EXTENDING THE RESEARCH ON UNDERSTANDING THE PRODUCTIVITY VARIATIONS BETWEEN WALES AND THE UK

Report to the Welsh Assembly Government

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Executive Summary

This study was commissioned to further the analysis of productivity done in a previous analysis (Boddy et al, 2006), both to bring this previous research up to date and to extend it in new dimensions. We have done the former by adding the data for 2004 to the analysis – the latest currently available.

The report begins by presenting a detailed, non technical summary of our results. We then survey the literature not just on productivity, but also on other issues such as internet usage, resource usage and the cost of waste. One of the extensions to the previous literature we survey includes the impacts of clusters – similar firms in close proximity - on productivity. The literature suggest that such clusters may be either associated with higher or lower productivity.

We then present summary data in graphical form relating to both the regions of Britain and the local authorities of Wales. Sections 5 and 6 present the regression results and in section 7 we report the conclusions, including interpreting our results, the theoretical innovations we have made and the policy implications.

The basis for this research is the Annual Respondents Data base (ARD). This contains detailed information on business establishments. Small establishments with less than 250 employees are sampled on a random basis and hence are not surveyed every year, with most appearing in the data base just once (Robjohns, 2006). The 'Osmotherly rules' are followed and a small firm with less than ten employers can only be sampled once every four years. Roughly a quarter of such firms are surveyed every year and for larger firms but still smaller than 250 the proportion is approximately 50%. This survey has been widely used in research in the UK.

Initial analysis of the data, reported in section 4, reveals large differences between different regions of Britain and also different local[1] authorities in Wales across a range of variables, including productivity, location of multinationals and energy usage. The purpose of the regression analysis is to attempt to explain these differences.

Productivity

The results were as in previous reports with respect to the impact of (i) higher population density increasing productivity, (ii) productivity being particularly sensitive to the proportion of people with no skills in the area, (iii) being much greater for multinationals than British firms who are part of a group and greater again than that of British stand alone firms and (iv) inversely related to time distance from London, but no other distance variable. In addition firms in clusters are now found to have a productivity advantage.

We further found that there was evidence for an optimal level of population density beyond which productivity actually began to decline. The data suggests that this critical turning point is at a population density of 6610 people per

[1] The term Local Authority is also used in this report to refer to the Unitary Authorities in Wales.

square kilometre. This is quite high, indeed higher than any other local authority area in Wales, although parts of those areas may be characterised by such high population density. We emphasise too that this needs more investigation as it is likely to vary between industries.

We also found there to be substantial differences between firms in rural and urban areas. ***Firstly, a high proportion of skilled workers boosts productivity for firms in urban areas but not rural. This finding may have implications for training policies.*** Both population density and time distance from London impact upon both rural and urban economies, but the impact of the latter is much greater for rural economies. Advantages of clustering are found equally in both urban and rural areas as are differences associated with ownership, although the disadvantage of stand alone British firms is greater in rural than urban areas. ***Regional differences are more pronounced in rural than urban areas with firms in Welsh rural areas at more of a disadvantage than firms in Welsh urban areas***.

Much of this tentatively suggests that rural areas are relatively more 'sealed' from other areas, knowledge takes longer to be diffused to rural areas and the disadvantage of stand alone firms or peripherality is greater. Consistent with this is a model of knowledge diffusion which first sees knowledge transferred from London to other major urban centres and then from these major urban centres to their rural hinterland. Rural firms near London are then at an advantage over other rural firms, as the first stage of this diffusion process is bypassed.

The analysis also revealed substantial differences between industries. The industries which suffer most from a high proportion of a 'no-skilled' labour force are manufacturing, wholesale-retail, catering and transport. Stand alone British firms are at less of a competitive disadvantage in manufacturing and construction, which may reflect the fact that other industries are more localised, and less subject to competition, or that, in the case of construction, technical progress has been slower. Time distance from London is critical for all industries other than catering and transport.

But perhaps the most interesting results from this report relates to the impact of clusters. They increase productivity in retail-wholesale, catering and the socio-education sectors, but reduce it in manufacturing and construction. To a large extent the former are industries where the customer goes to the firm, rather than in some form the opposite. This tentatively suggests that the advantages we have identified lie in firms of this type being focused in one locality – e.g. a shopping centre – which consumers can readily access.

Resource Usage

We analysed energy demand, fuel demand, demand for other services (very wide ranging includes postage, bank charges, non-road transport, payment for home-workers, etc), road transport, water, waste disposal, computer services, telecommunications services and the use of the internet for buying and selling.

The results suggest that demand for fuel, energy (which includes fuel) and road transport, are all linked to road infrastructure, in that they increase as this

deteriorates. In addition it is highest for multinationals and then British 'group firms', and lowest for British stand alone firms and the differences are substantial. ***That is given two firms with identical characteristics, in as far as we can measure them, a British stand alone firm will use over 35% less road services than a foreign, non-US multinational.*** Demand for all three also declines with population density and for fuel and energy decline with both the proportion of high and no skilled people in the local labour force. The results are such as to tentatively suggest that some of this decline with respect to energy and the highly skilled may be associated with a more efficient use of resources.

Demand for computer and telecommunications services, follows a very similar pattern as to productivity. The size of all these impacts can be seen in Table 1. Demand for both declines with time distance from London, and only this distance. They also increase with population density, increase with the proportion of the labour force who are highly skilled and decline with the proportion who have no skills. Demand for both is also greatest for multinationals and then British group firms and finally stand alone firms.

Related to this, conceptually at least, is the use of the internet for buying and selling. The probability of a firm using the internet to sell its products increases with the number of workers and also the size of the capital stock. It also increases with the proportion of highly skilled workers in the locality. It is also inversely related to the existence of clusters. The extent of Internet usage for selling is also less for stand alone British firms – although is quite high for British group firms. The results for internet buying are largely similar. However, there are differences. The probability now declines, significant at the 1% level, for firms in areas with a relatively high proportion of no skilled people. It also increases with time distance from London. Thus here is evidence that the internet is being used to reduce the disadvantages of peripherality.

Of the other results, the cost of waste disposal declines with population density and is less for British stand alone firms. One speculative interpretation could be that it is possible that the latter reflects the adoption of less rigorous standards, though compliant with regulations. The demand for other services increases with the proportion of highly skilled people in the locality and declines with the proportion of no skilled people. It is also lower for UK group firms than foreign multinationals and lower still for British stand alone firms. All of the distance factors are relevant with a pattern of signs which suggest that extent of usage increases with the quality of the road infrastructure to both London and other major conurbations. These results potentially suggest the importance of both supply side factors and possibly knowledge diffusion.

Miscellaneous Results: Capital Stock and Firm Location

We also examined a number of other factors including the determinants of capital stock, inventories, insurance costs, business rates, taxes paid – a proxy for profits and firm location. We deal briefly here with capital stock and firm location. Capital stock is greater in localities characterised by high skill levels it also increases with population density and declines with time distance from London, but not mileage nor any of the other distance variables. But given that, there are significant regional differences and it is in Wales quite high relative to both London and other regions.

Capital stock is also lower for UK group firms than multinationals and lower again for British stand alone firms.

With respect to location the evidence suggests that stand alone British firms tend to be found relatively more in less favourable locations, with poor transport infrastructure, lower population density and low skills. These firms are also relatively more likely to be located in Objective 2 areas, although not Objective 1, and less likely to be part of a cluster. There are significant regional variations and stand alone British firms are most likely to be found in the South West and Scotland.

Multinationals and British group firms are the reverse of this, but there is an important difference. British group firms tend to be relatively more attracted to areas with a high proportion of very skilled labour, but this is not the case with multinationals. Other things being equal multinationals are particularly likely to be located in Wales. That foreign multinationals are not particularly attracted to areas with high skill levels – but with medium skill levels – whereas British firms are, suggests multinationals in Britain are subsidiary activities with the key high skilled activities taking place elsewhere, most likely their country of origin.

Conclusions and Policy Implications

The results have emphasised the importance of looking at firm activities in a holistic sense. Superficially the existence of a highly skilled pool of labour in a locality has a relatively small impact on productivity when compared to the adverse impact of a large pool of people with no skills. But this is misleading. Our analysis has shown high skills to impact on capital stock, internet buying and selling, the use of computer services and telecommunications. In addition there is some tentative evidence to suggest that they facilitate the more efficient use of energy and disposal of waste.

All of these need to be looked at when evaluating a firm's performance and all will impact, and impact increasingly, on a firm's profitability. The analysis suggests that energy and fuel usage is relatively small for the median and even 75% quartile firms firms in peripheral areas, but is very high for some firms in those areas. This probably reflects market focus. Those firms in peripheral areas which do export outside the locality face very high transport costs. But for the mean firm the highest transport costs tend to be in areas close to very large urban areas, such as Flint which is close to Liverpool, and /or to the motorway network. It is this collection of firms which will be most adversely affected by increases in energy prices and other attempts to reduce the use of energy. But they will also impact relatively more on multinationals and British group firms, possibly because they sell their goods over a wider area and possibly because they need to link diverse plants in different locations together. ***Will this impact on the way multinationals behave and also increasingly influence their location decision? In the long-run almost certainly.*** Firms do not tend to respond quickly to short term changes, but rather factors which are perceived as long term. Thus if high energy prices remain in place over a prolonged period firms will come to respond to this in a way which is not immediately evident.

The difference between rural and urban areas is also a matter of concern for the policy maker. ***Our research suggests that firms in Wales are less productive than firms in the South East and London. But the gap between rural firms in the two areas is greater than the gap between firms in urban areas.*** This suggests that particular focus needs to be given to rural firms and their needs are slightly different. A highly skilled labour force is not so relevant for rural firms. But improving knowledge dissemination is of particular importance.

One way of doing this is by using IT to facilitate, e.g., networking. The evidence suggests that new developments in IT can help reduce the disadvantages of distance, but firms need help in learning about the possibilities. They need help in implementing IT fully into their business to make the best use of it, they also need help, particularly start up businesses in basic business skills and in gaining access to finance.

Throughout we have emphasised the differences between British stand alone firms and others, particular multinationals. ***Almost across the whole range of issues, stand alone firms do things differently.*** They are considerably less profitable than other firms, are based in less advantageous locations, use less capital stock, less energy, less services, such as banking and accountancy services, computer services and telecommunications services. They hold less inventories, pay less insurance and spend less on waste disposal. At first sight it might appear that less energy is associated with greater efficiency, but in practice this probably reflects a less intensive use of capital stock. On any dimension the stand alone firm seems less likely to take advantage of new techniques and is less likely to 'do things well'.

Why? Many of these stand-alone firms are also family firms and these too are often found to be less efficient possibly due a more limited pool of managerial talent to draw upon (Wall, 1998). Small firm owner-managers, generally, are reluctant to participate in formal training for themselves and their workforce (Storey and Westhead, 1996). The reasons are understandable, since resource constraints can make it difficult for small firms to engage in formal training and other initiatives. This may be compounded in rural areas by a more dispersed pattern of location.

To the extent that poorer performance may be caused by a lack of ambition, drive and energy, there is perhaps little the policy maker can do. But to the extent that it is caused by lack of knowledge, expertise and contacts then yes there is something that can be done. Participation in entrepreneurial networks can be one means of improving awareness, training and knowledge, but participation of entrepreneurs in networks can be limited outside larger urban areas due to the combined constraints of peripherality and lack of resources. In addition, the networks themselves may be less effective than their large urban equivalents, due their smaller membership, for example, as may be the case with Chambers of Commerce. As result effective networks have to be innovative and they have to utilise alternative means of disseminating knowledge and collective action. (Galloway, *et al*. 2003). Even networks within larger areas may need help and direction

1. Introduction

This study[2] attempts a more holistic analysis of productivity than, as far as we are aware, has previously been undertaken. We will not simply examine productivity per se but also some of the factors which themselves determine productivity. We will not simply be concerned with productivity as measured by positive or good 'output' but also be examining some of the negative or bad outputs such as environmental costs associated with productivity and resource use.

Productivity is an important issue for several reasons. One of the UK Government's main policy aims has been to increase levels of productivity in the UK towards those of other countries within the EU, such as France. This is because the productivity of the country as a whole dictates the prosperity of the country and both depend upon the productivity of the regions, and firms within the regions, that make up the country. It is relevant to talk of regions here as well as firms as the former can have a generic impact on firms within the region via location, skill and other characteristics. The HM Treasury has improving UK productivity levels as one of its most important policy objectives:

"Productivity growth, along side high and stable levels of employment, is central to long-term economic performance and raising living standards. Increasing the productivity of the economy is a key objective for the economy" (HM Treasury Website)

But at the beginning of the 21st century, outputs are only part of the story. Thus, we will examine energy usage as an impact into output, but this is also of importance in its own right of course. In the coming years there is likely to be increasing emphasis on economizing on energy usage and information is needed as to what extent this is currently possible without damaging productivity. But this is not just true for energy usage and all aspects of resource use. It is also true for waste disposal with, in rather a short space of time, landfill becoming a premium resource.

The basis for the analysis is the Annual Respondents Data base (ARD). This contains detailed information on busine ss establishments. Small establishments with less than 250 employees are sampled on a random basis and hence are not surveyed every year, with most appearing in the data base just once (Robjohns, 2006). The 'Osmotherly rules' are followed and a small firm with less than ten employers can only be sampled once every four years. Roughly a quarter of such firms are surveyed every year and for larger firms but still smaller than 250 the proportion is approximately 50%. This survey has been widely used in research in the UK. The raw data from this was combined with data on local authorities such as population density, skills and distance factors. The methodology will be based on regressions analysis using panel data techniques.

[2] This work contains statistical data from ONS which is Crown copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

The report begins by presenting a detailed, non technical summary of our results. We then survey the literature not just on productivity, but also on other issues such as internet usage, resource usage and the cost of waste. We then present summary data in graphical form relating to both the regions of Britain and the local authorities of Wales. Sections 5 and 6 present the regression results and in section 7 we report the conclusions, including interpreting our results, the theoretical innovations we have made and the policy implications.

2. Summary of Research

Literature & Theory

Much of the research in this report is quite technical and densely packed. The purpose of this section is to provide a reasonably extensive, non-technical summary of this research. However, considerations of implications, interpretation and policy conclusions are largely deferred until the final section of this report.

The basis for the research is the belief, a belief which grew as the work developed, that firms' activities should not be analysed in parts, e.g. the production function, the use of energy, location of multinationals, etc, but more holistically. This is so for two reasons. Firstly, the results may be partial and misleading. Secondly, the efficiency and impact of firms needs to be viewed in a holistic manner, not just their contribution to output for example, but also their use of scarce resources and production of waste. Typically we focus on the former, what is normally termed productivity. But the price of scarce resources, particularly oil but also metals such as tin, and the cost of waste disposal has been rising and the latter at least is expected to continue to rise. We believe that these are thus issues which will become increasingly apparent in the coming decade. Not to analyse firms holistically risks policies aimed at increasing productivity, narrowly defined, damaging firms on other dimensions.

The literature review emphasises the importance of ownership, scale of activities and geographical features such as location, skills, population density, etc. The literature also stresses the potential importance of clusters, although their impact on individual firms has seldom been rigorously tested. The literature identifies two potential effects on productivity, one positive through greater knowledge diffusion, etc, the other negative through greater competition. The role of knowledge diffusion is critical in this literature and helps explain, in part, the much commented upon advantage of multinationals.

Our measure of clusters is based on firms in 2-digit industries. This is quite a broad definition and is consistent with, e.g. Brenner (2007) and Forni and Paba (2002). Others have used measures based on finer industry specifications. To an extent which is the most appropriate is an empirical question. Our analysis finds the variable defined in this manner to be highly significant in several dimensions, but clearly this is an area which warrants further research.

But knowledge diffusion is not just relevant for productivity per se. It is also relevant for aspects of firm behaviour such as energy and fuel usage, adoption of new technology, and the production of waste. More efficient firms should use less resources, adopt new techniques more quickly and more extensively and produce less waste.

The Data: Britain

The data we use is defined in a table in the appendix and covers output as well as the amount of energy used, the cost of waste disposal, the use of the internet and computer and telecommunications services. It also relates to where different types of firms choose to locate. Much of this data is summarised in diagrammatic form in section 4 where it is discussed in greater detail. The figures in general relate to the

median and 75% quartile firms and are thus more representative of 'the average firm' than the mean, however, they are not totally representative of the region as in the ARD larger firms receive a greater weighting than small ones. This is the case for all the figures. None the less the trends are still informative.

Gross value added at factor cost (GVAFC) is highest for firms in London and then the South East followed by the North East and North West. Wales is 'average'. This relates to the mean, but the following figures focus on the median and 75% quartile firms. Figure 2 relates to the capital labour ratio. London has the highest and Wales and Scotland the lowest. This does not mean that Wales has a low capital labour ratio per se, but that the median form does.

Average road transport services bought in follow in Figure 3. These are again low in Scotland, Wales and the South West and highest in the Midlands. This is not the case for the mean with Wales having a higher figure than, e.g. the West Midlands. This suggests that the median firm in Wales is more focused on the locality than the median firm in the West Midlands, but that some firms in Wales face very high transport costs. Figure 4, in section 4, shows average energy costs per firm, which includes fuel. For the median and 75% quartile firms, they are again highest in the traditional industrial regions of England and lowest in Scotland, Wales and the SW.

Figures 5-7 reflect on the ownership structure of the regions. They tell an interesting story. The three most popular regions for multinationals are the North East, London and Wales. Two are regions on the periphery, with old established industries in decline. But they are not the extreme periphery and if parts of Wales are remote, parts are just two hours away from London by road. The least favoured regions are Scotland and the South West. British group firms are more evenly spread, but least commonly found in Scotland and Wales. This all means that British stand alone firms are most commonly found in Scotland, the South West and Wales. The final figures show the use of telecommunications and computer services. The latter is quite evenly spread but less so the former with Wales being on the low side. Which raises the question, why? Is this a potential policy issue?

The Data: Wales

The figures are informative. In this analysis we again focus on representative firms, i.e. the median and 75% quartile firms, rather than the mean, as one or two firms can have a disproportionate affect on the latter. For example the median firm in Ceredigion has low road service expenditure, but the mean is very high. This suggests that the median firm in this locality tends to be locally focused, but that those firms that do sell outside the region spend a great deal on road transport. More generally road usage for the median firm is lowest in Conwy, Denbigh, Ceredigion and Pembroke and highest in Flint, Wrexham, Blaenau Gwent and Caerphilly. This is a similar pattern as for Britain as a whole, with road usage for the median firm tending to decline with peripherality – but often with a high mean value. The cost of energy usage follows a similar pattern for both median and 75% quartile firms with the highest being focused on Flint, Wrexham and the LAs bordering the M4 east of Cardiff. Waste disposal costs vary enormously across Wales. They are greatest in Torfaen, followed by Caerphilly. They are lowest for firms in Denbigh, Conwy, Ceredigion and Pembroke. Once more this largely reflects industrial structure, but if there are charging differences across Wales, then it is possible that this too could be looked at from a policy perspective.

Figures 14-17 show that multinationals tend to locate either close to the English border, close to good road links and often both. Ceredigion, Pembroke, Cardigan and Denbigh see relatively low proportion of multinationals. British group firms also tend to locate to places with potentially good transport links, including Newport, Wrexham, Blaenau Gwent and Caerphilly. This leaves British stand alone firms focused on Ceredigion, Pembroke, Conwy etc, rather than Newport or Blaenau Gwent.

The final diagrams show the pattern of computer services and telecommunications usage. For the former the highest usage is in Cardiff and then Newport and in LAs to the east of Cardiff bordering the M4, Median usage in Ceredigion is not particularly high and is lowest in the more peripheral areas of Pembroke, Denbigh and Conwy. To an extent this almost certainly reflects supply side factors, but lack of knowledge and also perhaps differential access to broadband across the country may play a part.

The Regression Results: Productivity

The results of the previous study are confirmed. Multinationals remain the most productive of firms, followed by group firms, followed by British stand alone firms. In addition, productivity is partially determined by geographical features such as population density and distance. The key distance variable is distance from London. Also relevant are skills and the key variable to focus on is the proportion of the workforce with no skills – in many cases this means an inability to even read or write. We will return to this point subsequently, but for now emphasise that investing in the education of the least qualified could bring substantial benefits in terms of productivity.

But the research has added one new variable to the analysis, clusters. We find evidence to suggest that firms located in clusters – i.e. in areas with a relatively large number of similar firms – enjoy higher productivity. This is an important new result which adds to the literature. Another new result is that there appears to be a peak level of population density above which firm productivity begins to decline. This is actually quite high and no local authority in Wales exceeds this population density, although parts of the most densely populated areas may. Finally, and somewhat worryingly there is evidence that firms in Wales are less productive, given their characteristics, than we would otherwise expect.

The Regression Results: Industry Productivity

The basic results on productivity were expanded upon in two dimensions. Firstly we looked at productivity in different industries. The results reveal that there are substantial differences in different industries. The industries which suffer most from a high proportion of a ‘no-skilled’ labour force are manufacturing, wholesale-retail, catering and transport. Stand alone British firms are at a reduced competitive advantage in manufacturing and construction, which may reflect the fact that other industries are more localised, and less subject to competition, or that technical progress has been slower (in the case of construction). Time distance from London is critical for all industries other than catering and transport. But perhaps the most interesting results relate to the impact of clusters. They increase productivity in

retail wholesale, catering and the socio-education sectors, but reduce it in manufacturing and construction. The literature suggests a diversity of affects of clusters which can either increase or reduce productivity and this is what we seem to be seeing here. To a large extent the industries which gain from clusters are ones where the customer goes to the firm, rather than in some form the opposite. This tentatively suggests that the advantages we have identified in part lies in firms of this type being focused in one locality – e.g. a shopping centre – which consumers can readily access. These results are summarised in Table 1 below.

