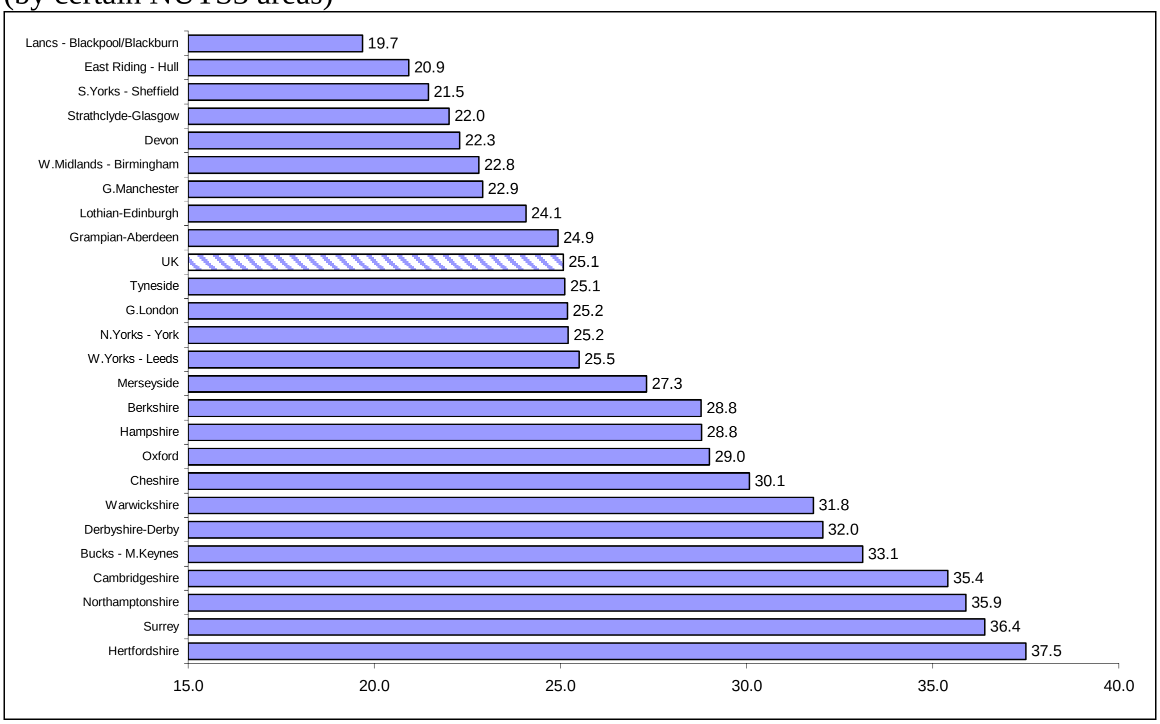
As to product innovations, Figure 16 shows the percentage of establishments that had product innovations during 2002-2004, and again a similar ranking across counties is achieved (the correlation between the percentage involved in R&D and innovating is 0.76).

Figure 15: R&D per head £'000 (in 2004) in establishments with R&D>0 (certain NUTS3 areas)