The Regression Results: Productivity, the Rural Urban Divide

Secondly we looked at productivity in rural as opposed to urban areas. We focus on the differences.

- A locality with a high proportion of skilled workers boosts productivity for firms in urban areas but not rural. This may reflect fundamental differences between rural and urban firms.

- Interestingly both population density and time distance from London impact upon both rural and urban economies, but the impact of the latter is much greater for rural economies.

- The disadvantage of stand alone British firms is greater in rural than urban areas.

- Regional differences are more pronounced in rural than urban areas: for example firms in Welsh rural areas are at more of a disadvantage than firms in Welsh urban areas.

Much of this tentatively suggests that rural areas are relatively more 'sealed' from other areas, knowledge takes longer to be diffused to rural areas and the disadvantage of stand alone firms or peripherality is greater. ***Consistent with this is a model of knowledge diffusion which first sees knowledge transferred from London to other major urban centres and then from these major urban centres to their rural hinterland. Rural firms near London are then at an advantage over other rural firms, as the first stage of this diffusion process is bypassed.*** This too is new to the literature. But there are other possibilities relating to possible other objectives of business owners and access to business support and finance. However this remains somewhat of a contentious issue with the evidence on whether it is a real issue being mixed.

Table 1: Summary of Impacts

	Distance Variables										
IMPACT VARIABLES	Time London	Miles London	Time Other	Miles Other	Population Density	% High Skills	% No Skills	Stand Alone	British Group	US	Clusters
Productivity	-4.50%	ns	na	Na	1.40%	Na	-18.60%	-11.30%	-2.70%	5.30%	Pos
Productivity rural	-9.13%	ns	na	Na	1.25%	Na	-21.30%	-13.30%	-4.72%	7.15%	Pos
Productivity urban	-3.08%	ns	na	Na	1.07%	5.12%	-17.60%	-9.25%	-1.60%	5.43%	Pos
Capital	-9.38%	Ns	na	Na	1.65%	11.90%	-2.46%	-21.30%	-4.92%	Ns	Ns
Energy Demand	5.68%	ns	6.24%	-10.15%	-2.22%	-20.80%	-11.90%	-11.57%	-3.07%	Ns	Ns
Fuel Demand	5.20%	-3.72%	8.83%	-12.50%	Ns	-8.11%	-8.46%	-18.54%	-6.19%	Ns	Neg
Demand other Services	-10.50%	3.66%	-6.25%	6.09%	3.82%	17%	-16.80%	-29.31%	-11.40%	Ns	Ns
Demand Road Transport	ns	-4.54%	13.00%	-20.40%	-1.56%	Ns	ns	-35.30%	-15.63%	-8.70%	Ns
Demand Water	ns	3.80%	na	Ns	Ns	-5.50%	Ns	ns	ns	Ns	Pos
Waste Disposal	ns	ns	na	Ns	-0.88%	-6.70%	Ns	-5.21	ns	Ns	Pos
Internet Buying	Pos.	ns	ns	ns	Ns	Pos	Neg	Neg	ns	Pos.	Neg.
Internet Selling	ns	ns	na	ns	Ns	Pos	Ns	Neg	ns	Ns	Neg.
Computer Services	-6.20%	ns	Na	Ns	3.35%	9.89%	-18.80%	-31.89%	-14.02%	ns	Pos
Telecommunications	-7.05%	ns	Na	ns	2.33%	8.97%	-12.80%	-23.74%	-10.77%	5.99%	Pos
Inventory	5.09%	na	Na	na	-1.75%	ns	ns	-18.80%	-4.97%	ns	Pos
Insurance	ns	ns	Na	ns	Ns	ns	ns	-7.58%	ns	-8.88%	Ns
Business Rates	-5.48%	3.11%	Na	ns	4.09%	ns	-23.30%	-24.27%	-8.45%	ns	Pos
Taxes Paid	-6.55%	3.46%	Na	ns	2.86%	ns	-22.40%	-23.05%	-6.99%	4.04%	ns

Pos/Neg: positive/negative impact as variable increases; Ns/na not significant or applicable - For all variables other than ownership, the figure shows the impact on productivity of increasing the variable by 100% (which sounds a substantial change, but could e.g. relate to making a low population density area slightly less so). For example, if we increase time distance from London by 100% then capital stock declines by 9.38%. Similarly inventories increase by 5.09%. When the time distance and mileage distance have opposite signs this suggests that it is the speed of travel, proxying the quality of road infrastructure which is relevant. For example, increasing the time distance from the nearest major conurbation other than London increase demand for road transport by 13%, but an increase in mileage reduces it by 20%, this suggests that partially what is relevant is speed of travel. For the ownership variables, the variable shows the impact of a firm being, e.g. a stand alone one rather than a foreign, non-US multinational. Hence such firms use 35.3% less road transport than the multinational. The impact of clusters is shown in terms of whether it significantly increases or reduces the relevant variable, e.g. fuel demand falls for firms in a cluster of similar firms.

The Regression Results: Other Results Summary

Table 1 summarises some of the key impacts. It summarises both the impacts of key variables across a range of variables such as productivity and waste. But it also summarises the determinants of those variables themselves. Below we discuss the key results focusing on the extent of usage of, e.g. those who do use computer services. More detailed analysis of these results can be found in sections 5 and 6. Discussion of the interpretation of these results and policy implications is largely delayed until the final section of this report.

With respect to services we distinguish between whether or not a firm buys that particular service, which we term 'incidence of usage' and if so the amount they buy which we term 'extent of usage'.

The Regression Results: Capital Stock

This is greater in localities characterised by high skill levels. This is important as there is only a relatively weak and variable linkage between such areas and productivity per se, but this result together with the impact of capital stock on labour means that highly skilled areas are associated with higher labour productivity. Capital stock is not linked to clusters, however it does increase with population density and declines with time distance from London, but not mileage nor any of the other distance variables. But given all this, there are significant regional differences. Capital stock is also lower for UK group firms than multinationals and lower again for British stand alone firms.

The Regression Results: Energy Demand

We focus on extent of energy usage, i.e. given the firm is a buyer of energy, how much do they buy. This increases with both capital stock and the labour force. Extent of usage is also lower in areas with a high proportion of people with no skills and particularly low in areas with large numbers of highly skilled people. There may be two affects at work. Firstly, such energy usage increases with the employment of people with middle skills as they are engaged in energy intensive activities, but secondly, highly skilled people are known to increase productivity, they may well also increase the efficiency with which energy is used.

Extent of energy usage, which is measured by value, also declines with population density, but is not linked to distance from London. However it declines with respect to mileage distance from the other major urban conurbations and also increases with respect to time distance from those conurbations. In part this suggests that, other things being equal, energy usage declines with mile distance from major conurbations, but is also higher in areas with poor road infrastructure. Interestingly extent of energy usage is lower in UK group firms than foreign multinationals and lower again in UK stand alone firms. There are also significant regional differences in extent of energy usage, given other characteristics, firms in all regions use less energy than those in London and then the South East, with the biggest difference being for firms in the North West and the East Midlands.

The Regression Results: Fuel Demand

We again focus on extent of usage. This increases with the proportion of people in the area with medium skills – in this case there is no real difference between the

impact of the proportion with high and low skills and hence it does appear to be medium skills that is the critical factor. Again this would appear to reflect upon the type of activity the firm engages in rather than any efficiency factors. Fuel usage also increases with time distance from London but not with respect to any of the other distance variables. As with energy usage it is lower for British group firms than foreign multinationals and lower again for British stand alone firms.

The Regression Results: Demand for Road Transport

There is no real linkage with the skill characteristics of the locality, but road transport costs decline as population density increases, again this may reflect reduced costs in delivering to customers. Road costs also decline with mileage distance from both London and for other conurbations with respect to the quality of road infrastructure. That is the worse the road infrastructure, the more is spent on road transport – implying that better road infrastructure can help firms economise on road transport costs. Finally, as with fuel usage, road transport costs are lower for British group firms than multinationals and lower still for British stand alone firms. The same possible explanations we put forward earlier also apply here. Finally, extent of usage is lower in Objective 1 areas. Is this a characteristic of the firms in these areas or a characteristic of the road infrastructure not otherwise picked up?

The Regression Results: Demand for Other Services

This really is a miscellany of diverse purchases. It increases with both labour and capital and with the population density of the locality – which may well reflect the availability of these other services. It also increases with the proportion of highly skilled people in the locality and declines with the proportion of no skilled people and this again may in part reflect supply factors. It is also lower for UK group firms than foreign multinationals and lower still for British stand alone firms. All of the distance factors are relevant with a pattern of signs which suggest that extent of usage increases with the quality of the road infrastructure to both London and other major conurbations.

The Regression Results: Demand for Water

The extent of demand amongst those who buy water declines with the proportion of highly skilled people and is greater in clusters. But neither population density nor the distance variables, apart from weak significance of mileage from London, are significant. Nor are there differences between different types of ownership of firms. However industry differences are substantial.

The Regression Results: Cost of Waste Disposal

The extent of demand amongst those who incur wastage costs declines with the proportion of highly skilled people in the locality, which is significant at the 5% level of significance and with population density. Once more such costs are significantly higher for firms located in clusters. Of the distance variables only time distance from major conurbations is significant. Whilst the cost of waste is significantly less for stand alone British firms. This may reflect the fact that such firms are less

productive or, more speculatively, that they follow lower (though not non-compliant with regulations) standards in disposing of waste.

The Regression Results: Internet Selling & Buying

We only have data on incidence of use rather than extent of use, i.e. on whether or not it is used by firms for these purposes. The use of the internet for sales increases with the size of capital stock and labour force. But the use of the internet for sales purposes does not vary with area characteristics such as population density or the distance variables, apart from internet buying the probability of which increases with time distance from London. To this extent the internet can be seen to be reducing the disadvantage of remoteness. The probability of a firm using the internet for buying or selling increases with the proportion of highly skilled people in the area and the former is inversely related to the proportion of lowly skilled people in the locality. Internet buying does seem more sensitive to skill characteristics the internet selling. The use of the internet for buying or selling is also inversely related to clustering, which suggests that firms in a cluster tend to both source and sell more within the locality than other firms.

The Regression Results: Computer Services Usage

This is higher in areas with a higher proportion of highly skilled labour as well as being lower in those areas with a high proportion of low skilled people. This is one of the relatively few occasions when usage of any activity clearly increases as we move up the skill ladder. It is again also positively and very strongly linked to population density. Once more this is likely to reflect supply side factors, in terms of both the number of firms offering such facilities and the range of such facilities being offered. This may also explain the greater use of such services if the firm is in a cluster – as supplier firms can specialise in serving that cluster. The use of computer services decreases with time distance from London, with none of the other distance variables being significant. It is possible that, as with productivity, this reflects a knowledge diffusion effect or the nature of the business activities. Similarly to productivity such usage is lower for UK group firms than multinationals and lower still for British stand alone firms.

The Regression Results: Telecommunications Usage

Extent of usage increases with the labour force and the capital stock. It has been increasing over the years, is higher in areas with a large proportion of people with high skills and lower in areas with large proportions of low skilled workers. Even more than with computer services extent of usage is inversely related to time distance from London, but none of the other distance variables are significant. It is also greater if the firm is in a cluster and lower for UK group firms than foreign multinationals and lower still for British stand alone firms. Usage also increases with the number of units in the group. There are relatively few regional differences, although firms in the South East and Scotland do exhibit greater extent of usage than other firms.

How to interpret these results? This is a long established but still rapidly evolving technology. Its long establishment results in there being relatively little differences in probability or incidence of usage due to knowledge asymmetries. That is almost all firms use the technology. The technology has been around long enough that most (almost all) firms in all areas are aware of its existence and hence the variables related to knowledge diffusion tend not to be significant. However they are very significant when we examine extent of usage as this is still a rapidly evolving area and hence information on its potential use is not equally spread across all firms in all areas. Thus we conclude that there is little impact of diffusion differences with respect to whether firms use this technology, but there may be a diffusion effect with respect to what people do with this technology and the extent to which they use it.

The Regression Results: Firm Location

Stand alone British firms are relatively less likely to locate in local authorities with a high proportion of highly qualified people and relatively more likely to be located in those areas where large numbers of people have low skills. They are also, and this is very significant indeed, to be found in areas with relatively low population densities. This does not mean that as population density declines so the number of stand alone firms increase, but rather that relative to firms in groups and multinationals they increase. This probability also increases with time distance from London, but declines with mileage distance from London, suggesting a location with relatively poor road infrastructure. The coefficients are very close in absolute terms and this suggests that what is critical is the average speed with which a journey to London takes rather than distance per se. These firms are also relatively more likely to be located in Objective 2 areas, although not Objective 1, and less likely to be part of a cluster. There are significant regional variations and stand alone British firms are most likely to be found in the South West and Scotland.

British firms which are part of a group, which may or may not be British multinationals, are relatively more likely to locate in areas where there is a relative concentration of highly skilled people and also in areas of high population density. They are also more likely to be located in areas where the average speed of travelling to both London and other major conurbations is high, suggesting good road transport infrastructure. Finally they are less likely to be located in Objective 2 areas. The highest proportion, given other characteristics, tends to be in Yorkshire and Humberside and the East and East Midlands, and the lowest in Scotland.

Foreign multinationals tend to be located in areas with relatively large proportions of medium skilled people, rather than those with high skills and more especially no skills. The probability of them being located in an area also increases with population density, although not to the same extent as UK group firms. Also as with UK group firms, speed of travel with respect to London is important as is locating in a cluster, indeed this is even more significant than for UK group firms. They are also less likely to be attracted to Objective 2 areas. ***There are substantial regional differences and other things being equal Wales tends to be the most favoured location followed by the North East.*** Further research could expand on this to analyse whether there is a discernable industry trend to the location patterns, e.g. do different types of multinationals locate in London as opposed to Wales, and with Wales in the Cardiff-Newport area as opposed to Wrexham, for example.

The Regression Results: Inventory Holdings

We now turn to other factors of firm behaviour, which although not direct inputs into production, reflect firm efficiency or factors which impact on profits. Inventories increase with the labour force, capital stock and GVAFC. Inventories also decline as population density increases, but increase if the firm is part of a cluster. The former may reflect the greater ease of getting supplies as well as closeness to customers, the latter may reflect once more the impact of competition, forcing firms to provide a better service by having more stocks ready to meet demand. They are lower for British group firms and lower again for British stand alone firms. Other things being equal there are significant differences across the regions and after those in the North East, firms in Wales tend to hold low stocks.

The Regression Results: **Insurance Costs**

Insurance costs increase with the labour force, total output and capital stock, the most important factor is capital stock. They have been rising steadily over the years. They are lower for British stand alone firms, and surprisingly perhaps, US multinationals, but there are very little systematic differences across locality characteristics – although there is some evidence they are lower in Wales.

The Regression Results: Business Rates

These increase with labour, capital and GVAFC. There is no linkage with the proportion of highly skilled people in an area, but there is an inverse relationship with the proportion of low skilled people. They increase with population density, but decline with time distance from London and there is evidence too that they increase with the quality of the road infrastructure. They are lower for UK group firms than multinationals and lower again for UK stand alone firms and greater in clusters. All of this suggests the somewhat reasonable conclusion that business rates reflect the quality of the location for business purposes. Other things being equal they are high for Scotland, London and to a lesser extent the East and low for Wales and to a lesser extent the North West, the South West and the East Midlands. This then potentially represents something of a competitive advantage for Wales. Finally, there is evidence that they are lower in Objective 1 areas.

The Regression Results: **Taxes Paid**

This is an interesting variable as it is in part at least, a proxy for profits and in reality it is this which we are interest in as much as taxes. Total taxes increase with the labour force, the log of gross value added and capital stock. They are lower for firms in areas with a high proportion of low skilled people, are directly related to population density and inversely related to time distance from London. However the positive significance of miles from London suggests that both time distance from London, and average speed of travel to London – reflecting quality of road infrastructure – are significant factors. Taxation is lower for British group firms than multinationals, with US multinationals paying particularly high levels of taxation, and lower still for stand alone British firms. The differences are considerable and greater than for GVAFC. There are significant regional differences but these can be

summarised as firms in Scotland paying the highest taxes followed by those in London, the East and then the South East, followed by the other regions. However the lowest taxes are paid by firms in Wales, given all other characteristics.

3. A priori Expectations & Rationale

The Previous Report

Business-level data indicated that there is a considerable headline gap between Wales and London as the leading, benchmark region in terms of output per employee. The key question, however, was the extent to which we could account for the gap between Wales, London and a range of other regions and could identify the relative importance of different factors, enabling us to see the effect of these on productivity differentials measured relative to London.

What the analysis showed is that inclusion of successive variables progressively reduced the productivity gap to a level that is insignificant in a statistical sense. In other words, we could explain away the productivity gap, statistically speaking at least, in terms of these known and inherently plausible factors. The factors that were important were capital stock and industrial composition. This indicated that differences in industrial structure do contribute to differences in productivity but not to a very major extent. Also important were ownership structure, the skills level of the local workforce and population density. Finally, significant was travel time to London, not mileage to London and not distance to other major towns/cities. These results also emphasised that multinationals were far more productive than UK firms, particularly UK stand alone firms.

Productivity

The literature on productivity in general has its origins in modern economic growth theory, where the quantity of the labour force has always been employed as an important explanatory factor behind the change in the level and rate of output, along with the level of capital in the neoclassical growth model. The failure of this model to accurately account for changes in output was partially solved with the augmentation of the model to incorporate human capital, and now much of the literature that attempts to account for differences in income and productivity rates across economies frequently highlights the importance of skills (see, for instance Mankiw, Romer and Weil (1992)). The new economic geography literature (Krugman, 1991) has added to this by also emphasised the importance of location.

We assume, as is common (Griffith, 1999), a Cobb Douglas production function:

$$Y = AK^{\beta 1}L^{\beta 2} \qquad (1)$$

where *K* is capital stock, *Y* is Gross value added at factor cost (GVAFC) and *L* the labour force. *A* represents efficiency factors which we model as:

$$A = \exp(\beta_0 + \mathbf{\beta_2 X} + \text{Industry variables} + \text{Regional Variables}) \qquad (2)$$

X will include data on ownership, population density[3], skills characteristics of the locality and distance variables reflecting efficiency factors relating to managerial efficiency and technical knowledge, agglomeration and human capital.

Knowledge Diffusion

Bartlesman and Doms (2000) note an S shaped diffusion pattern of technology or 'knowledge capital' though the economy. This is consistent with a literature which suggests innovation and knowledge diffusion can be modelled as 'contagion' and that this can be spread geographically often via firm networks (Pittaway et al, 2004, Griffith et al, 2004). Innovations are also more likely in a large sophisticated market place receptive to new ideas. Hence we assume major population centres will be 'major innovation centres', where new techniques and products tend to be first introduced and the speed of knowledge diffusion will be an inverse function of distance from such centres. The literature also indicates that knowledge diffusion may be more rapid when there are localized clusters of firms.

The literature also suggests that, given the level of knowledge and capital, stand-alone firms are less efficient than firms who part of groups, possibly due to an ability to spread overheads.

Ownership

There has been considerable research done on the impact of ownership on productivity. Criscuolo and Martin (2003) use the ARD database to investigate the impact of foreign ownership on productivity. They find strong evidence of a US productivity advantage which is consistently greater than for other multinational enterprises (MNEs). However, they also find that MNEs *per se* also have productivity advantage over other non-MNEs. These conclusions are consistent with those of others; see for example, Doms and Jensen (1998) and Griffith et al. (2004).

Evidence also exists at the national level and Girma et al. (2001) find foreign firms have higher productivity levels than domestic firms, and they pay higher wages. Moving away from multinationals, Girma and Gorg (2007) decompose the productivity advantage of foreign multinationals into a technology and a scale effect and show that the positive effect of multinationals is primarily due to a technology effect. Again knowledge diffusion is critical

Conglomerates, or groups of firms, have also been found to have a productivity advantage over stand alone firms (Schoar, 2002). Barth et al. (2005) conclude that family firms tend to be less efficient than non-family owned firms possible because they rely on a more limited pool of managerial ability. Wall (1998) found a productive gap of 18% between family firms and non-family firms in Western New York.

Human Capital

[3] This relates to population density in 1981 as there is the possibility that a region with an unexplained increase in productivity will attract firms and workers and have a higher density.

The HM Treasury (2001) has commissioned a number of reports into the nature and causes of productivity differences across the UK and argues that skill differences are one of the most important causes of these regional productivity differences. At one extreme London has the highest regional productivity rate, partly because it has the highest quantity of skilled labour force in the UK, particularly in terms of those with a university degree. If firms that intensively employ skilled workers realise this (and *ceteris paribus*) then they are more likely to locate to London rather than to locate other UK regions.

However, this phenomenon is accentuated by the recognition by the skilled worker that his/her skills are in greater demand in London and therefore their wages might be higher. Rice, Venables and Patacchini, (2006) focus on income per worker (defined as gross value added (GVA)) in NUTS3 regions of Great Britain and, amongst other things, emphasise the importance of skills, which in this case is identified through the proportion of the economically active population who have either no formal qualifications or degree level qualifications. An increase in the former tends to reduce income per worker and the latter to increase it.