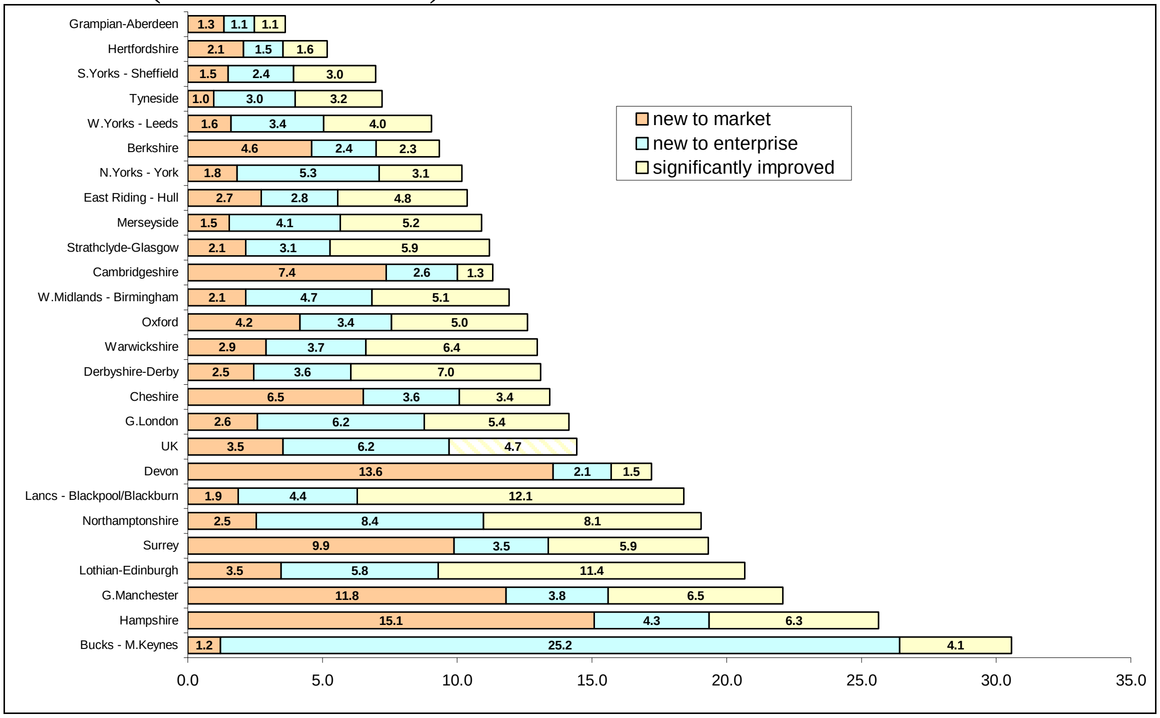
Source: weighted CIS4

Figure 16: Percentage of UK establishments with product innovations 2002-2004 (by certain NUTS3 areas)



Source: weighted CIS4

Figure 17: Percentage of turnover (2004) due to product innovations introduced in UK 2002-2004 (certain NUTS3 areas)



Source: weighted CIS4

When total sales are attributed to product innovations at the county level, the differences across areas is larger than at the standard regional level (Figure 17). Over 30% of turnover in Buckinghamshire was due to product innovations, although most of this was attributable to 'new to enterprise' goods and services. There are also some interesting differences when compared to Figure 16; for instance, only 5.2% of turnover in Hertfordshire was associated with innovations (placing it second lowest in the diagram) and yet 37.5% of establishments in this area innovated (placing it first in Figure 16).

In terms of measuring absorptive capacity, while no direct information on this variable is available, the CIS dataset does contain information on key elements of organisational learning and networking processes that can be related to absorptive capacity. Those cover: external sources of knowledge or information used in innovation activities and their importance[6]; partnerships with external bodies on innovation co-operation[7]; and the

[6] In CIS these are grouped under the following sub-headings with associated elements: (a) Market: suppliers; customers; competitors; consultants; commercial labs/R&D enterprises; (b) Institutional: universities; government research organisations; other public sector (e.g. business links, Government Offices); and private research institutes; (c) Other: professional conferences, meetings; trade associations; technical press, computer databases; fairs, exhibitions; and (d) Specialised: technical standards; health & safety; environmental standards and regulations. Respondents were asked to rank how important each factor is (from 0 – not used, to 4 – high importance).

[7] These are grouped under the following sub-headings with associated elements: (a) Market: suppliers; customers; competitors; consultants; commercial labs/R&D enterprises; (b) Institutional: universities; government research organisations; (c) Specialised: private research institutes. Respondents were asked to

introduction of changes in organisational structure and HRM practices which can be related to internal capabilities and thus (internal aspects of) absorptive capacity[8]. Harris and Li (2006) have used this diverse information in order to extract measures of absorptive capacity using factor analysis. For present purposes, I use CIS4 data and take the most important factor as a proxy for absorptive capacity; consequently, it has overall a mean of 0 and a standard deviation of 1 (by construction).