Geographical Factors

Many papers focus on distance effects. A model that incorporates a spatial element must naturally incorporate distance decay. Gravity-type models are often employed with this in mind. Economic mass has been found to be important in determining the distribution of income per worker across NUTS3 regions of Great Britain by Rice, Venables and Patacchini. By *economic mass* these authors mean the presence of a large population of working age within 80 minutes driving time. Their estimates suggest that doubling economic mass raises productivity by 3.5%.

Weisbrod and Treyz (1998) note that productivity can be affected by many factors, including the level of technology and the quality and capacity of various supporting infrastructures, including transportation networks. They suggest that highway investments can improve productivity and lead to economic growth at the local level for local businesses in three distinct ways. First, it can reduce travel costs for serving existing trips; second, it can reduce inventory/logistic costs; and thirdly, it can increase operating scale and accessibility economies.

An important area of associated research is that on “time-based competition”, which examines how speed and reliability of product delivery have become increasingly important factors in business growth (Blackburn, 1991). More generally, McCann (1993) suggests producers solve the “logistics-costs location production problem” when deciding on their optimal shipment frequency and their choice of production location. Over the long term, the profit-maximising location of production may differ if logistics costs are added to direct user travel costs and therefore the optimal location will vary with industry and the bulkiness of goods.

Clusters

Much has been made in the literature of clusters which relate to the specialization of an industry within a locality. Clusters can arise as a result of natural cost advantages such as soil, climate, coastal location, infrastructure, etc. Examples include wine growing, ship building and mining. Much of the discussion surrounding

clusters relates to spillover advantages between firms in facilitating knowledge diffusion, external economies of scale, etc. These could be physical spillovers that reduce the cost of transportation and other factor inputs by economies of scale in sub-contractor's production. The agglomeration of firms also increases the possibilities of specialisation between firms as more specialised tasks in firms can be outsourced (Madsen et. al, 2003).

Clusters may also raise productivity for other reasons as discussed in Audretcsh and Feldman (2004). Proximity enhances the ability of firms to exchange ideas and be cognizant of important recipient knowledge. The key factor is that much knowledge tends to be communicated by personal and indeed visual contact, rather than by mail. Particularly important is the potential impact of such knowledge transfer on innovations. ***However, in increasing competition it is possible they may reduce productivity (Rosenthal and Strange, 2004)***. This could happen because of the incomplete appropriation of the returns from innovation as other firms imitate that innovation. Similarly increased competition can drive down prices hence reducing productivity when measured in terms of the value of output produced.

In the literature, clusters have previously been discussed by e.g. Combes and Overman (2004). But they have generally been applied to explain the productivity of geographical areas rather than, as we will be doing here, firms located in those areas. Hence in this respect we are expanding the boundaries of knowledge. Our measure of clusters will relate to the proportion of firms in the locality which are in the same industry as a particular firm. Further details on this are given in Appendix 1.

We will also be including variables such as population density in the locality to proxy agglomeration effects. A further factor that needs to be considered, which has important policy implications, is the effects of energy consumption on productivity. To date there have been a number of studies which have identified the relationship between energy intensity and productivity growth, such as Jorgenson (1981). Finally we will be seeking to determine whether there are any differences between firms in Objective 1 and Objective 2 areas and other firms.

Modelling Resources Use

In this research we go beyond modelling productivity to also examine the factors which impact on productivity and resource use. Our approach will be similar to that for output, i.e. the demand for resources and the production of 'output bads' will depend upon capital stock, labour force and all the factors which impact upon output. Four factors are relevant: (i) scale of activity, (ii) specific technical characteristics of that activity, (iii) efficiency of usage and (iv) unit cost of usage as it may vary from location to location.

Hence the significance of ownership, e.g., may in part be due to the impact this has on output, but also on, e.g. the relative efficiency of resource use or the scale of use by multinationals. Similarly, the impact of skills will depend both on its impact upon output and its impact upon efficiency with respect to resource use. We anticipate that efficiency in this respect will be like any other efficiency variable and be subject

to imperfect information and the speed of dissemination of latest techniques and best practices.

This will be our approach to modelling all of these additional variables including location. In this respect we will be pushing the new economic geography and related literature forward and asking how far it is relevant for activities of firms other than simply productivity. But in doing this we must be aware of specific theoretical factors relating to specific variables as well as the literature surrounding those variables. The latter will help us both understand and interpret our results. This is the task we turn to in the following sections.

Energy, Fuel & Transport Usage

We anticipate that efficiency in this respect will be like any other efficiency variable and be subject to imperfect information and the speed of dissemination of latest techniques and best practices. Fuel and transport use will also depend upon both the scale of activity and efficiency factors, but in addition will depend upon geographical and firm specific factors. For example, a firm in a peripheral, low population density area can expect to face high transport costs ***if it is exporting outside its immediate area.*** In addition, a firm with several plants linked together in some form of vertical integration may be expected to face higher transport costs than firms not so linked.

Telecommunications

The telecommunications industry is of particular, theoretical, interest. It is an old established technology and in its basic form should have now been 100% diffused with no knowledge asymmetries. However having said that we anticipate no differences in incidence of usage[4], we do have such expectations for extent of usage. This is still a rapidly evolving area and we expect there to be differences in knowledge similar to those we have argued are relevant for productivity, i.e. again these will be based on ownership, distance and locality characteristics.

The Cost of waste

Once more we assume the cost of waste disposal will be determined by a production function as for normal output. Waste is an output from production just as much as what we normally think of as output. The only difference is that this is an output firms will, increasingly, be trying to minimise, albeit subject to other objectives and costs. We say increasingly as it has only been in recent years that waste has become a significant factor in policy makers' and firms' thinking. But with environmental and indeed political pressures from the EU as well as treaty obligations, land fill may be expected to become increasingly expensive and also there will increasingly be an obligation on firms to dispose of their waste economically and to ensure that their consumers are also able to do this.

[4] Throughout we differentiate between incidence of usage and extent of usage. Incidence of usage refers to whether or not a firm makes use of, e.g. road transport. Given that a firm does make use of such services, extent of usage refers to the amount of usage.

For many firms this will become particularly important. An example of this are those affected by the WEEE regulations which make producers of Electrical and Electronic Equipment (EEE) responsible for those products when they become waste. Another example is the EU Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive, which e.g. from 2006 put limits on the maximum permitted levels of lead, mercury, cadmium, etc in a product. Waste, all waste, is going to become an increasingly important factor in firm's calculations and minimising associated costs will begin at the product design stage.

In the UK about 19% of waste comes from manufacturing and of this 51% goes to landfill. The cost of waste has been steadily rising. In 1996 a landfill tax was introduced. The cost of waste abatement differs across local authorities, with counties in the commuter belt exhibiting the highest costs (Chapple et al, 2006). Shadbegian and Gray (2006) find evidence that firms who are more efficient in the environmental dimension are also more efficient along the economic dimension as well. In passing we mention the Porter (1990) hypothesis that strict, correctly enforced environmental regulation can lead to secondary benefits for firms in terms of both improved product design and waste reduction. The heart of this is the assumption that waste implies that resources have been incompletely, ineffectively or inefficiently used. The literature on this is however inconclusive at best (see Crotty and Smith, 2006).

But how can we expect the cost of waste to vary from firm to firm? There are four factors at work, firstly scale factors, i.e. the amount the firm produces, secondly, the implicit nature of the product, thirdly the efficiency with which the firm can produce with minimal waste and then dispose of that waste efficiently and finally the extent to which it chooses to comply or over-comply with regulations. Efficiency in waste disposal is likely to depend upon efficiency factors and knowledge as previously discussed.

But there is a fourth factor, to what extent is the firm implementing the current regulations properly and to what extent is the firm doing more than is required by current legislation because either it is anticipating future legislation or for whatever reason it wishes to behave in an impeccably correct manner. Some firms may go beyond statutory requirements due to factors such as reputation benefits (Arora and Cason, 1996; Chapple et al, 2006). For example some firms have adopted ISO14000 – the environmental management system standard – and others have joined local initiatives such as Envirowise.

Firm Location

Finally, we turn to factors which although they do not directly enter the production function impact on profits indirectly, beginning with location. Is this random between firms? Or do stand alone British firms tend to locate in different locations than, e.g., multinationals and if so why?

Most studies tend to look at the number of multinationals in a region. Our analysis is, of course, based at the level of the firm and hence we will in effect be analysing the factors which influence the relative location decisions of three types of firm: (i) the British stand alone firm, (ii) the British or UK group firm and (iii) the foreign

multinational. For example, if agglomeration economies are important these will show up as positively significant in characterising whether a firm is a multinational relative to some other firm type. Hence in effect we analyse, for example, the probability of a firm being a multinational with this probability being dependent upon geographical and industry specific factors. In practice this has similarities to analysing the proportion of firms in a locality who are foreign multinationals, British group firms or stand alone firms.

To an extent the location of a firm can be part accidental. Firms are where they are because that is where their founder happened to live. On the other hand some firms also relocate, sometimes under the pressure of market forces and often following expansion. At this point in time, if not before, one would expect their location not to be random but to be in part based on a calculation of financial advantage, based on transport infrastructure, distance to markets, availability of a qualified workforce, extent of local competition and quality of environment.

In this decision, not all factors are equally relevant for all firms. For a large establishment access to a substantial pool of qualified labour is likely to be of greater importance than for a small establishment. In part this depends how big the owner(s) want the business to be, some do not want to grow beyond a certain size, but others do and for them factors which impact upon the potential size of market are important.

Thus, we argue that the probability of a firm being located in an area is a function of the natural advantages of that area for that firm. This will not be the same for all firms as these will depend on the industry, the intended market and the type of activity. Hence if the firm is effectively a production or service facility, then key will be (i) access to skilled, but not necessarily highly skilled, labour, (ii) agglomeration economies and (iii) good transport links to connect the firm to its markets, its suppliers and possibly other plants in the group. In addition factors such as chance dictate location particularly for smaller firms who are not necessarily profit maximisers.

Much of the literature has focused on multinationals. There is evidence that low taxes and other incentives attract multinationals (Devereux and Griffith, 1998). Crozet, Mayer and Mucchielli (2004) with respect to the location of multinationals in France found agglomeration economies to be important, but national or EU policy incentives had only a minor role. There is strong evidence that agglomeration factors are important in attracting multinationals (Barrios et al, 2006). Barrios et al do not find population density to be important but two variables they term localisation and urbanization are important. They also conclude that regional policy has only been successful in attracting low-tech multinationals to designated areas.

The localisation variable is similar to the cluster variable we will use. The urbanisation variable reflects more on an area's degree of specialisation in any one industry – not necessarily the industry of the firm we are examining. Urbanisation shows the degree of diversity of a locality, the specialisation shows how important any one industry is to the locality. They concluded that the localisation variable had no impact in attracting hi-tech firms, but they were important in attracting low-tech multinationals.

Internet buying/selling, use of telecommunications and computer equipment.

These are implicitly part of the productivity story. The internet is, still, a relatively new phenomenon and although most firms probably now have access to the basic technology, taking advantage of this to its largest extent may still be expected to vary between firms according to their access to that knowledge. To an extent the internet can be used to buy or sell goods as an alternative to other ways of buying and selling and this may be more prevalent in peripheral regions.

The literature has tended to focus on individual firm usage of the internet rather than its association with geographical characteristics. In this respect, Eikebrokk and Olsen (2007) focus on e-business competences which may be linked to skills in the locality. Guerrero, Egea and Gonzales (2007) analyse internet banking and conclude that a major factor determining the use of internet banking was trust in the internet channel. In general this literature does emphasise the importance of trust or confidence in the safety of e-commerce.

Inventories

For many years the literature within economics has suggested that firms held inventories to minimise production costs to avoid bunching production in the face of decreasing returns to scale. In this case the quality of transport infrastructure had no relevance for inventories. However Shirley and Winston (2004) argue that better transport infrastructure allows firms to reduce inventories because orders will be received more quickly with less uncertainty. But with US data they find the returns to vary from modest to trivial.

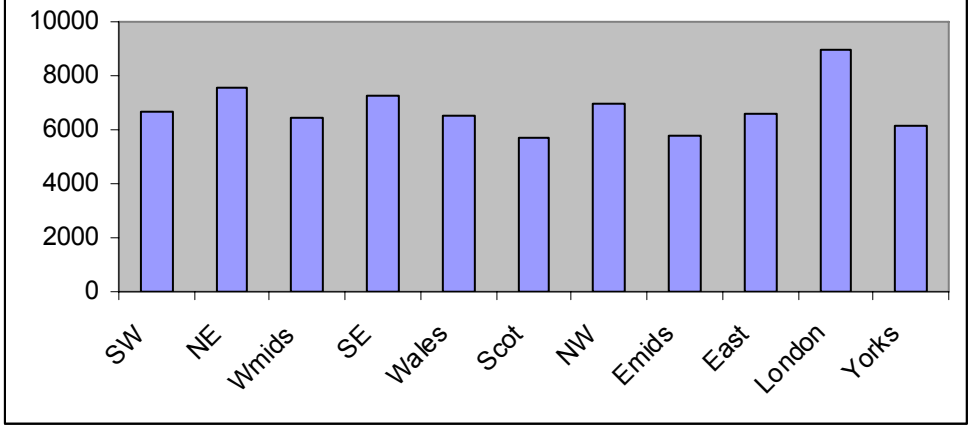
Dimelis and Lyriotaki (2007) conclude that, in a study based in Greece, the larger a firm and the greater the foreign level of foreign participation then the lower would be inventory investment. This was justified on the grounds of economies of scale and advanced technological and administrative systems applied by foreign owned firms. However slightly counter to this, Gertler and Gilchrist (1994) find evidence that small manufacturing firms draw down their inventory stocks following a monetary shock whilst large firms appear able to borrow to smooth out inventories.

4. The Data

The Annual Respondents Data base (ARD) draws Information together from a variety of sources including historical records, tax returns and various surveys. Those firms with employment below a certain level are sampled on a random basis and hence are not surveyed every year. The ARD provides information on the establishment rather than the firm per se. Some data, e.g. output, relates to the firm or enterprise level which is then imputed in order to provide data for individual establishments. It is possible to link other data to the establishment dataset using postcode data available for all establishments. The full set of variables included in our analysis is listed in Appendix 1.

In this section we present some of the raw data in diagrammatic form for first Britain's regions and then the Welsh local authorities. Average gross value added at factor cost (GVAFC) is shown in Figure 1. The figures represent the mean in the sample, they are not typical of 'the average firm', but much greater driven up by very large firms, nor are they totally representative of the region as in the ARD larger firms receive a greater weighting than small ones. This is the case for all the figures. None the less the trends are still informative. GVAFC is highest in London and then the South East followed by the North East and North West. Wales is 'average'.

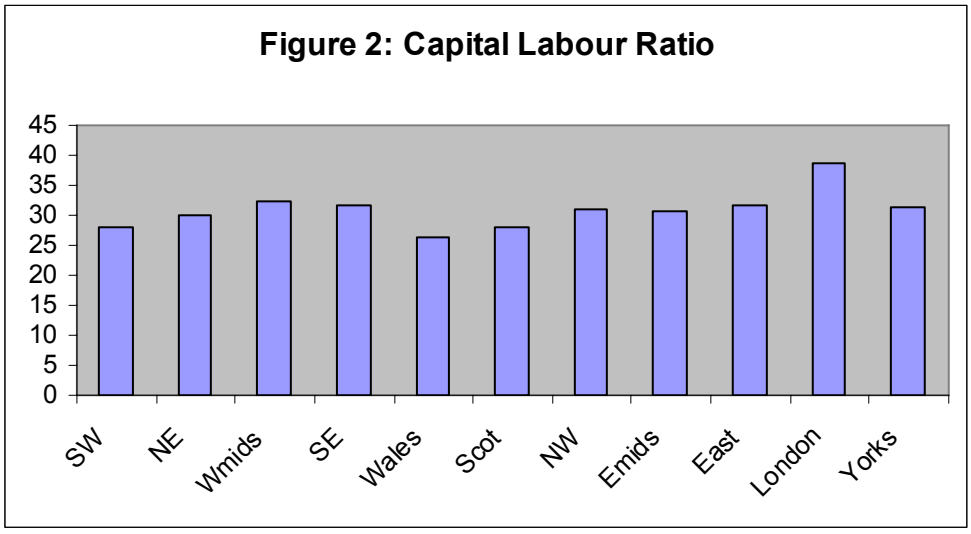
Figure 1: Average GVAFC



Value in terms of £000 pa. All data on GVAFC relates to the establishment.

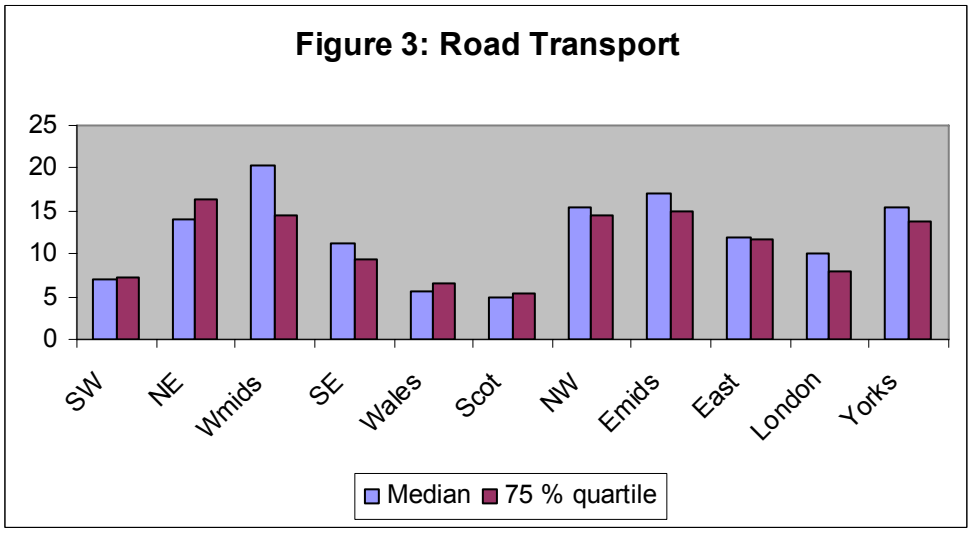
Figure 2 shows the average capital labour ratio. Unlike Figure 1 which relates to the mean, this relates to the median establishment and hence represents the 'average firm' rather than the mean average. Unless stated, this is the case in the remaining diagrams as, particularly when we look at local authorities in Wales, one or two large firms can have a substantial impact on the mean. Not surprisingly the trends

are similar to those in Figure 1. London has the highest capital labour ratio. The lowest figures are in the South West, Scotland and Wales. This does not necessarily mean, e.g., that the capital labour ratio is low in Wales, but that for the median firm it is on the low side. This suggests that the trends in Figure 1 are partially explained by capital stock per worker.



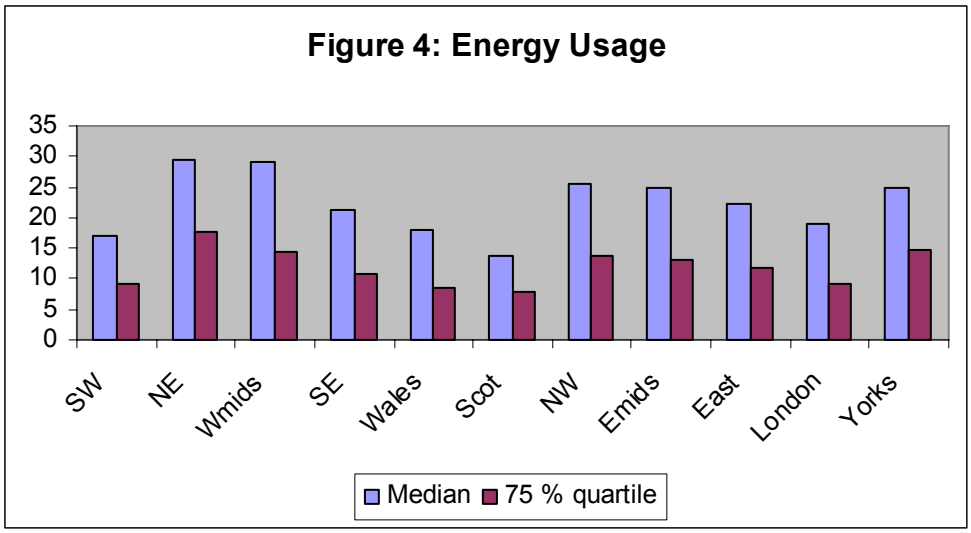
Value in terms of £000 per worker for the median firm.

Average road transport costs per firm are shown in Figure 3, they are highest for the West Midlands, Yorkshire+ Humberside, the North West and the East Midlands. They are lowest for Scotland, Wales and the South West. In addition the ratio of the 75% quartile firm to the median is greatest in these three regions. These figures relate to the buying of road transport, rather than 'in-house' road transport, but for most firms who export outside the region this may well be particularly relevant.