Figures 18 and 19 present some preliminary results; in Figure 18, I have ranked the regions from highest to lowest on the basis of overall region rankings ignoring sector and whether R&D took place or not. Thus, London comes first, and the North East is last. Firstly, there is the expected strong positive link between mean values for absorptive capacity and whether establishments spent on R&D. Absorptive capacity also is on average higher in services when R&D takes place (reflecting the smaller number of sectors within services that do R&D, i.e. its more specialised nature); similarly, absorptive capacity is on average lower in services when no R&D takes place.

It can be seen from Figure 18 that London overall scores highest on mean absorptive capacity because it does relatively much better in the service sector (and manufacturers in London not doing R&D have on average relatively higher absorptive capacity indices). The North East comes bottom of the rankings largely because of the low values of absorptive capacity in those establishments that did no R&D in services, which were relatively a large sub-group of enterprises operating in the region.

Lastly Figure 19 shows the overall regional rankings for absorptive capacity. Regions like Scotland, Wales, and Northern Ireland do relatively well (having overall scores around the national average). However, when we limit the data to those employing less than 250, average levels of absorptive capacity is much lower in those regions. Thus it should not be surprising that in various assessments of 'regional innovation systems' it has often been found that in lower growth regions a weak link in such systems is usually the low absorptive capacity levels of smaller local firms, who do not (or cannot) internalise the external knowledge that is available in their localities (see, for example, Roper *et. al.*, 2006, for Scotland).

Figure 19 shows that absorptive capacity is much lower in smaller establishments. This is confirmed in Table 3 which shows the results from regressing the absorptive capacity index obtained for each establishment on region and size-band dummies (while controlling for sector). A stepwise procedure confirms that the average level of absorptive capacity is 0.57 higher for larger establishments, while London and the South East have significant positive 'place' effects of 0.1 and 0.07, respectively.

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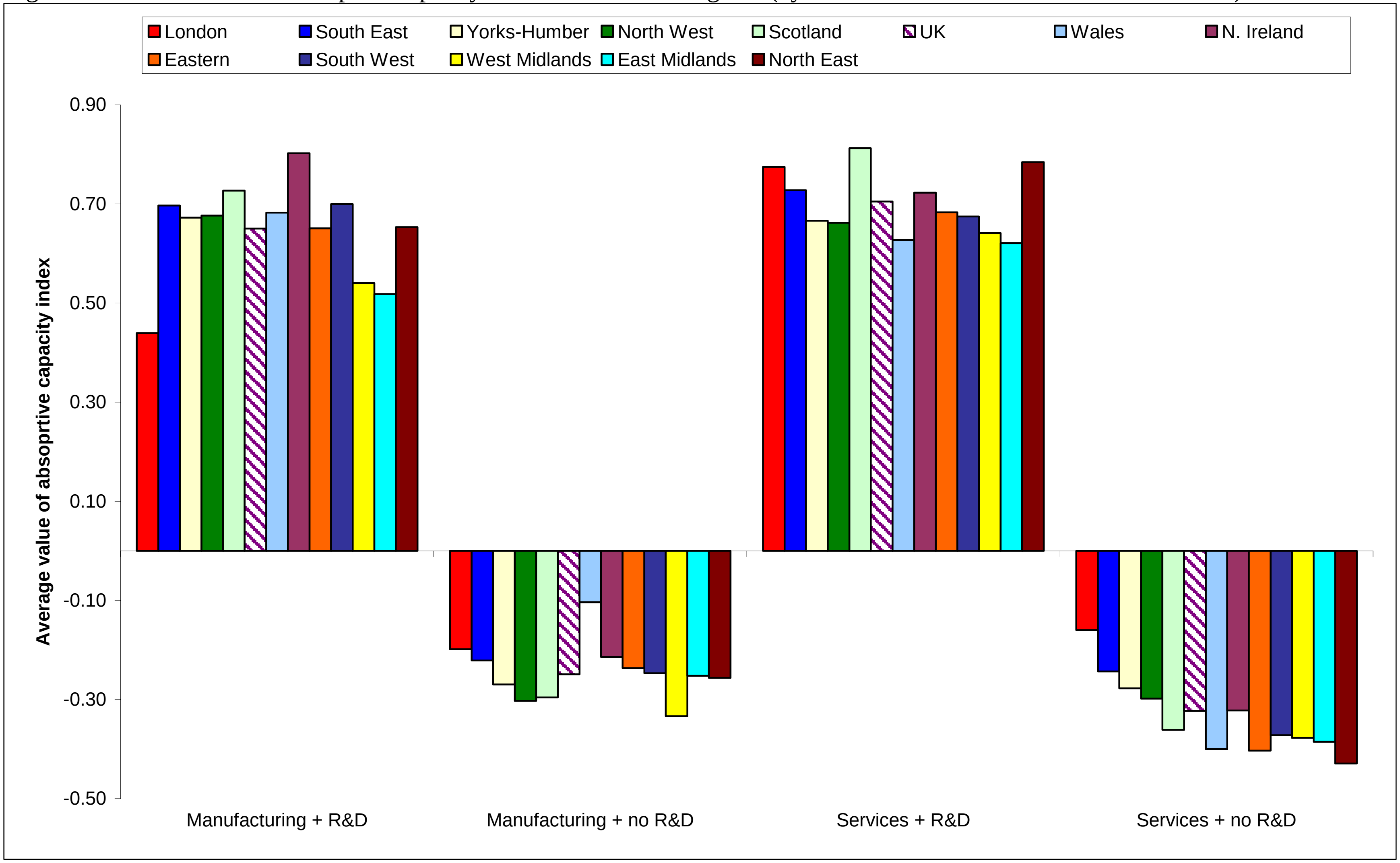
indicate whether cooperation was with organisations that were 'local', 'national', 'European', 'US' or in 'Other' countries. From this we could identify cooperation at the national (which also includes local) and international level.