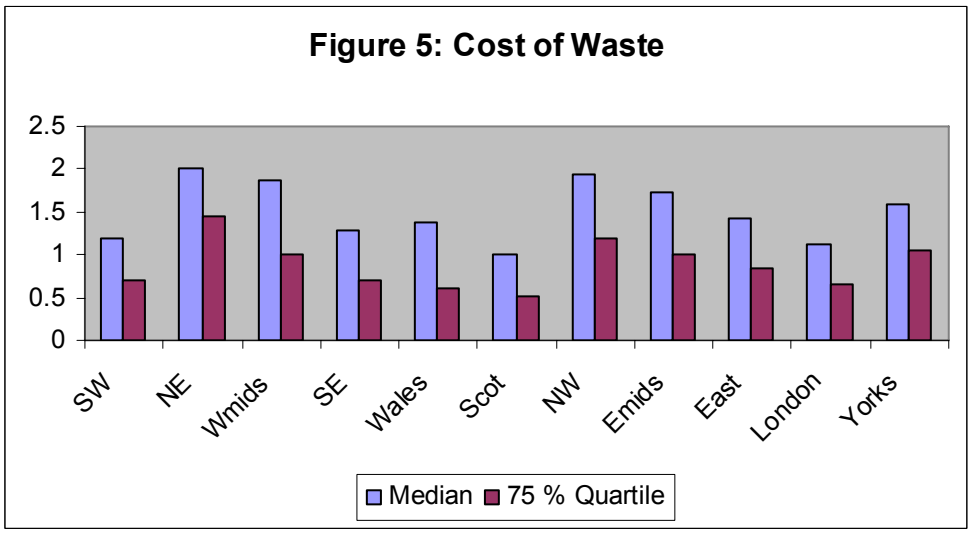
Note: the 75% quartile figure has been divided by 10 for presentational purposes otherwise these figures would dominate the histogram. Throughout it is made clear when this practice is followed. Value in terms of £000 pa.

Figure 4 shows average energy costs per firm. As with road transport, they are highest in the traditional industrial areas of England and lowest in the three areas already identified of Scotland, the South West and Wales, although the differences are not as great as with transport. These costs include petrol usage.



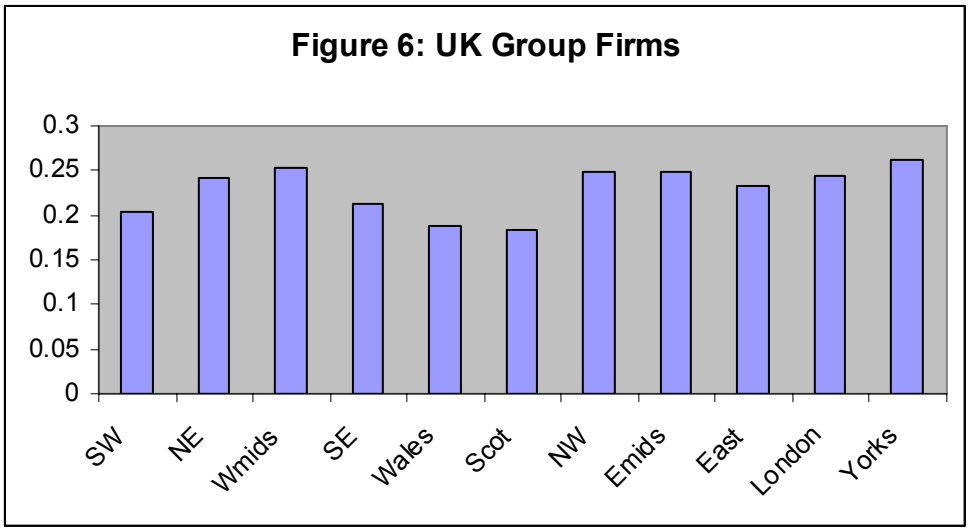
Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

Figure 5 shows the cost of waste. This is greatest in the traditional industrial areas of England again, and lowest in Scotland and the South West, but this time not so much Wales, at least for the median firm.



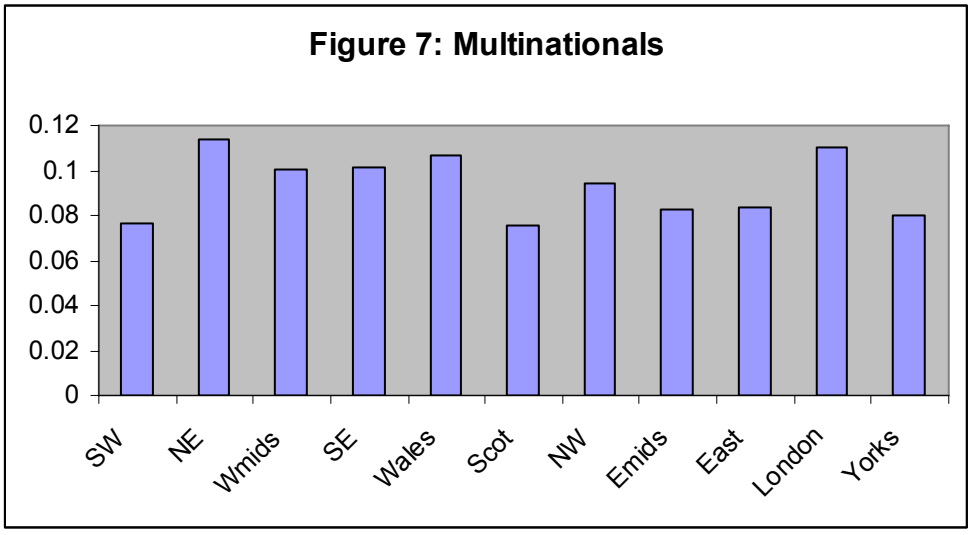
Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

Figure 6 shows the proportion of UK group firms. The lowest proportions are in Scotland and Wales and the highest in Yorkshire and Humberside and the West Midlands.



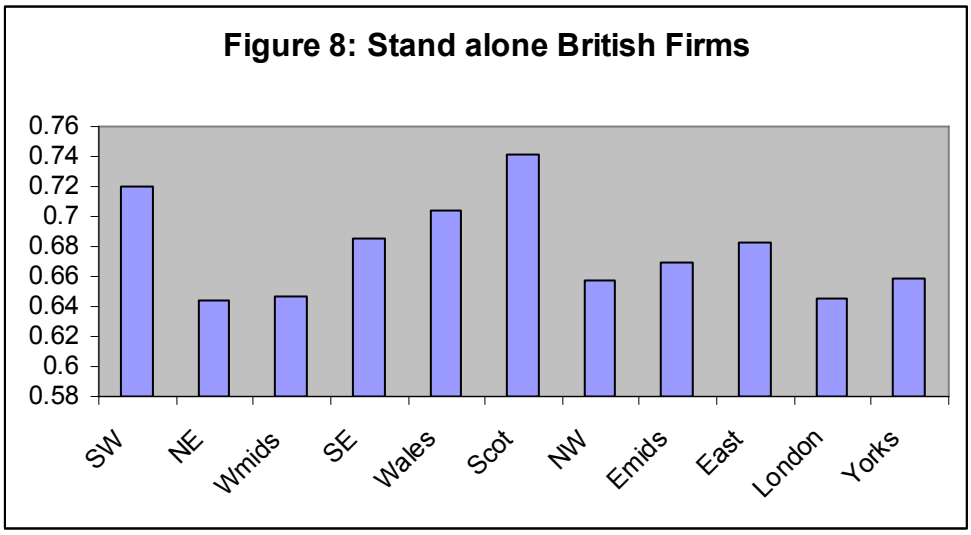
Data relates to the proportion

Figure 7 shows the proportion of multinationals in Britain. These are quite evenly spread, but are highest in the North East, Wales and London and lowest in Scotland and the South West.



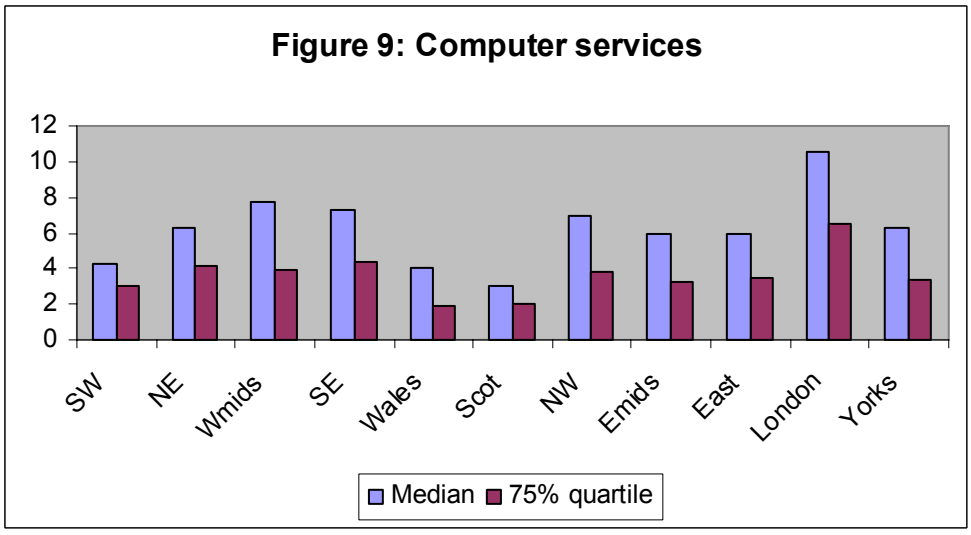
Data relates to the proportion

Finally with respect to ownership, we have the proportion of stand alone British firms. These are highest in the South West, Scotland and Wales which are largely peripheral regions. They are lowest in the North East and London.



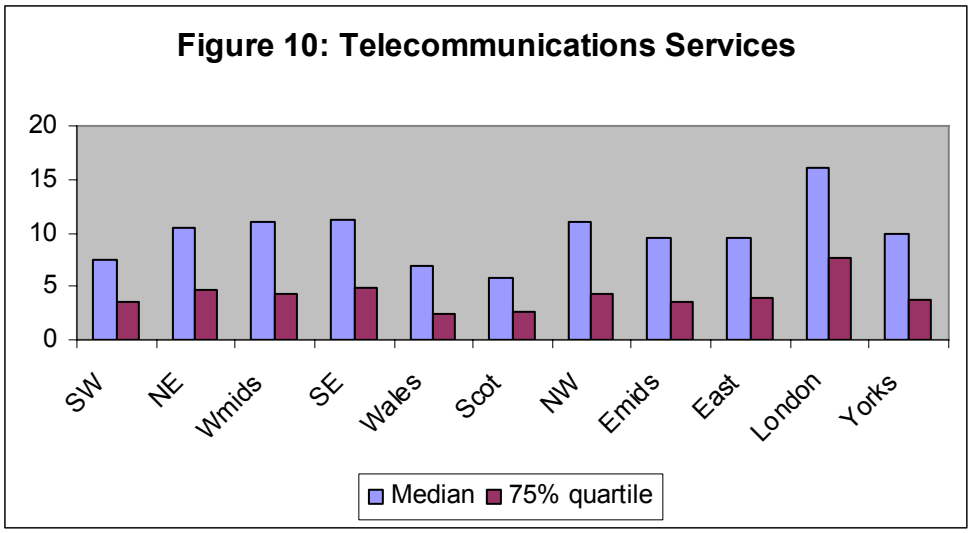
Data relates to the proportion

The use of computer services by the median firm is highest in London and lowest in Scotland, Wales and the South West. When we look at the firm represented by the 75% quartile – i.e. a larger firm, then relative to the rest of the country Wales and also Scotland are particularly low.



Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

The highest usage for telecommunications services lies with firms in London, the lowest usage is in Scotland, Wales and to an extent the South West.

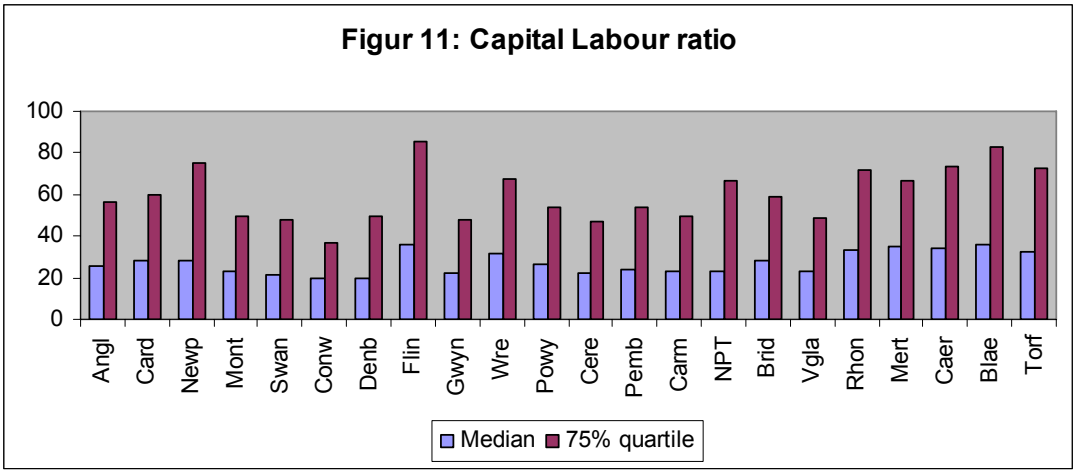


Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

Turning now to local authorities in Wales, the figures with means are particularly problematic as with relatively small numbers, one or two very large firms can dominate the averages. In the diagrams and tables below we have the following definitions:

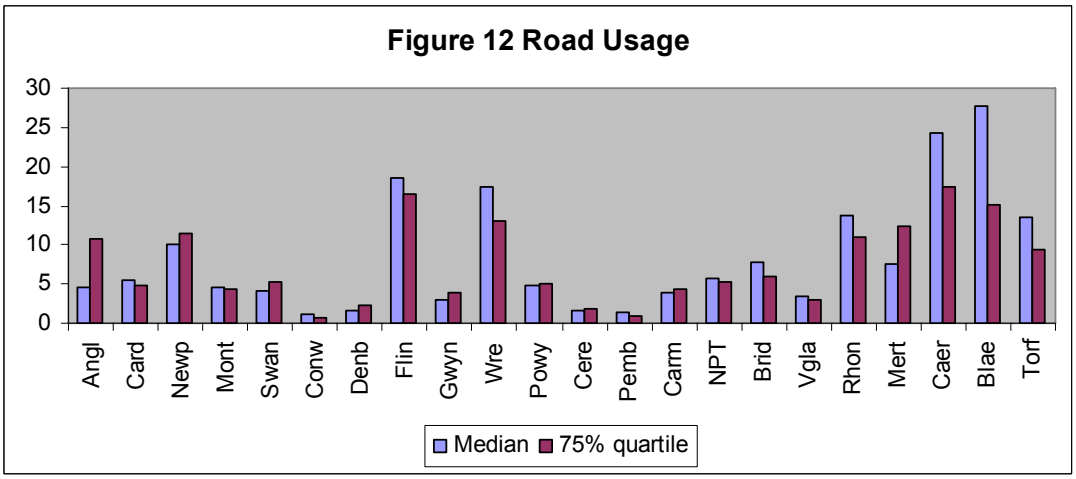
Angl=Anglesey, Card=Cardiff, Newp=Newport, Mont=Monmouth, Swan=Swansea, Conw=Conwy, Denb=Denbigh, Flin=Flint, Gwyn=Gwynedd, Wre=Wrexham, Powy=Powys, Cere=Ceredigion, Pemb=Pembroke, Carm=Carmarthen, NPT=Neath Port Talbot, Brid=Bridgend, Vgla=Vale of Glamorgan, Rhon=Rhondda Cynon Taff, Mert=Merthyr Tydfil, Caer=Caerphilly, Blae=Blaenau Gwent, Torf=Torfaen

First the average or mean capital labour ratio is highest in Anglesey, followed by Gwynedd, Pembroke and Neath and Port Talbot. It is lowest in Conwy. These figures are not shown, but instead the median and 75% quartile and here the picture is substantially different. For the median firm, the highest capital labour ratios are in Flint and also Rhondda, Merthyr, Caerphilly and Blaenau Gwent. They are low in Conwy, Monmouth, Swansea, Denbigh, Ceredigion.

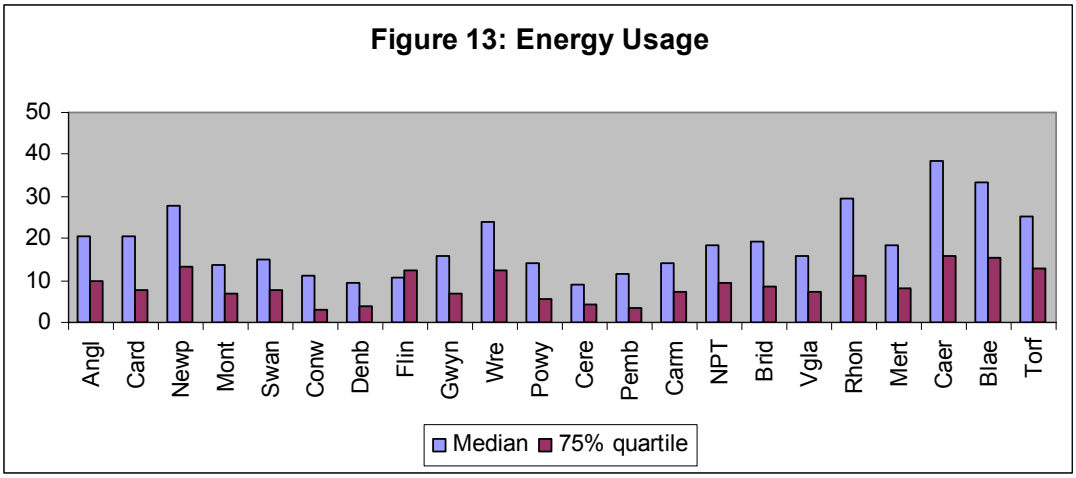


Note: Value in terms of £000 per worker.

We can see that in terms of average road use per se, the highest median firms are in Filint, Wrexham, Blaenau Gwent and Caerphilly. The lowest are in Conwy, Denbigh, Ceredigion and Pembroke. To a large extent these figures are determined by peripherality, but also by industrial structure – which in itself in large part is a consequence of location. We emphasise once again that the figures relate to road services bought in and not provided 'in-house'. Of all the services we discuss this exhibits the largest difference between the median and 75% quartile firm – and may be a reflection of the possibility that the former is more focused on local markets.



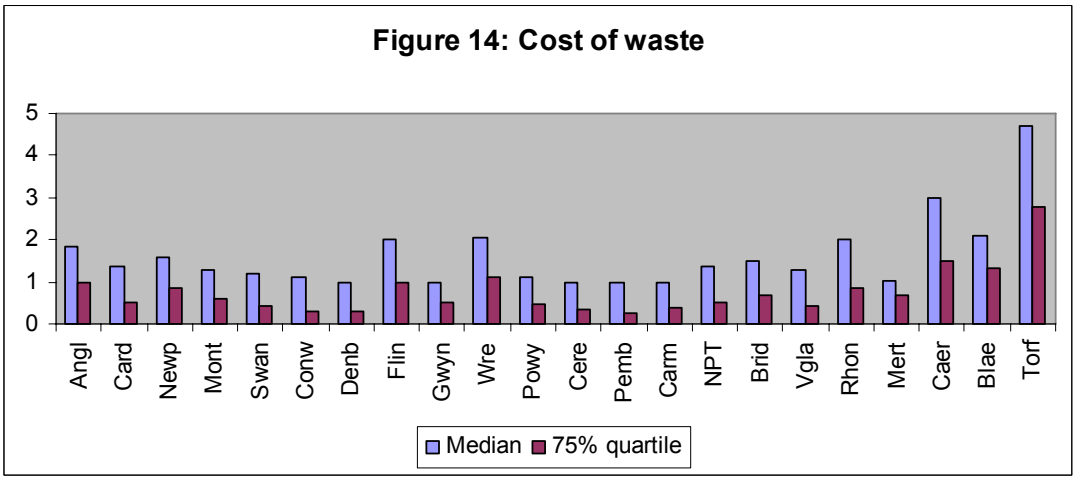
Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.



Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

Figure 13 shows energy usage. The biggest users of are Caerphilly, Blaenau Gwent, Rhondda and Newport. The smallest users are in the more peripheral areas Ceredigion, Pembroke and Denbigh. The differences are even more pronounced when we look at firms on the 75% quartile, where e.g. the firm in Caerphilly uses almost five times the energy of one in Conwy. This will be explained by both scale, but more importantly industrial structure and perhaps intensity of use. It should be remembered that energy includes fuel.

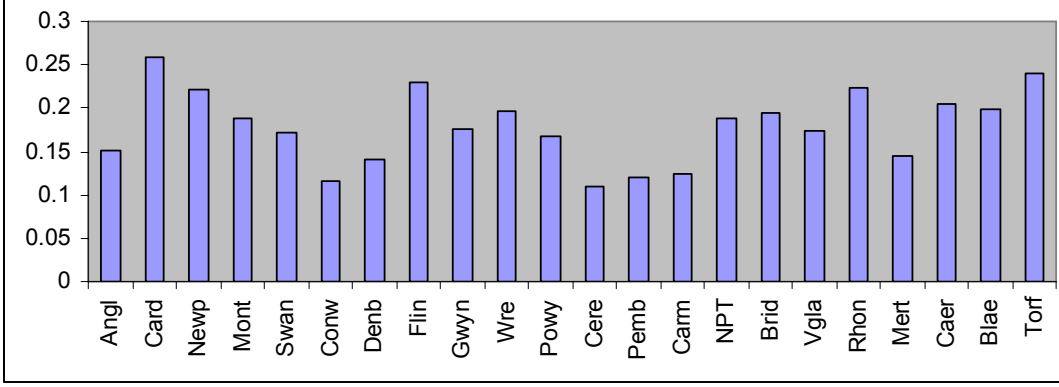
The average cost of waste for firms across Wales is shown in Figure 14 and differs substantially across regions. It is greatest in Torfaen, followed by Caerphilly. It is lowest for firms in Denbigh, Conwy, Ceredigion and Pembroke. Once more this largely reflects industrial structure.



Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

British group firms are least commonly located in Anglesey, Conwy, Ceredigion, Pembroke and Carmarthen, the more remote parts of the country.