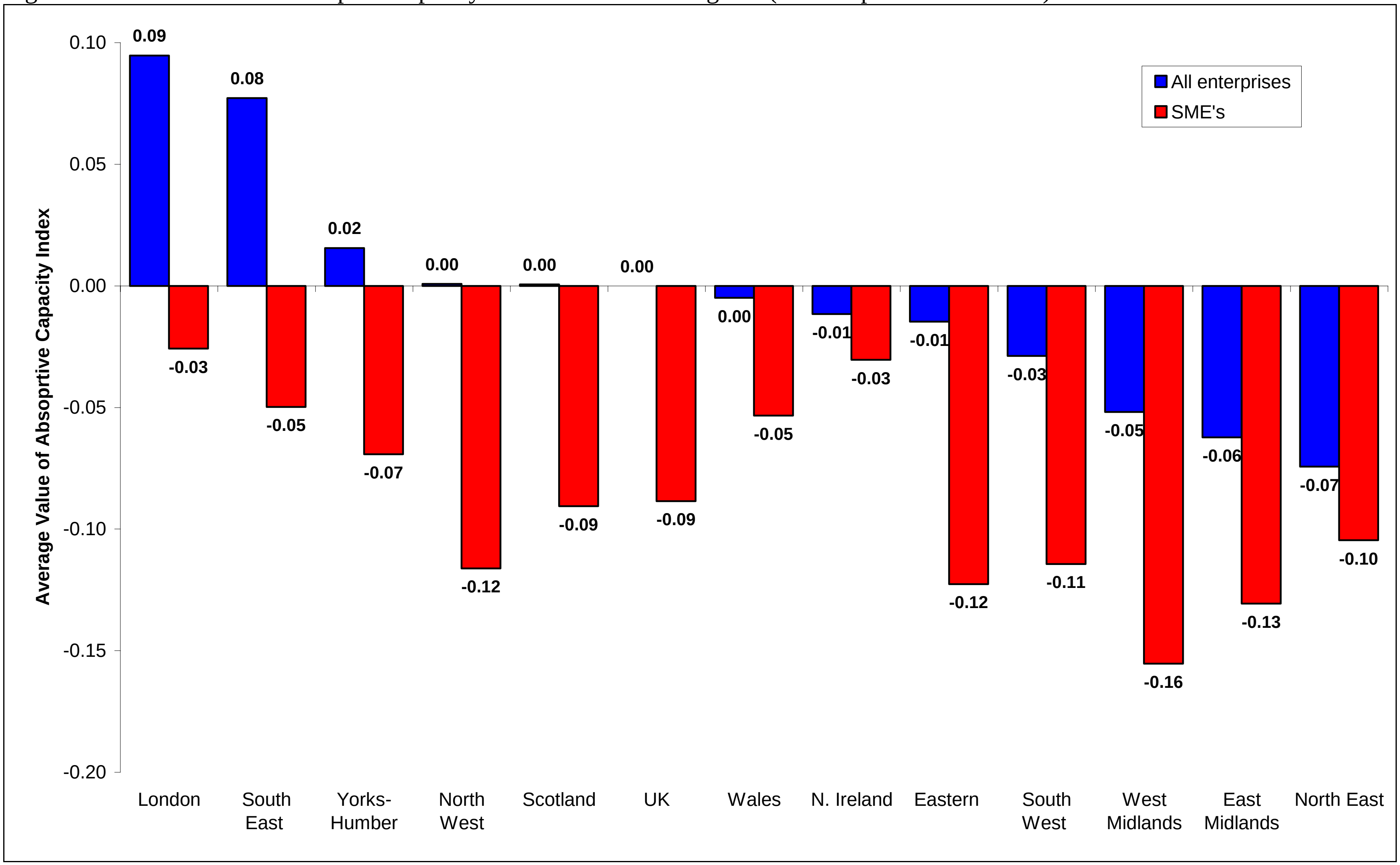
[8] These are measured by the implementation of new or significantly changed corporate strategies, advanced management techniques (e.g. knowledge management, quality circles), organisational structures (e.g. Investors in People, diversification), and marketing concepts /strategies. Each set of changes is ranked from 0 (not used) to 3 (high impact) to indicate its effect on business performance.