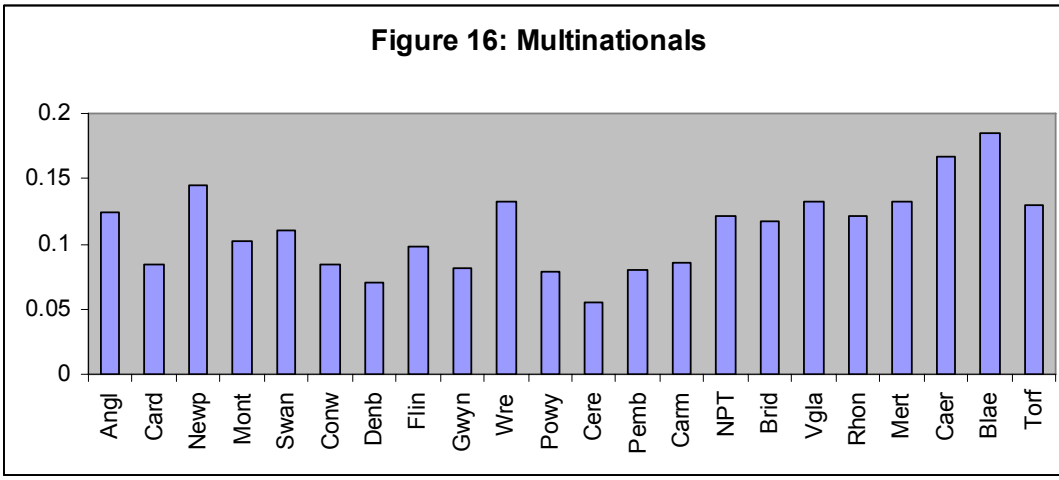
Figure 15: British group firms



Data relates to the proportion

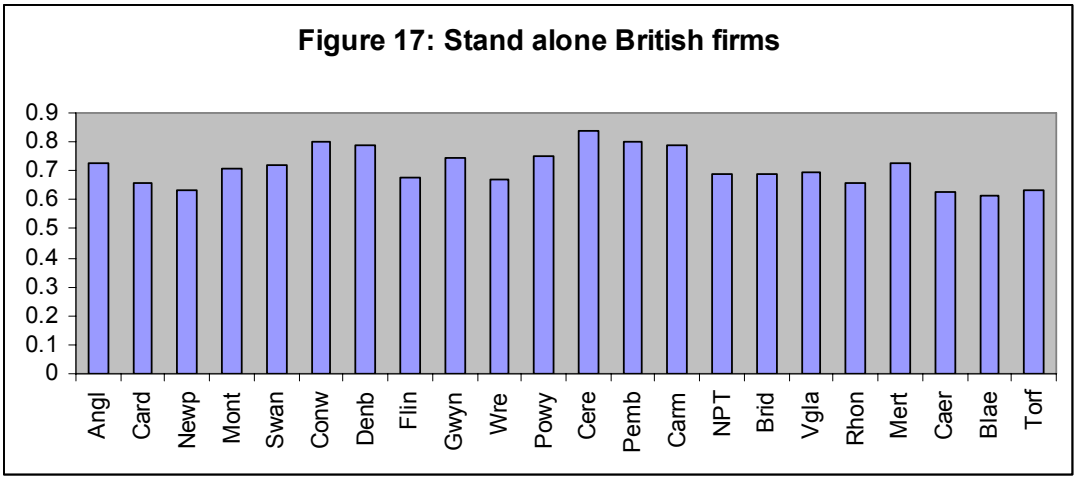
Foreign multinationals are most commonly located in Blaenau-Gwent, Caerphilly and Newport and least commonly located in Ceredigion, Denbighshire, Powys and Pembrokeshire. To a considerable extent the former are in regions with good transport links and the latter in more remote areas.

Figure 16: Multinationals



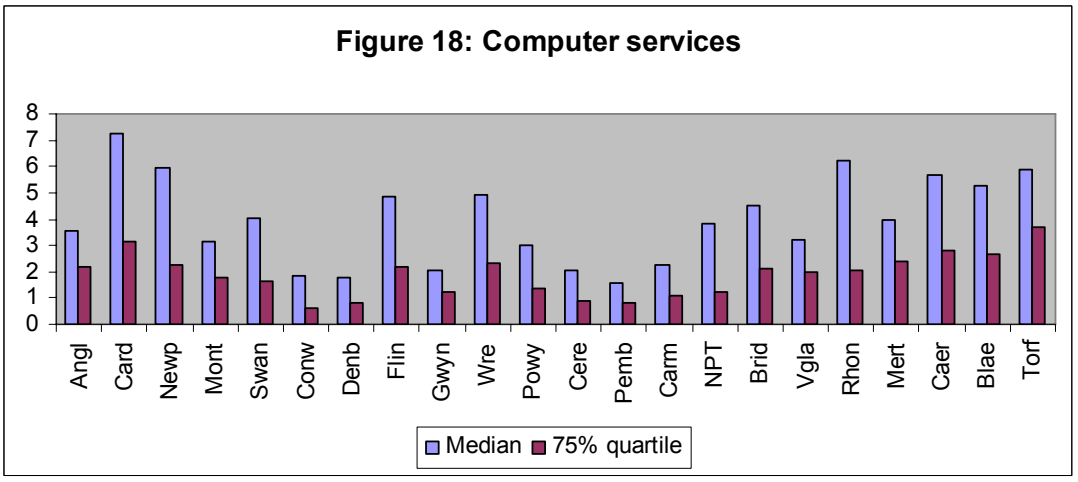
Data relates to the proportion

The pattern of stand alone firms is of course the mirror image of the patterns for British group firms and foreign multinationals.



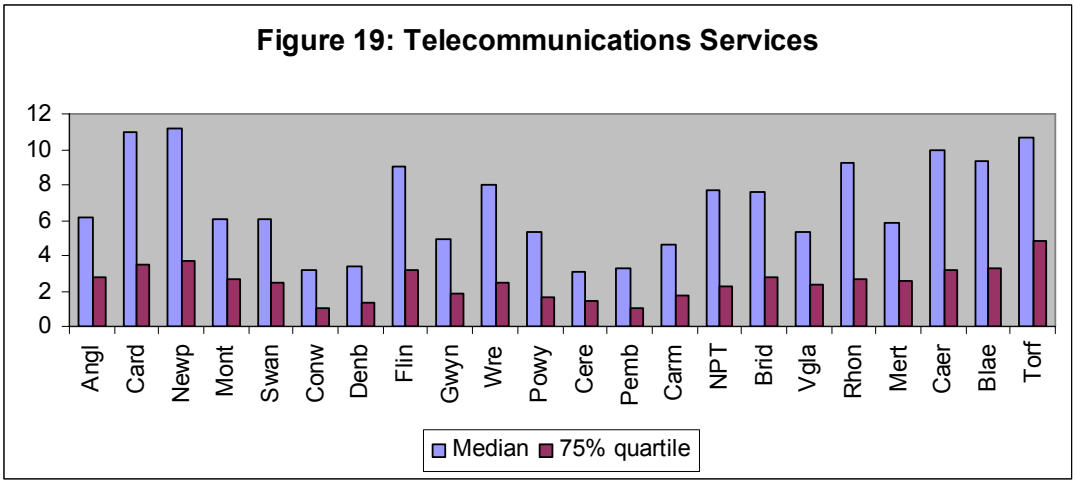
Data relates to the proportion

The pattern of computer service usage across Wales is given in Figure 18 and shows a hugely diverse pattern. In terms of the mean, this is particularly high in Ceredigion and Denbigh, which was not expected, and then Cardiff which was. In part Ceredigion is explained by the two Universities and other public bodies located there. However, when we look at the median, as showed in Figure 18, there are substantial differences. Highest usage is in Cardiff and then Newport and in LAs to the east of Cardiff bordering the M4. Median usage in Ceredigion is not particularly high and is lowest in the more peripheral areas of Pembroke, Denbigh and Conwy. To an extent this almost certainly reflects supply side factors, but lack of knowledge and also perhaps differential access to or demand requirements for broadband may play a part.



Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

Figure 19 shows the pattern of telecommunications services. Usage is highest in Newport, Cardiff and Torfaen. It is low in the more peripheral areas.



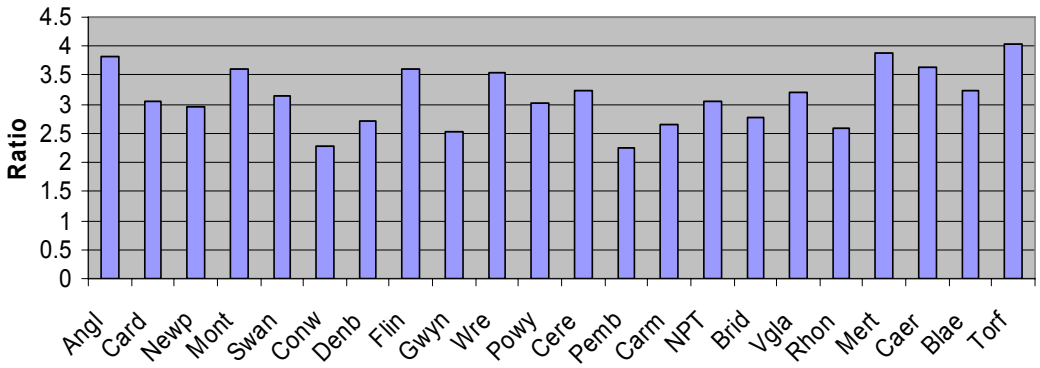
Note: the 75% quartile figure has been divided by 10. Value in terms of £000 pa.

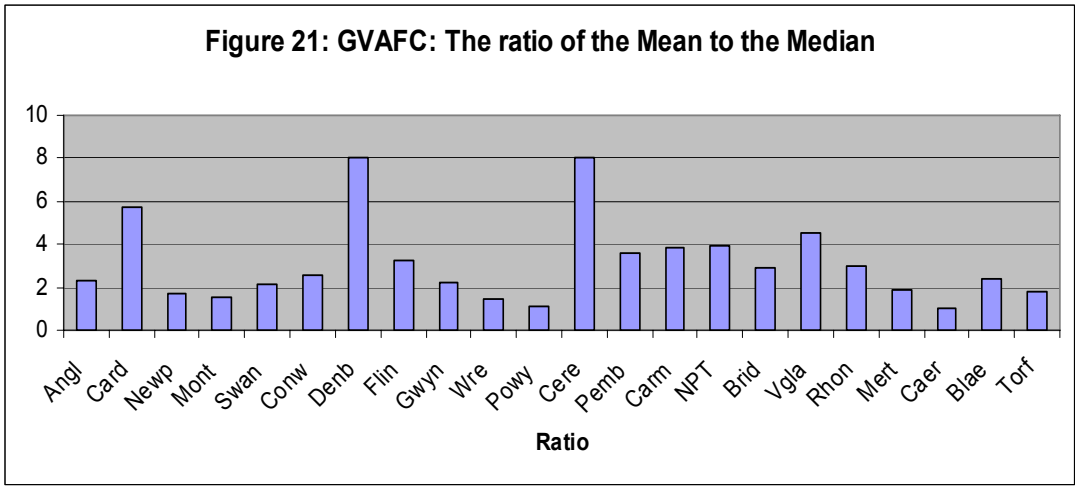
The Local Authorities of Wales in a Snapshot.

The Figures in the tables which are discussed below are indicative of differences rather than an exact picture of the characteristics of the local authority. They reflect, unless otherwise stated, the characteristics of the median firm. This is not the same firm in each case, as the median firm for energy usage is unlikely to be the median firm for road usage. The data can however be analysed in a number of ways. For example the ratio of the median or 75% quartile's firm GVAFC to the mean gives an insight into firm structure. A high ratio of mean GVAFC to the 75% quartile GVAFC is indicative of a number of large firms – perhaps just one or two – above the 75% quartile pushing the mean up. This may well be also indicative of an area highly dependent upon a small number of large firms. Whilst a low ratio of the median to the 75% quartile firm is indicative of a flatter distribution. In addition, the data needs to be used in conjunction with others. These are illustrated below in Figures 20 and 21.

Few characteristics – e.g. large number of small firms, high median sized firm, are inherently bad. Regions can and do prosper with many diverse structures. But if the locality is shown to have problems in terms, e.g. of high unemployment, outward migration etc, this data can help illuminate where the problems lie.

Figure 20: GVAFC: The ratio of the 75% percentile firm to the Median

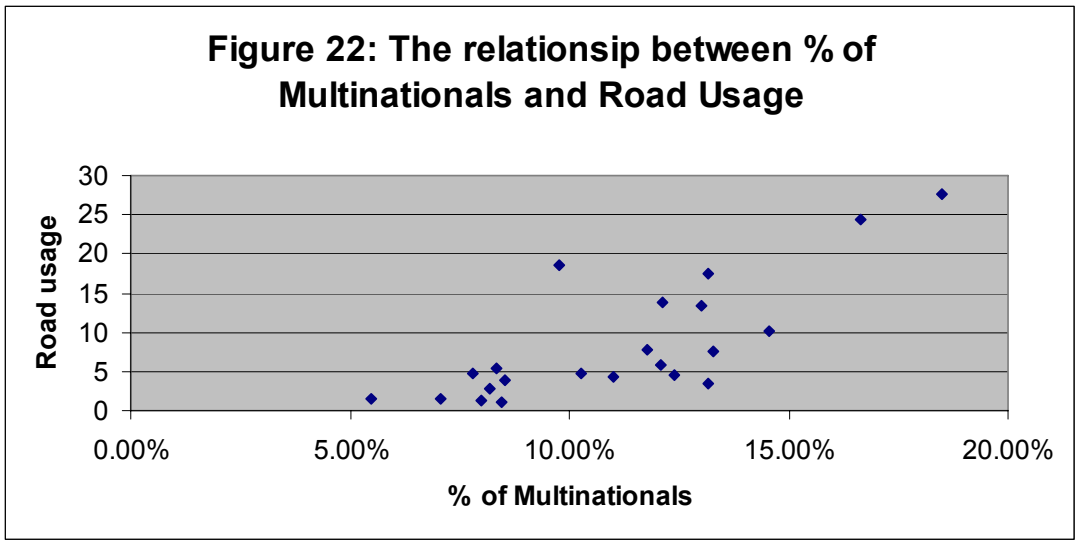


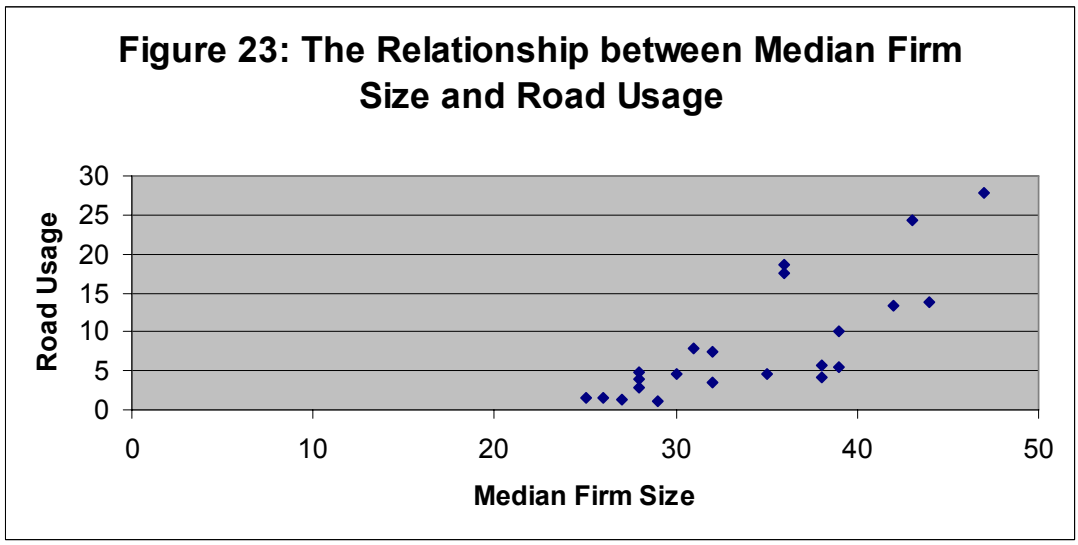


Note Denbigh and Ceredigion have been capped at 8.

In interpreting this data too it should be borne in mind that the variables tend to be interrelated. Hence a large number of multinationals does tend to be associated with high road transport usage – as reflected by Figure 22. This may well be both cause and effect, that is multinationals are attracted to areas with good transport links and then use those transport links. Figure 23 sheds more light on this in showing the relationship between firm size and road transport services. That median usage increases with median firm size is not surprising, both are in absolute terms. But the slope of the line linking the two suggests that the rate of increase is much more than proportionate. Hence local authorities where the median firm has fewer than 30 workers sees the median firm spend less than £5,000 on road transport services, whereas firms in a local authority where the median firm has 45 workers spend approximately £15,000. Again this may be cause and effect, good transport links facilitate larger firms with a widely dispersed market.

More generally low transport usage can be associated with firms in the local authority serving a local market, rather than a wider one nationally or internationally. That this is the case for Cardiff reflects the importance of the city as the most important market in Wales. Whereas for the more remote regions it is probably reflective of poor transport infrastructure resulting in it being uneconomic for most firms to attempt to market their goods outside their locality. But firms in these areas who do export outside the locality are likely to be faced by very high relative road transport costs. This gives an interesting insight on those firms who are most likely to be affected by increasing transport costs.





Anglesey: The median firm is characterised by an average numbers of workers (35) but the larger firm at the 75% quartile is much larger than average (123). The capital labour ratio for the median firm is slightly below average, but for the 75% quartile firm slightly above average. This leads to GVAFC above average for the 75% quartile firm, but perhaps given the size of its labour force not by as much as we would expect. For the median firm expenditure on road services, computer and telecoms is less than average, but on energy and waste slightly more. In terms of firm ownership it has quite a representative distribution for Wales.

Cardiff: The characteristics are largely as one might expect for the capital and chief city in Wales. Both the median and 75% quartile firms are characterised by an above average numbers of workers. The capital labour ratio for the median firm is slightly above average, but for the 75% quartile firm almost exactly average. This leads to GVAFC above average for both the 75% quartile and median firms. The

difference is quite substantial and, e.g. for the 75% quartile firm is higher than Anglesey despite the latter having a substantially greater workforce. For the median firm expenditure on road services is close to the average for Wales as a whole, but less than the average for local authorities (because Blaenau Gwent pushes that average up). Expenditure on waste is also less than average, but on energy slightly more. Expenditure on telecoms is the highest in Wales for the median firm and the second highest for the 75% quartile firm – only slightly behind Newport. In terms of firm ownership it has more UK group firms and less stand alone firms than the average and slightly fewer multinationals.

Newport: Even more so than Cardiff, both the median and 75% quartile firms are characterised by an average numbers of workers. The capital labour ratio for the median firm is about average, but for the 75% quartile firm considerably greater than the average. This leads to GVAFC above average for both the 75% quartile and median firms and even higher than Cardiff. For the median firm expenditure on all services is greater than the average, with the exception of waste. The high expenditure on road services relative to Cardiff – which does not of course include in-house road transport – tentatively suggests that the median firm in Cardiff is more focused on serving the locality and in Newport has a more dispersed market. In terms of firm ownership it has more UK group firms and multinationals and less stand alone firms (the third lowest) than the average.

Monmouthshire: This is easy to describe, everything less than the average. A smaller workforce, particularly for the 75% quartile firm and smaller capital labour ratio, again particularly for the 75% quartile firm. Given these it is not surprising that GVAFC is smaller than the average. This is also the case for all of the services including road transport. In many respects Monmouth in terms of characteristics lies in between the characteristics of areas such as Cardiff and Newport and the less prosperous, more remote, ones we discuss later on. In terms of firm ownership it has quite a representative distribution for Wales.

Swansea: The median firm is characterised by an above average numbers of workers and the 75% quartile firm by a workforce close to the average. The capital labour ratio for the median firm is below average for both the median and the 75% quartile firms. This leads to GVAFC slightly below the average for both categories of firms. For the median firm, expenditure on almost all services is less than average. It is, perhaps surprisingly, particularly low for road transport services. The exception to this trend is for computer services where expenditure is slightly greater than the average. In terms of firm ownership it almost an exact replication of that for Wales as a whole.

Conwy: This is again easy to describe, everything much less than the average and in many categories the lowest. The median firm has one of the smallest workforces and the 75% quartile firm the smallest workforce. The capital labour ratio for the former is also the smallest in Wales and for the latter substantially the smallest in Wales. Given these it is not surprising that GVAFC for both the median and 75% quartile firm, is the smallest in Wales and again the difference is substantial. Expenditure on road transport services is almost non-existent and on energy and waste amongst the lowest. Expenditure on both computer services and telecommunications services are the second lowest. Given all of this it is perhaps

not surprising that the locality has one of the highest proportion of stand alone firms in Wales and almost the lowest proportion of British group firms.

Denbighshire: This shares many of the characteristics of Conwy. Both the median firm and 75% quartile firms have some of the smallest workforces in Wales. The capital labour ratio for the former is the second smallest in Wales and for the latter one of the smallest in Wales. Given these it is not surprising that GVAFC is also one of the smallest in Wales, but nonetheless much greater than for Conwy. Expenditure on road transport services is the third lowest in Wales, on energy the second lowest and on waste the joint lowest. Expenditure on computer services is again the lowest and telecommunications services amongst the lowest. Given all of this it is again perhaps not surprising that the locality also has one of the highest proportion of stand alone firms in Wales and the second lowest proportions of multinationals. The proportion of British group firms is also low.

Flintshire: Both the median and 75% quartile firms have a labour force slightly greater than the average. Whilst the capital labour ratio for both categories of firms are also well above the average. As a consequence the GVAFC of both categories of firms are also above average, particularly for the 75% quartile firm. Expenditure on road services is particularly high, being the second highest in Wales. Possibly as a result of this expenditure on energy, which of course includes fuel for 'in-house' transport, is on the low side and well below average. The rationale being that product distribution is outsourced rather than done internally. Expenditure on all other services is considerably above the average, particularly telecommunications services. Slightly surprisingly perhaps, Flint also has fewer multinationals, but more UK group firms than the average.

Gwynedd: Everything much less than the average and in many categories amongst the lowest. The median firm has the fourth smallest workforce and the 75% quartile firm is also smaller than the average. The capital labour ratio for the former is also below average and for the latter substantially below average, being one of the smallest in Wales. Given these it is not surprising that GVAFC is considerably below average, although not amongst the lowest. Expenditure on energy is below average, but not exceptionally low. However, expenditure on all other services does tend to be on the low side, particularly waste services and computer services. Given all of this it is perhaps not surprising that the locality has an above average of stand alone firms in Wales and a smaller than average proportion of multinationals.

Wrexham: Both the median and 75% quartile firms have a labour force greater than the average, particularly the latter. The capital labour ratio for both categories of firms are also well above the average. As a consequence the GVAFC of both categories of firms are also above average, particularly for the 75% quartile firm which is similar to Cardiff. Expenditure on road services is particularly high, being the fourth highest in Wales. Expenditure on all other services is considerably above the average, although never amongst the highest. Wrexham also has fewer stand alone firms than the average and more UK group firms and multinationals.

Powys: Everything much less than the average and in many categories amongst the lowest. The median firm has the fourth smallest workforce and the 75% quartile firm also has a much smaller workforce than the average and lower than Gwynedd.

The capital labour ratio for both categories of firms is also below average, although not amongst the lowest. Thus it is not surprising that GVAFC is below average, but again it is not amongst the lowest for either category of firm. This is also case for expenditure on road services. However, expenditure on energy is amongst the lowest in Wales. Expenditure on all other services does tend to be on the low side, but it is again not amongst the lowest in Wales. Given all of this it is perhaps not surprising that the locality has an above average number of stand alone firms in Wales and a very small proportion of multinationals.

Ceredigion: Everything much less than the average and in many categories amongst the lowest. The median firm has the smallest workforce, but relative to the average the 75% quartile firm is better, being only the fourth smallest. The capital labour ratio for the former is also below average, but not exceptionally so, but for the latter is amongst the lowest. Given these it is not surprising that GVAFC is considerably below average. It is interesting to note the high mean value for GVAFC which is, as with Denbigh, perhaps indicative of a few very large 'firms' pushing the average up. Expenditure on road transport services is very small and that on energy the lowest in Wales, as it is for waste. Expenditure on computer services is one of the lowest in Wales and on telecommunications services the lowest. Given all of this it is perhaps not surprising that the locality has the highest proportion of stand alone firms in Wales and the lowest of both UK group firms and multinationals.

Pembrokeshire: Everything much less than the average and in many categories amongst the lowest. The median firm has the second smallest workforce, and the 75% quartile firm the joint smallest (with Denbigh). The capital labour ratios although below average are quite high for this type of region (characterised by small firms, etc). Nonetheless, GVAFC is amongst the lowest for the median firm and is the second lowest for 75% quartile firm. Expenditure on road transport is also the second lowest in Wales. Energy usage is amongst the lowest in Wales and that on waste services the joint lowest. It is also the lowest for computer services and one of the lowest for telecommunications services. Given all of this it is perhaps not surprising that the locality has the second highest proportion of stand alone firms in Wales and the second lowest of both UK group firms and multinationals.

Carmarthenshire: This too is in the low employment group of local authorities for both the median firm and 75% quartile firm. The capital labour ratios for both groups of firms are also on the low side. Together these account for Carmarthen having the fifth smallest GVAFC for both categories of firms. Expenditure on road transport is also low, but not as low as e.g. Conwy and Ceredigion. This is also the case for expenditure on energy. However, waste expenditure is the joint smallest in Wales and for computer services the fifth smallest. Expenditure on telecommunications is also on the low side. Given all of this it is again perhaps not surprising that the locality also has one of the highest proportions of stand alone firms in Wales and one of the lowest proportions of multinationals.

Neath & Port Talbot: The median firm employs slightly more, and the 75% quartile firm slightly less, than the average numbers of workers. However, the capital labour ratio for the median firm is below average and for the 75% quartile firm above average. This leads to GVAFC slightly below average for both the 75% quartile and median firms. For the median firm expenditure on road services is slightly above

average for Wales as a whole, but below the average for local authorities (mainly because Blaenau Gwent pushes the latter average up). It is also below average for waste, but on other services close to the average. Indeed for telecoms it is above average. In terms of firm ownership it has slightly more UK group firms and multinationals and consequently less stand alone firms than the average.

Bridgend: The median firm employs slightly less and the 75% quartile firm slightly more than the average numbers of workers. The capital labour ratio for the median firm is also slightly above average and for the 75% quartile firm marginally below average. This leads to GVAFC above average for the median firm and slightly below for the 75% quartile firm. For the median firm expenditure on road services is more than the average for Wales as a whole. Expenditure on all other services is above average, apart from waste disposal. In terms of firm ownership it has slightly more UK group firms and multinationals and consequently less stand alone firms than the average.

Vale of Glamorgan: Both the median and the 75% quartile firms are characterised by below average numbers of workers. The capital labour ratio for the median firm is below average for both the median and the 75% quartile firms. This leads to GVAFC slightly below the average for both categories of firms. However the mean figure for GVAFC is substantially above the average for the local authorities as a whole indicating the existence of some larger employers. For the median firm expenditure on all services is less than average. It is particularly low for road transport services. In terms of firm ownership it has more multinationals than average and fewer stand alone firms.

Rhondda: Both the median and 75% quartile firms have a labour force greater than the average, particularly the latter. The capital labour ratio for both categories of firms are also well above the average. As a consequence the GVAFC of both categories of firms are also well above average, particularly for the median firms which is the highest of any local authority in Wales. Expenditure on all services is well above the average. In terms of firm ownership it has slightly more multinationals than average and a very high proportion of UK group firms, leading to fewer than average stand alone firms.

Merthyr: The median firm has slightly fewer workers than the average, the 75% quartile firm substantially more. The capital labour ratio for both categories of firms are also well above the average, particularly the former. It is thus slightly surprising that the GVAFC of both is slightly less than one might expect, with the median firm being below average and the 75% quartile firm being only slightly above average. As with Wrexham, the mean GVAFC is on the low side suggesting a relatively small number of larger firms. For the median firm expenditure on road services is substantially more than the average for Wales, Expenditure on all other services is close to the average, apart from telecommunications services where it is a little on the low side. In terms of firm ownership it has more multinationals than average and fewer UK group firms

Caerphilly: Both the median and 75% quartile firms are characterised by a labour force well above the average, indeed the latter is the highest of any local authority in Wales. The capital labour ratio for both is also well above the average. This leads to GVAFC above average for both the 75% quartile and median firms, indeed the

second and fourth highest respectively. Given this, the mean GVAFC is very low suggesting a relatively small number of larger firms. For the median firm, expenditure on all services is very great and on energy it is the highest in Wales. Expenditure on all services is amongst the highest in Wales and that on telecommunications very high. In terms of firm ownership it has a high proportion of UK group firms and an even higher proportion of multinationals and consequently the second lowest proportion of stand alone firms. In this respect it may have benefitted from its assisted areas status.

Blaenau Gwent: Similar to Caerphilly. Both the median and 75% quartile firms are characterised by a labour force well above the average, indeed the former is the highest of any local authority in Wales and the latter the second highest. The capital labour ratios for both are also the highest of any local authority in Wales. This leads to high GVAFC for both the 75% quartile and median firms, but in neither cases not quite the highest, For the median firm expenditure on all services is very great and for road services it is easily the highest and indeed has a substantial effect for the average for local authorities in Wales as a whole. On energy it is the second highest in Wales and on telecommunications is also very high. In terms of firm ownership it has a high proportion of UK group firms and the highest proportion of multinationals and consequently the lowest proportion of stand alone firms. However, given all this it does have a relatively small number of firms, and in particular a small number of small firms. The data suggests relatively few Welsh stand alone firms. It does have Objective 1 status and this may have attracted multinationals and British group firms to the locality.

Torfaen: Similar to Blaenau Gwent and Caerphilly. Both the median and 75% quartile firms are characterised by a labour force well above the average with respect to Wales as a whole. The capital labour ratios for both are also very high although not the highest in Wales. This leads to high GVAFC for both the 75% quartile and median firms, and for the latter the highest in Wales. For the median firm, expenditure on all services is very high. On waste disposal it is the highest in Wales and on telecommunications is the second highest after Newport. In terms of firm ownership it has the second highest proportion of UK group firms and also a high proportion of multinationals and consequently a low proportion of stand alone firms. In this it may have benefitted from its Tier 1 Assisted Area Status.

Table 2: Summary Characteristics of Welsh LAs

	Capital Labour Ratio		Employment		GVAFC			Road
	Median	**75pc**	**Median**	**75pc**	**Median**	**75pc**	Mean	Transport
Anglesey	26.00	56.80	35	123	621	2369	5559	4.64
Cardiff	28.40	60.10	39	105	918	2794	15972	5.44
Newport	27.90	75.60	39	112	970	2878	4824	10.12
Monmouth	23.20	49.40	30	79	556	2002	3065	4.65
Swansea	21.00	47.90	38	85	652	2045	4444	4.22
Conwy	19.40	37.00	29	46	374	853	2180	1.1
Denbigh	19.60	49.50	26	49	414	1124	21893	1.59
Flint	36.10	85.20	36	92	848	3053	9792	18.57
Gwynedd	22.60	47.50	28	67	516	1308	2871	2.87
Wrexham	31.70	67.60	36	109	787	2794	4170	17.44
Powys	26.30	53.80	28	61	518	1568	1787	4.79
Ceredigion	22.30	47.10	25	58	375	1209	20797	1.53
Pembroke	23.90	53.90	27	49	454	1021	3638	1.28
Carmarthen	22.70	49.30	28	56	469	1250	4843	3.92
Neath & PT	22.70	66.60	38	83	673	2054	8114	5.74
Bridgend	28.30	59.00	31	87	760	2111	6197	7.78
V.Glamorgan	22.90	48.80	32	78	607	1949	8849	3.49
Rhondda	33.30	72.10	44	104	1024	2641	7872	13.83
Merthyr	34.90	66.90	32	98	585	2274	4255	7.55
Caerphilly	33.90	73.80	43	124	965	3516	3739	24.3
Blaenau G.	35.50	82.60	47	123	1015	3279	7893	27.73
Torfaen	32.30	72.40	42	115	928	3742	6617	13.45
Wales	26.30	59.60	33	83	677	2117	7416	5.6
GB	30.90	68.70	28	109	675	2878	7030	9.34
Average of Welsh LA	27.17	60.65	33.64	84.86	675	2167	6922	8.68

Notes: average relates to average of Welsh LA figures in table. Expenditure figures are in £000 p.a.

Table 2 (continued): Summary Characteristics of Welsh LAs

	Employ-ment	Energy Usage	Waste Usage	Compuer Services	Telecoms Services	UK Group	MNEs	Stand Alone
Anglesey	35	20.70	1.85	3.57	6.19	15.09%	12.40%	72.51%
Cardiff	39	20.64	1.38	7.24	11.00	25.88%	8.35%	65.77%
Newport	39	27.61	1.59	5.97	11.19	22.19%	14.55%	63.26%
Monmouth	30	13.58	1.30	3.14	6.07	18.86%	10.27%	70.88%
Swansea	38	15.00	1.20	4.04	6.02	17.07%	10.99%	71.94%
Conwy	29	11.00	1.12	1.85	3.17	11.50%	8.47%	80.02%
Denbigh	26	9.30	1.00	1.79	3.35	14.13%	7.06%	78.81%
Flint	36	10.75	2.00	4.87	9.00	22.88%	9.76%	67.36%
Gwynedd	28	15.93	1.00	2.03	4.91	17.54%	8.18%	74.29%
Wrexham	36	24.08	2.04	4.95	8.00	19.67%	13.18%	67.15%
Powys	28	14.00	1.11	3.00	5.31	16.81%	7.80%	75.39%
Ceredigion	25	9.00	1.00	2.05	3.12	10.96%	5.48%	83.56%
Pembroke	27	11.37	1.00	1.59	3.31	11.93%	7.99%	80.08%
Carmarthen	28	14.00	1.00	2.27	4.61	12.44%	8.52%	79.04%
Neath PT	38	18.45	1.35	3.85	7.72	18.91%	12.10%	68.99%
Bridgend	31	19.08	1.50	4.52	7.63	19.52%	11.76%	68.71%
V.Glamorgan	32	15.71	1.28	3.20	5.38	17.37%	13.17%	69.46%
Rhondda	44	29.65	2.00	6.23	9.22	22.32%	12.13%	65.54%
Merthyr	32	18.34	1.03	4.00	5.82	14.39%	13.28%	72.32%
Caerphilly	43	38.46	3.00	5.70	10.00	20.46%	16.63%	62.91%
Blaenau G.	47	33.49	2.09	5.25	9.34	19.79%	18.49%	61.72%
Torfaen	42	25.06	4.72	5.90	10.66	23.90%	13.00%	63.10%
Wales	34	18.87	1.62	3.96	6.86	17.89%	11.07%	71.04%
GB	33	18.00	1.37	4.00	7.00	21.33%	8.99%	69.69%
Average of Welsh Las	28	19.00	1.17	4.72	7.77	18.86%	10.68%	70.46%

Notes: average relates to average of Welsh LA figures in table. Expenditure figures are in £000 p.a.

5. The Results: Based on Britain

All Industry Productivity

The models are estimated using random effects. Fixed effects estimation was not feasible because of the large number of firms included just once in the sample. As with cross section analysis this will impart bias if the explanatory variables are correlated with the error term, due, e.g., to it reflecting unobserved entrepreneurial ability. The use of random effects also permitted dummy variables for regions and sub-regions.

We begin our analysis with an update on the productivity work. This update takes several forms in the basic equation covering all industries. Firstly we now include data up to 2004 – the latest year currently available. Secondly we include population density and population density squared rather than the log of population as this will allow us to determine whether a turning point exists. Thirdly we will include not population density per se, but population density in 1981 which reduces the potential that this variable could be jointly determined with productivity. 1981 was chosen as the data is derived from the first census after major local government reorganization in the 1970s. It is important to emphasise that the results are, in terms of significance, largely unchanged if we instead use current population density. Fourthly we have constructed a clustering variable, to estimate the potential impact of clusters on productivity. To our knowledge this is one of the first times this type of variable has been used in a micro-data base analysis of individual firms.

The first equation relates to Gross value added at factor cost (GVAFC) as the dependent variable. The results are similar to before in that both labour and capital remain significant. The key skills factor is low skills in that firms in a local authority with a high proportion of people with low skills tend to exhibit lower productivity. This emphasises that in terms of impact the biggest gains can be made by focusing on those with no skills, although this is something we later qualify due to the indirect impacts of a high skilled workforce. Time distance from London remains a critical factor in determining productivity and it is *only time distance from London*. None of the other distance variables including a distance weighted population mass variable are significant at even the 10% level, as the regression in the third equation illustrates. The most productive firms are US multinationals followed by other foreign multinationals and then UK group firms and finally, and a long way behind, British stand alone firms. Given all the other variables in the equation there are few significant regional differences. At the one percent level of significance firms in Scotland are more productive than we would otherwise expect them to be and at the 5% level of significance firms in the South East are also more productive, whilst firms in Wales are less productive then we would otherwise expect them to be.

We now examine the impact of the additional or changed variables. Firstly, population density, which is population density in 1981, remains significant in that productivity increases as population density increases. But our results show that there is indeed a turning point. Both population density and its square are significant with opposite signs which indicate an inverted U shaped relation with productivity, that is productivity first increases as population increases, but the

marginal impact steadily declines and eventually a critical point is reached after which any further increases in population density leads to a decline in productivity. The data suggests that this critical turning point is at a population density of 6610 people per square kilometre. This is quite high, indeed higher than any other local authority area in Wales, although parts of those areas may be adversely affected. We emphasise too that this needs more investigation as it is likely to vary between industries.

Thirdly we note that the cluster variable is positively significant at the 1% level of significance. This means that for any firm, as the proportion of firms in a locality in the same industry as itself rises, then so does productivity. This is one of the first times that evidence has been found for the existence of clustering effects in this type of data set and we believe this to be an important result. The final column reproduces these results but for Gross value added adjust for regional price disparities. There are now significant differences between regions, although the significance of the other variables has not changed.

Throughout these results private firms are more productive than the alternative and productivity declines with the number of units the data relates to.

Industry Productivity

The Table below adds to these results those of an industry analysis. The results suggest important industry differences. Firstly, the cluster variable is positively significant in the retail-wholesale, catering and social-education sectors. The latter includes, the social work, community work and education sectors. To a large extent these are industries where the customer goes to the firm, rather than in some form the opposite. This tentatively suggests that the advantages we have identified lie in firms of this type being focused in one locality – e.g. a shopping centre – which consumers can readily access, rather than advantages of firms being in close proximity with respect to e.g. knowledge diffusion, access to a common pool of labour, etc as discussed in Audretcsh and Feldman (2004). To counter this we note that for two industries there is evidence of a negative impact of clustering on productivity, these are manufacturing and construction. Manufacturing is a slightly unusual industry as it has been in long-term decline in the UK for a number of decades. It is possible that the coefficient on clustering mirrors this decline in traditional manufacturing areas. But it is also possible that clusters, in increasing competition for, e.g., supply firms to larger ones, can also *reduce* productivity (Rosenthal and Strange, 2004) partly because they reduce price. Although if the market is further afield this is unlikely to be the case.

There are other differences between industries. First, time distance from London is significant for all industries except catering and transport, given our earlier arguments relating to the relationship between this variable and knowledge diffusion it is possible that this suggests a relatively low rate of technical change in these industries. Population density is significant for all industries apart from those in the social-education sector. This is also the only sector where firms in localities with a high proportion of skilled people benefit from higher productivity. Finally, there are significant differences in productivity according to ownership in all industries apart from construction.

Table 3: Industry Regression Results

	Manuf-acturing	**Constru-ction**	**Retail Wholesale**	**Catering**	**Trans-port**	**Social – Education**
Log(employment)	0.756**	0.779**	0.7665**	0.779**	0.833**	0.718**
	(154.22)	(101.54)	(149.06)	(74.54)	(93.64)	(116.42)
Log (capital)	0.230**	0.203**	0.216**	0.164**	0.161**	0.220**
	(64.18)	(35.98)	(68.29)	(17.71)	(24.61)	(46.17)
Full time ratio	0.529**	0.220**	0.729**	0.62**	0.59**	0.736**
	(21.10)	(6.67)	(55.57)	(23.17)	(16.53)	(40.57)
Log (high-skills)	-0.0138	0.0528	0.0018	-0.0044	-0.104*	0.133**
	(0.58)	(1.11)	(0.07)	(0.08)	(1.99)	(3.31)
Log (no-skills)	-0.283**	0.0106	-0.182**	-0.220*	-0.317**	0.0723
	(7.28)	(1.37)	(4.31)	(2.49)	(3.86)	(1.18)
Log (pop den)	0.0157**	0.0118*	0.0144**	0.0231**	0.0197**	-0.0049
	(4.60)	(2.02)	(4.27)	(3.86)	(2.57)	(0.98)
Cluster	-0.0270**	-0.333*	0.364**	0.877**	0.368	0.717**
	(2.62)	(2.49)	(5.09)	(5.41)	(1.57)	(5.21)
Log(London time)	-0.0341**	-0.0701**	-0.045**	-0.0134	0.0160	-0.0902**
	(3.09)	(3.58)	(4.11)	(0.65)	(0.77)	(4.91)
UK group firm	-0.0110	0.0032	-0.125**	-0.0451	-0.0386	-0.206**
	(1.14)	(0.08)	(7.54)	(0.93)	(1.33)	(3.95)
US multinational	0.073**	0.188	0.0846**	0.0149	-0.0157	-0.0659
	(5.11)	(1.49)	(2.79)	(0.14)	(0.26)	(0.82)
UK stand-alone	-0.0652**	-0.0608	-0.239**	-0.290**	-0.158**	-0.277**
firm	(6.00)	(1.43)	(14.35)	(5.87)	(5.11)	(5.29)
Private firm	0.343**	0.270**	0.178*	0.355**	0.0317	0.195**
	(5.63)	(7.00)	(2.35)	(10.63)	(0.65)	(15.55)
Log (#plants)	-0.0024	-0.0112	-0.067**	0.0254	-0.0401**	0.0137
	(0.35)	(0.88)	(10.30)	(1.80)	(3.01)	(1.52)
Regional Variables	Insignif-icant	Insignif-icant	Scotland significant	Yorks + H. signif	Insignif-icant	Insignif-icant
Sector Variables	None	None	None	None	None	None
Year Fixed Effects	Significant	Significant	Significant	Significant	Significant	Significant
Observations	44847	10364	48269	10028	9829	22475
R^2	0.892	0.936	0.888	0.905	0.916	0.878
Wald	182957**	83342**	213745**	47086**	50941**	83910**

Equations estimated using random effects (fixed effects not possible due to data limitations). (.) denotes *t* statistics and a **/* denotes significance at the 1%/5% levels. The dependent variable in each regression is log(GVAFC). Constant terms omitted. The level of significance for regional, sector and year fixed effects is 1%.