Figure 18: Mean values of absorptive capacity 2002-2004 for UK regions (by sector and whether R&D was undertaken)



Source: calculations based on CIS4

Figure 19: Mean values of absorptive capacity 2002-2004 for UK regions (all enterprises and SME's)



Source: calculations based on CIS4

Table 3: OLS regression of determinants of absorptive capacity

Dependent variable: Absorptive capacity index	$\hat{\beta}$	*t*-value
Intercept	-0.261	-24.6
West Midlands	-0.081	-3.1
London	0.096	4.5
South East	0.067	3.1
Manufacturing (coded 1)	0.132	7.4
50 – 249 employees	0.325	17.1
250+ employees	0.567	15.0

Source: based on CIS4 data

Conclusions

There are significant disparities across the regions of the UK (and indeed across the EU). Theoretical and empirical evidence suggests strongly that this is because of a ‘space’ effect. That is in some areas firms do ‘better’ at least in part because of the attributes of the location in which they operate; e.g. through potentially greater technological spillovers and stronger other untraded interdependencies. But to benefit, I have argued that these firms must have more intangible assets that are associated with higher levels of absorptive capacity. It is also likely that competition, leading to the “survival of the fittest”, is likely stronger in regions with the highest levels of socio-economic performance. Cities seem to have an important role to play in fostering higher productivity growth, presumably through agglomeration effects. Essentially, a range of demand- and supply-side factors determine sub-national (and hence nation) growth, and geography matters.

But as I said at the start, we still lack empirical evidence obtained from rigorously specified and estimated economic models. Hence, perhaps the title of this talk should have been: “Drivers of Output Growth in UK regions and Cities: *the Need for More* Empirical Evidence Using Micro-Databases)”.

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