Productivity in Rural and Urban Areas

We now build on these basic results by looking at the difference between rural and urban production functions, where the former is defined as a current population density of less than 200 and the latter as greater than 800. The results are shown in Table 2 in the appendix relating to regressions. We focus on differences between the two.

We first note that a locality with a high proportion of skilled workers boosts productivity for firms in urban areas but not rural. This may reflect fundamental differences between rural and urban firms. However, the presence of a high proportion of people with no skills adversely impacts upon both localities. Interestingly both population density and time distance from London impact upon

both rural and urban economies, but the impact of the latter is much greater for rural economies. Advantages of clustering are found equally in both urban and rural areas as are differences associated with ownership, although the disadvantage of stand alone British firms is greater in rural than urban areas. Regional differences are more pronounced in rural than urban areas and thus for example firms in Welsh rural areas are at more of a disadvantage than firms in Welsh urban areas relative to the rest of the country.

Much of this tentatively suggests that rural areas are relatively more 'sealed' from other areas, knowledge takes longer to be diffused to rural areas and the disadvantage of stand alone firms or peripherality is greater. Consistent with this is a model of knowledge diffusion which first sees knowledge transferred from London to other major urban centres and then from these major urban centres to their rural hinterland. Rural firms near London are then at an advantage over other rural firms, as the first stage of this diffusion process is bypassed. However, other explanations may also be consistent with these results.

The Impact of Energy & other Input Usage on Productivity

The second regression in Table 3 in the appendix gives one further dimension to production functions. This time we add purchases of energy, water, materials and fuel, road transport and other services. These are already included in the calculations of gross value added at factor cost and hence there is no obvious reason to suspect that they would add to productivity. We will be examining the demand for these types of input separately in subsequent regressions, but in column 2 of Table 3 we include them in the set of explanatory variables for GVAFC. Fuel, energy and water usage all increase productivity at the 1% level of significance and road transport usage at the 5% level of significance. Only purchase of 'other services' has no impact on productivity. We defer a discussion of the implications of this until we have examined the demand for these services.

Demand for Capital

Table 3 also contains information on certain other variables of interest, beginning with capital stock where the results are shown in column 1. This increases with the labour force and is greater in localities characterised by high skill levels. This is important as we noted earlier a relatively weak and variable linkage between such areas and productivity per se, but this result together with the impact of capital stock on output means that highly skilled areas are associated with higher productivity per worker.

Capital stock is not linked to clusters, however it does increase with population density and decline with time distance from London, but not mileage nor with any of the other distance variables. Capital stock is also lower for British group firms than multinationals and lower again for British stand alone firms. Given the earlier differences noted with respect to productivity per se this means that the worker in a British stand alone firm is far less productive than one in a multinational and indeed even workers in British group firms are substantially less productive than those working in foreign multinationals both because multinationals appear more productive per se and because they tend to have greater capital per worker.

Energy Demand

We begin our analysis of the services firms buy by looking at demand for energy and fuel. The results are shown in Table 4 in Appendix 2. We emphasise at the outset that energy includes fuel. Three equations are estimated for each. Firstly, one related to whether or not people buy such inputs, we term this variable 'energy usage' or 'incidence of usage', i.e. it distinguishes between firms who use, in this case, energy and those who do not. Secondly we analyse 'extent of usage', that is provided they are users, then how much do they use and thirdly this second equation repeated for Wales.

Turning first to what distinguishes firms who buy energy from those who do not. This probability increases with both the number of workers and the level of capital stock, with the latter being particularly important. Unusually in these regressions the proportion of part time workers is not an important factor, but usage is higher in areas characterised by a large proportion of low skilled workers and declines with population density. Incidence of usage also increases with time distance from London with none of the other distance variables significant. To an extent all these equations on usage of services are reduced form ones with output excluded. We were concerned about simultaneity problems. ***However, none of the above results changed when we added GVAFC, that is capital stock e.g. retained its sign and significance***. Throughout these regressions this is the case.

Turning now to the amount of energy bought, this again increases with both capital stock and the labour force. This time the proportion of the labour force working full time is a significant factor. Extent of energy usage is lower in areas with a high proportion of people with no skills and particularly low in areas with large numbers of highly skilled people. There may be two affects at work. Firstly, such energy usage increases with the employment of people with middle skills as they are engaged in energy intensive activities, but secondly, highly skilled people are known to increase productivity, they may well also increase the efficiency with which energy is used.

Energy usage also declines with population density, but is not linked to distance from London. However it declines with respect to mileage distance from the other major urban conurbations and also increases with respect to time distance from those conurbations. In part this suggests that, other things being equal, energy usage declines with mileage distance from major conurbations, but is higher in areas with poor road infrastructure.

Interestingly, energy usage is lower in British group firms than foreign multinationals and lower again in British stand alone firms. There are also significant regional differences in energy usage, given other characteristics, all regions use less energy than firms in London and then the South East, with the biggest difference being for firms in the North West and the East Midlands. Initially our expectations were that differences in energy usage would be similar to differences in productivity, with efficiency in one area translating into other areas. There is some evidence for this, but much of the results suggest the opposite, e.g. multinationals use more energy. We will thus defer an interpretation of these results until later.

Fuel Demand

We now turn specifically to fuel usage. The results are also shown in Table 4. Again the labour force and even more so capital stock are dominant factors. Usage is not related to skills, distance, nor population density. But it is lower in clusters. Extent of fuel usage is also linked to these same variables. In addition, the extent of usage increases with the proportion of people in the area with medium skills – in this case there is no real difference between the impact of the proportion with high and low skills and hence it does appear to be medium skills that is the critical factor. Again this would appear to reflect upon the type of activity the firm engages in rather than any efficiency factors.

Fuel usage also increases with time distance from London but not with respect to any of the other distance variables. As with energy usage it is lower for British group firms than foreign multinationals and lower again for British stand alone firms. This time we will suggest a rationale at this stage. British firms who are part of a group may experience higher costs than British stand alone firms because of (i) they experience high transport costs in dealing with a more dispersed customer base or (ii) because of a need to transport goods and people between different firms within the group. This will then also apply to foreign multinationals with the added factor that their customer base may be even more dispersed as may other firms within the multinational group. Specifically we know that many foreign multinationals based in the UK both serve a European market and have other establishments within Europe.

Finally, we have already noted that fuel usage is lower for firms located in a cluster which suggests one potential advantage of clusters in reducing interaction costs. This specific point is as far as we are aware new to the literature.

Demand for Road Transport

The next analysis concerns the purchase of other services (which includes non-road transport) and road transport. The results are show in Table 5 in Appendix 2. We discuss the latter first. Usage declines with the labour force and increases with capital stock. This is the first time we have had this result, one partial interpretation is that the probability of using road transport increases with the capital labour ratio. Usage also increases with the proportion of no skilled workers in the area and none of the distance variables are significant. Usage is also significantly less in both Objective 1 and Objective 2 areas. Finally we note usage is less likely in clusters.

Turning to the extent of usage, we get the results that such purchases increase with both labour force and capital stock, with the latter being the dominant factor. There is no real linkage with the skill characteristics of the locality, but road transport costs decline as population density increases. Again this may reflect reduced costs in delivering to customers. Road costs also decline with distance from both London and for other conurbations with respect to the quality of road infrastructure. Finally we note a similar pattern as with fuel usage with respect to type of firm. Road transport costs are lower for British group firms than multinationals and lower still for British stand alone firms. The same possible explanations we put forward earlier also apply here. Finally, extent of usage is lower in Objective 1 areas. Is this a

characteristic of the firms in these areas or a characteristic of the road infrastructure not otherwise picked up?

Demand for Other Services

This really is a miscellany of diverse purchases. Usage, as also shown in Table 5, increases with capital stock, but not labour, but apart from that is fairly random. Extent of usage however is very different across firms. It increases with both labour and capital and with the population density of the locality – which may well reflect the availability of those other services. It also increases with the proportion of highly skilled people in the locality and declines with the proportion of no skilled people and this again may in part reflect supply factors. It is also lower for UK group firms than foreign multinationals and lower still for British stand alone firms. All of the distance factors are relevant with a pattern of signs which suggest that extent of usage increases with the quality of the road infrastructure to both London and other major conurbations.

Demand for Water

The results are show in Table 6 in Appendix 2. Usage increases with both capital stock and labour. It increases with time distance from London and is less in areas with a high proportion of highly skilled people. It is also greater for British firms, stand alone or in groups, than multinationals. Many of these effects may relate to the type of activity the firm is engaged in.

The extent of demand amongst those who buy water declines with the proportion of highly skilled people and is greater in clusters. But neither population density nor the distance variables, apart from weak significance of mileage from London, are significant. Nor are there differences between different ownership of firms. In all the impression is that this is a relatively random variable across firms determined largely by industry and to a lesser extent regionality as firms in London and then the North West buy more water than other regions. However, few of the variables which we associate with efficiency are significant suggesting perhaps that this is an aspect of behaviour firms have not given a priority to.

Cost of Waste Disposal

The results are also show in Table 6 in Appendix 2. Firstly usage increases with capital stock, but not labour force. As with water it increases with distance from London, and is less in areas where there is a large proportion of highly skilled people, but now also declines as the proportion of people with no skills rises. Again as with water it is greater for British firms than multinationals.

The extent of demand amongst those who incur wastage costs declines with the proportion of highly skilled people in the locality which is significant at the 5% level of significance and with population density. Once more such costs are significantly higher for firms located in clusters. Of the distance variables only time distance from major conurbations is significant. Whilst the cost of waste is significantly less for stand alone British firms. This may reflect the fact that such firms are less productive or, more speculatively, that they could follow lower standards in

disposing of waste (though not non-compliant with regulations). The latter would of course be a cause for concern.

Internet Selling & Buying

For these variables we only have incidence of usage, i.e. whether a firm uses the internet in this way or not, but not extent of usage. The results are show in Table 7 in Appendix 2. The probability of a firm using the internet to sell its products increases with the number of workers and also the size of the capital stock. It also increases with the proportion of highly skilled workers in the locality. It is also inversely related to the existence of clusters. The probability of internet usage for selling is also less for stand alone British firms – although is quite high for British group firms. There are some regional differences with firms in the North East and Scotland being particularly unlikely to sell over the internet. There is no real difference for any of the internet variables we are analysing between Objective 1 and Objective 2 regions given there other characteristics. In terms of industry the construction and social & education sectors are less likely to use the internet and wholsesale retail more likely.

The results for internet buying are largely similar. Internet buying increases with firm size, with the proportion of highly skilled people in the locality, is less for stand alone British firms and also less in clusters. As with selling it is less common, other things being equal, in the North East. However, there are differences. The probability now declines, significant at the 1% level, for firms in areas with a relatively high proportion of no skilled people. It also increases with time distance from London – but none of the other distance variables are significant. In terms of locality firms in the East and the South East are significantly more likely to use the internet for buying. One interesting industry difference is that manufacturing firms are less likely to use the internet for buying, but were relatively more likely to use it for selling.

Computer Services Usage

The results are shown in Table 8 in Appendix 2. The probability of using computer services increases with the size of the firm as measured by capital stock and to a less extent the labour force. This probability has been steadily increasing during the period 1998-2004. It is not higher in areas with a high proportion of highly qualified people, but is less in areas with a large proportion of poorly qualified people. It also increases with population density – probably reflecting supply side factors, i.e. the availability of firms supplying computer services. It is however unrelated to any of the distance variables. Nor is there any difference in terms of the nature of firm ownership, except for one unusual feature, it is significantly lower for US multinationals. Its usage also declines as the number of firms in the group increases. In terms of industry differences, such usage is most likely to relate to firms in wholesale/retail and least likely to firms in catering. There are significant regional differences and firms in Wales are much more likely to make use of such services than anywhere else in the UK, with the South East the next most likely.

We now analyse the extent of computer usage by those firms who use some. Again this usage has been increasing over time and also increases with labour and capital stock, the significance of both being very great. This time it is higher in areas with a higher proportion of highly skilled labour as well as being lower in those areas with a high proportion of low skilled people. This is one of the relatively few occasions when usage of any activity clearly increases as we move up the skill ladder. It is again also positively and very strongly linked to population density. Once more this is likely to reflect supply side factors, in terms of both the number of firms offering such facilities and the range of such facilities being offered. This may also explain the greater use of such services if the firm is in a cluster – as supplier firms can specialise in serving that cluster.

The use of computer services decreases with time distance from London, with none of the other distance variables being significant. It is possible that, as with productivity, this reflects a knowledge diffusion effect. Similar to productivity such usage is lower for UK group firms than multinationals and lower still for British stand alone firms. The differences are substantial and much greater than for productivity. There are relatively few regional differences, although usage tends to be greater in the East and the South East. In many respects these results are similar to those for productivity, leaving the impression that similar forces are at work.

Telecommunications Usage

The results are also shown in Table 8. Telecommunications are an older technology than computers and we might expect that this will reduce systematic differences as compared with computer service usage, but nonetheless it is still a technology which is evolving quite rapidly. Whether firms make use of telecommunications services or not depends on the size of capital stock and the labour force. Usage has not been changing over time as with computer services. Nor is it linked to area characteristics such as skills, population density and distance variables. It is however greater in Wales followed by the East and the South East. All of these are similar to the results for computer services usage. There is however one significant pattern of usage which is a reverse or mirror image of that for computer services. This is that such usage is greatest for British stand alone firms followed by British group firms.

The extent to which use is made of such services is much more similar to usage of computer services. Extent of usage increases with the labour force and the capital stock. It has been increasing over the years, is higher in areas with a large proportion of people with high skills and lower in areas with large proportions of low skilled workers. Even more than with computer services extent of usage is inversely related to time distance from London, but none of the other distance variables are significant. It is also greater if the firm is in a cluster and lower for UK group firms than foreign multinationals and lower still for British stand alone firms. Usage also increases with the number of units in the group. There are relatively few regional differences, although firms in the South East and Scotland do exhibit greater extent of usage than other firms – other things being equal, including of course distance from London.

How to interpret these results? They are possibly a reflection of the statement we initially made that this is a long established but still rapidly evolving technology. Its

long establishment results in there being relatively little differences in probability of usage due to knowledge asymmetries. The technology has been around long enough that most (all?) firms in all areas are aware of its existence and hence the variables related to knowledge diffusion tend not to be significant.

However they are very significant when we examine extent of usage, as this is still a rapidly evolving area and hence information on its potential for business is not equally spread across all firms in all areas. Thus we conclude that there is little impact of diffusion differences with respect to whether firms use this technology, but there is a diffusion effect with respect to what people do with this technology and the hence the extent to which they use it.

Firm Location

The results with respect to firm location for different types of firms are interesting. These are shown in Table 9. Beginning first with stand alone British firms, they are less likely to locate in local authorities with a high proportion of highly qualified people and more likely to be located in those areas where relatively large numbers of people have low skills. They are also, and this is very significant indeed, to be found in areas with relatively low population densities. That is the probability of a stand alone British firm locating in a particular area is inversely related to population density. This does not mean that as population density declines so the number of stand alone firms increase, but rather that relative to firms in groups and multinationals they increase.

This probability also increases with time distance from London, but declines with mileage distance from London. The coefficients are very close in absolute terms and this suggests that what is critical is the average speed with which a journey to London takes rather than distance per se. A low average speed is indicative of a poor road transport infrastructure and it is in such areas where British stand alone firms are more likely to be found than other types of firms. Indeed not only is it the average speed to London but also to other major urban centres. These firms are also relatively more likely to be located in Objective 2 areas, although not Objective 1, and less likely to be part of a cluster. In short to a large extent they are located relatively more in the less attractive areas from a productivity perspective than other firms. There are significant regional variations and stand alone British firms are most likely to be found in the South West and Scotland.

Turning now to British firms which are part of a group, which may or may not be multinationals, these are relatively more likely to locate in areas where there is a relative concentration of highly skilled people and also in areas of high population density. They are also more likely to be located in areas where the average speed of travelling to both London and other major conurbations is high, suggesting good road transport infrastructure. Finally they are less likely to be located in Objective 2 areas. In all these respects they are the opposite of their stand alone counterparts. Again there are significant regional differences. The highest proportion, given other characteristics, tends to be in Yorkshire and Humberside and the East and East Midlands, and the lowest in Scotland.

Finally we turn to foreign multinationals. These tend to be located in areas with relatively large proportions of medium skilled people, rather than those with high

skills and more especially no skills. The probability of them being located in an area also increases with population density, although not to the same extent as UK group firms. Also as with UK group firms, speed of travel with respect to London is important as is locating in a cluster, indeed this is even more significant than for UK group firms. They are also less likely to be attracted to Objective 2 areas. There are substantial regional differences and other things being equal Wales tends to be the most favoured location followed by the North East whilst the South West and Yorkshire and Humberside are the least favoured regions.

To summarise it would appear that both UK group firms and multinationals tend to locate in places favourable to productivity relative to stand alone British firms. But there are differences between them. That foreign multinationals are not particularly attracted to areas with high skill levels – but with medium skill levels – whereas British firms are, suggests multinationals in Britain are largely subsidiary activities with the key high skilled activities taking place elsewhere, most likely their country of origin. We also note that Objective 1 areas do not appear as a particular magnet for such firms, but Objective 2 areas are a distinctly unpopular location for both.

Inventory Holdings

We now turn to other factors of firm behaviour, which although not direct inputs into production, reflect firm efficiency or factors which impact on or reflect profits. Going back to Table 3, the results in column 3 indicate that inventories increase with the labour force, capital stock and GVAFC. We include GVAFC in these regressions as there is less risk of their being a simultaneous relationship between these variables. Inventories also decline as population density increases, but increase if the firm is part of a cluster. The former may reflect the greater ease of getting supplies as well as closeness to customers, the latter may reflect once more the impact of competition, forcing firms to provide a better service by having more stocks ready to meet demand. They are lower for British group firms and lower again for British stand alone firms. This is counter to some results elsewhere, but is consistent with research that concludes that better funded firms are more able to keep inventories immune from the economic cycle, the argument being that in a downswing poorly funded firms have to economise on inventory holdings. Other things being equal there are significant differences across the regions and after those in the North East, firms in Wales tend to hold low stocks. Distance factors per se are not significant.

Insurance Costs

Insurance costs increase with the labour force, total output and capital stock, the most important factor is capital stock. They have been rising steadily over the years. They are lower for British stand alone firms, and surprisingly perhaps, US multinationals, but there is very little systematic differences across locality characteristics – although there is some evidence they are lower in Wales. This raises the question of why they are lower for US multinationals?

Business Rates

These increase with labour, capital and GVAFC. There is no linkage with the proportion of highly skilled people in an area, but there is an inverse relationship

with the proportion of low skilled people. They increase with population density, but decline with time distance from London and there is evidence too that they increase with the quality of the road infrastructure. They are lower for UK group firms than multinationals and lower again for UK stand alone firms and greater in clusters. All of this suggests the somewhat reasonable conclusion that business rates reflect the quality of the location for business purposes. The better the location in terms of distance, population density, skills or clusters, the greater are business rates. In addition there are significant regional differences. Other things being equal they are high for Scotland, London and to a lesser extent the East and low for Wales and to a lesser extent the North West, the South West and the east Midlands. To an extent perhaps, other things being equal, this may then represent something of a competitive advantage for Wales – although if such low rates are caused by an adverse location this would not be the case. Finally, there is evidence that they are lower in Objective 1 areas.

Taxes Paid

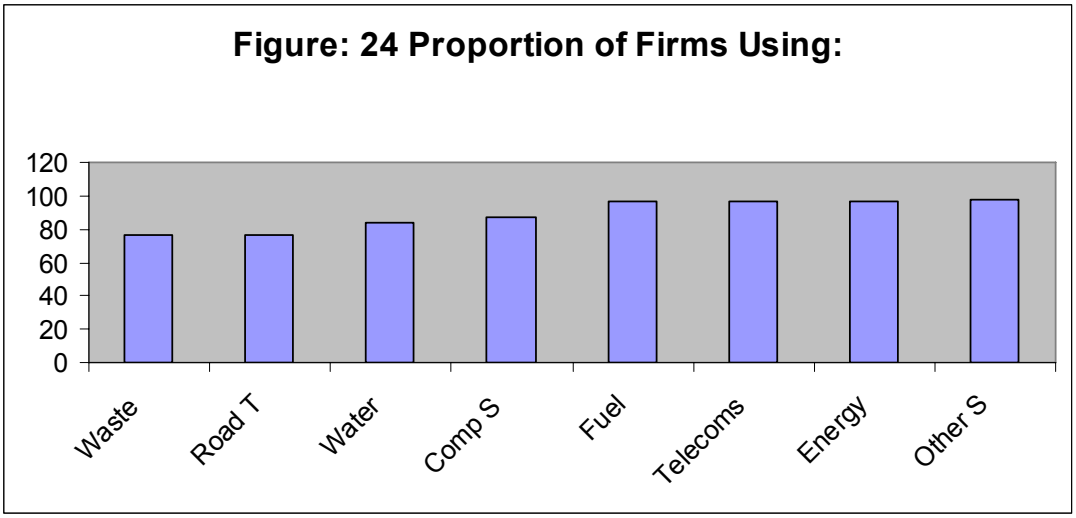
Finally, in Table 3, we turn to total tax paid. This is an interesting variable as it is in part at least, a proxy for profits and in reality it is this which we are interested in as much as taxes. Total taxes increase with the labour force, the log of gross value added and capital stock. They are lower for firms in areas with a high proportion of low skilled people, are directly related to population density and inversely related to time distance from London. However the positive significance of miles from London suggests that both time distance from London, and average speed of travel to London – reflecting quality of road infrastructure – are significant factors.

Taxation is lower for British group firms than multinationals, with US multinationals paying particularly high levels of taxation, and lower still for stand alone British firms. The differences are considerable and greater than for GVAFC. There are significant regional differences but these can be summarised as firms in Scotland paying the highest taxes followed by those in London, the East and then the South East, followed by the other regions. However the lowest taxes are paid by firms in Wales, given all other characteristics. As in virtually all regressions there is no evidence of any impact on the firm of being in an Objective 1 or 2 region.

Overall, these are interesting conclusions particularly if the linkage can be made to profitability. It must be emphasised that these are differences given the level of output and given too the level of capital stock and the size of the labour force. Thus most likely they reflect efficiency factors which push up profits and thus also taxes.

Overview on Usage

In Figure 24 we present summary data on the proportion of firms using different types of services. For energy, fuel, other services and telecommunications it is almost 100%. But it is less for waste and road transport.



Note: Other S denotes other services; Comp S denotes computer services

6. The Results: Based on Wales

The results for Wales are based on far fewer observations and in general we feel that the results for the country as a whole are more informative about firms in Wales. Nonetheless, there are some interesting conclusions to be drawn. With relatively few observations we combined the LAs into groups rather than including a separate dummy variable to represent each of them. Thus Powys Pembroke and Carmarthen are contiguous and Anglesey and Ceredigion are both are both coastal areas far from the centre of Wales. This is not perfect and as more data becomes available then more groups with more closely related localities can be used.

Productivity

Table 2 shows the results for Wales based on GVAFC. There are differences between the results for Britain as a whole and those for Wales. We focus on these differences and if not mentioned then the results are similar or at least not dissimilar. The results do tentatively suggest that the positive impact of a locality with a high proportion of highly qualified people is less in Wales than in the rest of the country. Is this a reflection of the type of activity carried out in Wales? As with the regions of Britain there are no significant sub-regional differences. With respect to the rural areas alone population density is no longer a significant factor. Finally with respect to urban areas, they do not appear to be sensitive to the proportion of low skilled people in the area nor to clusters. Again there are no differences between sub-regions.

Industry Productivity

Table 10 reports the industry results for Wales, although in some cases we are now dealing with quite small samples. Because of this relatively few coefficients are significant, although in general they retain the same signs as the regressions for all the country. But there are still some interesting results. Unsurprisingly labour and capital remain significant for all industries. Clusters remain significant for catering, again suggesting the importance of location for this industry and stand alone British firms are significantly less productive for catering and wholesale-retail. There are also significant sub-regional differences for catering, with firms in all areas being less productive than those in Cardiff-Newport. This is particularly the case in Monmouth-Torfaen and Blaenau-Merthyr-Caerphilly.

Energy & Fuel Demand

Energy demand is not particularly different in Wales to the rest of Britain. There are no significant sub-regional differences. However, British stand alone firms use considerably less energy relative to other firms, other things being equal, than they do in the rest of the country. Fuel usage is also relatively similar to that in the rest of Britain. However, again British firms, this time both groups and stand alone firms, use considerably less energy relative to multinationals than they do in other parts of the country. There are also considerable sub-regional differences with Newport-

Cardiff being the lowest users and Blaenau-Merthyr-Caerphilly and Swansea-Neath & Port Talbot—Bridgend-Vale of Glamorgan-Rhondda being the highest.

Other Services & Road Transport Demand

This is similar to that for the rest of Britain. Sub regionally Blaenau-Merthyr, North West Wales and Central Wales use more of such services than other regions. There are some differences with respect to road transport, in particular such expenditure has not been changing over time as much as in the rest of Britain. It also tends to decline as the cluster variable increases, in contrast to the rest of Britain, where there is no significant impact of clusters. However, conversely it is not responsive to Objective 1 status. Given other characteristics there are no significant differences between the different sub-regions of Wales.

Demand for Water & the Cost of Waste Disposal

There are relatively few significant differences in the demand for water in Wales and that for the UK as a whole and no sub-regional differences. However, the impact of clusters is greater than for the rest of the UK and stand alone British firms use significantly less water than British group firms or multinationals.

There are more differences with the cost of waste. In Wales, this is not so sensitive to the proportion of highly skilled people in the locality, but is even more sensitive to clusters than for the UK as a whole. In particular the cost of waste disposal significantly increases as the cluster variable increases. This may be for many reasons, but one possibility is that such clusters of activity are more stringently regulated and also there is an element of peer firm regulation ensuring ethical behaviour. In addition stand alone British firms incur substantially less costs than other firms. This was also evident for firms across the UK, but is much more evident in Wales. Sub-regionally, other things being equal, the costs of waste disposal are significantly less in Monmouth-Torfaen. This seems inconsistent with the Torfaen data in Fig. 14. Two things may explain this: Industry structure which is also included in the regression and the fact that we are combining firms in the two areas.

Internet Buying & Selling

The internet selling equation for Wales shows few differences to the rest of Britain and given other characteristics, there are few sub-regional differences. The same is true for internet buying. The coefficients on the time variables do suggest that the use of the internet, particularly for selling, was slower to be used in Wales than the country as a whole.

Computer & Telecommunications Usage

Computer service usage declines with the degree of clustering, in sharp contrast to the rest of Britain. It also increases with the number of units in the firm. There is also some evidence that it is greater in Objective 2 regions. There are also significant sub-regional differences with it being highest in Blaenau-Merthyr and Monmouth-Torfaen.

Demand for telecommunications services has been increasing less during the time period than in Britain as a whole. There is little evidence of differences between the sub-regions of Wales.

Firm Location

There are differences between the results for Britain as a whole and those for Wales. We focus on these differences and if not mentioned then the results are similar. Firstly with respect to stand alone British firms, time distance from London is not significant in impacting on the location of these firms, nor are any of the other distance variables per se. In contrast to Britain as a whole, stand alone firms in Wales are relatively more likely to be located in clusters. They are also less likely to be located in Objective 1 and even more so Objective 2 areas.

For British group firms, they are relatively less likely to be located in low-skill areas and more likely to be located in high population density areas. They are relatively more likely to be located in Objective 1 and still more Objective 2 areas. Finally multinationals in Wales are attracted to areas of high skills – which is different to the results for Britain as a whole – but not particularly less likely to be found in low skill areas. Nor are they likely to be located in clusters.

7. Summary, Conclusions, Policy Conclusions

A Holistic Approach

Previous work has focused on productivity as such, our analysis has been more holistic in both focusing on both those factors which determine productivity and also other outputs – as reflected by the cost of wastage. Our results are in general consistent with other work in other areas. But they add to and give new insights to that work in ways which are intuitively plausible.

Productivity

The results themselves are summarised in section 2. In this section we seek to interpret those results. Firstly focusing on productivity, it is clear that the factors previously identified as impacting on productivity are still relevant. These include time, but not mileage, distance from London, skills, with the proportion of people with no skills in the locality being a critical factor and population density. This is the case whether we use population density as defined in 1981 or its current level. In addition we have identified a positive role for clustering, in all firms combined, but when we look at specific industries we can discern two effects. In those industries where the customer goes to the firm, clustering appears to boost productivity. But in other firms, specifically manufacturing and construction, clustering is associated with lower productivity, possibly reflecting the impact of greater competition which would be good for the consumer but not the firm. In manufacturing this may be unlikely for firms who produce for a market outside the local area, but not so much for supplier firms to larger manufacturing firms. However, the results with respect to manufacturing may also reflect the decline that has occurred in this industry over a prolonged period.

But for the moment we emphasise the view which was formed earlier that knowledge diffusion is a key factor in explaining the significance of factors such as distance is still valid. But our analysis has been suggestive of another factor, which although somewhat obvious has not been greatly emphasised in the literature. Our analysis showed that productivity was significantly increased by greater energy usage and also fuel and water usage. But why should this be, given that we are dealing with Gross value added at factor cost, a value added term from which the cost of energy usage, e.g., will have been netted out? There are several potential explanations, but the one we put forward here is that given two firms with the same capital stock and the same labour force, but with firm A using more energy than firm B, this is suggestive that firm A is utilising its capital stock more intensively. Thus if firm A uses its capital stock for twelve hours a day and firm B just eight hours, then in a sense A has 50% more capital stock than B. In this respect we would also expect it to have greater output.

The Impact of Skills

We concluded that a high proportion of highly skilled workers in a locality has only a limited impact on productivity per se. But this does not mean that high skills are not important. Firstly, we note that it is a very significant factor in determining capital

stock. To put some dimension on this impact, we note that if there is a 10% increase in the skills in a local authority then this will raise capital stock by 1.2% and this in turn will increase Gross value added at factor cost by some 0.24%, in addition to the direct impact of higher skills on productivity. To summarize, reducing the proportion with no skills in a locality will tend to increase the productivity of workers with a given a capital stock, but increasing the proportion of highly skilled people will also increase the amount of capital per worker.

But apart from the impact on capital stock and productivity increasing the skills base can in general be seen to be an attractor for British group firms and that this tends to be good as these firms tend to be more productive than British stand alone firms – far more productive. There is also evidence that firms in an area with a large proportion of highly skilled people will see lower energy usage and to an extent this may be due to greater energy efficiency. Moving up the skill ladder by an area also facilitates the use of business services by firms, although this has no perceived impact on productivity per se, and the use of technology such as the internet. Finally, there also seem to be efficiencies to be gained in terms of waste disposal. Not all of these costs are associated with the firm itself hiring a more skilled workforce. Some can be linked to the quality of services provided to the firm, but all relate to the gains from skilling up the labour force in an area.

Higher Energy Prices

That energy and fuel usage is inversely related to the quality of transport infrastructure confirms the theoretical expectation that increases in energy prices and other attempts to reduce the use of energy will impact most directly upon firms in less accessible areas. However, our analysis of the Welsh LAs suggested that in such areas the median firm is more locally focused than in other areas and thus has lower transport costs. It is the firm who is selling outside its locality that is really exposed to higher fuel prices. But they will also impact relatively more on multinationals and British group firms, possibly because they sell their goods over a wider area and possible because they need to link diverse plants together. Will this impact on the way multinationals behave and also increasingly influence their location decision? Almost certainly yes, at least in the long-run. Firms do not react immediately to changes such as that reflected by higher oil prices. They need to be certain that it is a long term change and not a short term phenomenon. Once that is the case, the initial impact will be on new plant locations, i.e. firms moving to a region, say the EU, for the first time. But eventually high cost locations will see established firms move to lower cost locations.

Also in the long-run firms will find ways to cut back on energy and resource use, but as this begins with product design, the lead time lags can be long. In the short term with a given technology and infrastructure, firms have little flexibility in cutting back on resources. But there is some, and our evidence tentatively suggests that there are differences between firms in the efficiency with which they use energy.

Waste

The production of waste and waste disposal will become increasingly important to both localities and firms as the cost of waste and waste disposal rises. Our analysis has suggested that the cost of waste disposal may reflect efficiency factors and

thus again here is a role for policy in facilitating knowledge dissemination. In addition, there are large variations around Wales and it is of interest and possible policy relevance to know to what extent these are caused by supply side and pricing factors coming from the waste disposal industry sector.

Multinationals are Different

The work has also emphasised that foreign multinationals are different from British firms, particularly stand alone British firms, not just with respect to productivity but on a wide range of dimensions. They tend to be characterised by higher levels of capital stock than even British group firms, pay more tax, indicative of higher efficiency and profitability, and business rates, indicative of better locations. They also tend to use more energy and fuel than their British counterparts and also make greater use of business services and spend more on road transport. But there are interesting anomalies along the way. Why do US multinationals pay such low insurance premiums?

Small Firms are also Different

But if multinationals are different then so are stand alone firms. Almost across the whole range of issues, stand alone firms do things differently. They are considerably less profitable than other firms, are based in less advantageous locations, use less capital stock, less energy, less services, such as banking and accountancy services, computer services and telecommunications services. They hold less inventories, pay less insurance and spend less on waste disposal. On any dimension the stand alone firm seems less likely to take advantage of new techniques and is less likely to 'do things well'

The literature suggests that many of these stand-alone firms are also family firms and these too are often found to be less efficient possibly due to a more limited pool of managerial talent to draw upon (Wall, 1998). Small firm owner-managers, generally, are reluctant to participate in formal training for themselves and their workforce (Storey and Westhead, 1996). The reasons are understandable, resource constraints can make it difficult for small firms to engage in formal training. This may be compounded in rural areas by a more dispersed pattern of location, being further away from knowledge networks and resources such as training and computer services.

To the extent that poorer performance is caused by any lack of ambition, drive and energy, there is perhaps little the policy maker can do. But to the extent that it is caused by lack of knowledge, expertise and contacts then yes there is something that can be done, by perhaps promoting networks as indicated below.

Rural Firms

These are a particular kind of small firm. The analysis suggests that they are different to firms in urban areas and may need different policies on the part of government. They tend to be at an even greater disadvantage relative to rural firms close to London than are urban firms. The literature suggests that rural firms face several disadvantages with some literature suggesting access to capital and paying premium rates for business advisory services (Deakins and Freel, 2005). But the

evidence is not totally conclusive and the more general economic evidence does not always seem quite so supportive of significant finance gaps. This is an area which warrants further research.

Smallbone, *et al*. report that the perceived issues surrounding the issue of finance for SMEs in rural communities identified by support providers, namely Business Links….. "are exacerbated in many rural areas by problems of physical access faced with the closure of many rural branches" (Smallbone, *et al*. p.29). More generally, due to the sparse population and low business concentrations in rural regions the delivery of business support in these regions is more expensive and attracts what has become known as a 'rural premium' (Smallbone, *et al*. 2002)

Rural firms are also at a disadvantage in terms of access to networks. Tacit knowledge is developed in industrial districts between co-operating firms. Clearly a rural firm may find it more difficult to be part of such a network and hence find it more difficult to take advantage of such knowledge. With respect to skills, rural firms would appear to be doubly disadvantaged in that remote rural areas tend to have a high proportion of people with no skills and then this impacts disproportionately on the rural firm, although of course not all rural firms across all rural areas.

Hence policy to enhance rural and small town firm productivity might consider focussing upon (i) reducing the proportion of people with no skills, and (ii) ensuring, and again the internet may help, that rural businesses have suitable access to business support services. Further research on issues such as access to finance for rural firms may also be of merit. The internet may also be used to try and replicate some aspects at least of the benefits derived from agglomeration and clustering. For example, lack of access to specialist suppliers and services might be eased by web-based searches, networks and purchasing.

The Potential of IT

We have seen there is evidence that ownership, distance factors, population density and an urban location all appear to impact on the speed of knowledge dissemination along several dimensions. What can be done to augment this process to speed knowledge dissemination to those in remoter low population density areas, particularly the stand alone firms? There is no reason why electronic networks cannot be built up linking firms across the region, across the country, across the world, fostering the dissemination of ideas.

Participation in entrepreneurial networks can be one means of improving awareness, training and knowledge, but participation of entrepreneurs outside the larger towns can be limited due to the combined constraints of peripherality and lack of resources. In addition, the networks themselves may be less effective than their city equivalents, due their smaller membership, for example, as may be the case with Chambers of Commerce. As a result effective networks have to be innovative and they have to utilise alternative means of disseminating knowledge and collective action. (Galloway, *et al*. 2004).

Firms may need help in learning about the possibilities IT offers. They may also need help in implementing IT fully into their business to make the best use of it. They may also need help, particularly start up businesses in basic business skills and in gaining access to finance. They might in some cases also benefit from IT 'hubs' in small town and indeed larger town locations and help with organising business networks, both local to help with sourcing and more widespread to help with knowledge diffusion.

But IT can do more, particularly for firms in remoter areas, than facilitate knowledge dissemination. The evidence also suggests at times that the disadvantage associated with distance and peripherality is being reduced by IT and other technological developments.

But not just IT

In this respect it is a matter of concern that the data shows firms in Wales to be slow to adopt technologies such as internet buying and selling and appear to make relatively low usage of services such as those related to computers and telecommunications. IT will continue changing the world we live in, including the business world. Given the analysis here, this suggests that it should be a priority to ensure that new developments which can enhance business efficiency are accessible to firms across Wales.

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APPENDIX 1: VARIABLE DEFINITIONS

GVAFC	Gross value added at factor cost, sometimes deflated by regional price deflator.
Employment	Number of workers employed, full and part time.
Capital	Capital stock in constant prices obtained from the ARD data base, estimated by the ONS.
Full time ratio	Proportion of workers who are fulltime.
High skills/No skills:	Proportion of the labour force with either a first degree or equivalent *in the locality of the establishment not the firm itself.* For no skills it is the proportion with no formal qualifications.
Pop Den	Population density in the establishment's locality in 1981, represents agglomeration effects.
London Time/Miles	Travel time miles from the main council offices in the firm's locality to the Bank of England by road as determined from the Automobile Association website.
Other Cities Time/ Miles	Travel time miles from the main council offices in the firm's locality to the nearest of Leeds, Birmingham, Manchester and Glasgow, the four largest urban areas in Britain outside of London, by road as determined from the Automobile Association website.
Cluster	The difference between the proportion of firms in the locality in the same two digit industry as the i'th firm and the proportion of firms in this industry in the total sample.
UK Group firm	Operative if the firm is part of a UK owned group of firms.
US multinational	Operative if part of a US multinational.
Stand-alone firm	Operative if a British firm, which is not part of a group.
Private Firm	Privately owned firm.
# Plants/Units	Number of plants/units the respondent is replying for (to reflect potential diseconomies)
Inventories	Value of all stocks held at the end of th period – in general the calendar year. This includes Work in Progress but excluding VAT and progress payments on long-term contracts.
Internet buying	The use of the Internet, Electronic Data Interchange or any other electronic network to place orders for goods and services.
Internet selling	The use of the Internet, Electronic Data Interchange or any other electronic network to receive orders for goods and services.
Energy Usage	Energy used in the running of the business (including petrol, diesel, electricity and gas etc.) (amount payable).
Water Usage	Water used in the running of the business (amount payable), cost includes rates.
Cost of Waste	Sewerage charges and other costs of waste disposal (amount payable).
Insurance	Amounts payable for commercial insurance premiums.
Road Transport	Amounts payable for road transport services, includes buses and taxis for staff.
Telecommunications	Amounts payable for telecommunication services including mobile phones.
Computer services	Amounts payable for computer and related services (including repairs and maintenance and installation of office machinery and computers) excluding computer hardware and software.
Other services	Amounts payable for other services purchased (e.g. non-road transport and travel, professional services, postal services, research, rent paid, banking charges, legal costs and accounting fees etc., payments to home-workers).
Taxes Paid	Total amount payable in taxes, duties or levies to government.
Business rates	Amounts payable in national non-domestic (business) rates.
Objective 1 or 2	An Objective 1 or 2 area.
Regional Variables	Based on : North West, Yorkshire and Humberside, North East, West Midlands, Wales, Scotland, South West, East Midlands, East, South East, Bedfordshire[b]. MFD is a dummy variable for a firm in multiple regions.

Local Authorities in Wales
Industry Variables[a]:

Manufacturing	Includes mining and power: sic92 >15000 & sic92 <45000
Construction	sic92>45000 & sic92<50000
Wholesale/retail	sic92>50000 & sic92<55000
Catering	includes hotels: sic92>55000 & sic92<60000
Transport	sic92>60000 & sic92<65000
Social-Education	social work, community and education: sic92>80000 & sic92<90000

Notes: With respect to services we distinguish in the text between 'incidence of usage' and 'extent of usage'. Incidence of usage refers to whether or not a firm makes use of e.g. road transport. Given that a firm does make use of such services, extent of usage refers to the amount of usage. Hence when used in a regression incidence of usage is a binary variable.
[a]Hence the default is a range of smaller industries, including agriculture and fishing.
[b] Bedfordshire, Buckinghamshire and Berkshire are now parts of East and South East regions, but identified separately in ARD. The locality is based on the NUTS4 or LAU1 definition. Details on the data base can be found at:
http://www.statistics.gov.uk/about/bdl/downloads/BDLdatasets-ard.pdf

Appendix 2: Regression results

Table 1: Basic Productivity Equations

Variable	allinds1	allinds2	allinds3	allind~1
Log Employment	.75**	.75**	.75**	.751**
	343.37	***343.37***	***341.71***	***341.85***
Log Capital	.211**	.211**	.211**	.211**
	134.10	***134.10***	***133.43***	***133.29***
1998	-.217**	-.217**	-.218**	-.216**
	-43.99	***-43.99***	***-44.04***	***-43.54***
1999	-.221**	-.221**	-.221**	-.22**
	-46.69	***-46.69***	***-46.39***	***-46.42***
2000	-.196**	-.196**	-.196**	-.196**
	-42.20	***-42.20***	***-41.92***	***-41.92***
2001	-.144**	-.144**	-.145**	-.144**
	-31.80	***-31.80***	***-31.83***	***-31.72***
2002	-.113**	-.113**	-.114**	-.112**
	-24.86	***-24.86***	***-24.92***	***-24.65***
2003	-.0835**	-.0835**	-.0834**	-.0838**
	-18.78	***-18.78***	***-18.65***	***-18.76***
Fulltime	.716**	.716**	.712**	.717**
	97.94	***97.94***	***96.96***	***97.52***
High Skills^{L}	.026	.026	.0233	.0245
	1.83	***1.83***	***1.53***	***1.71***
Low Skills^{L}	-.186**	-.186**	-.18**	-.18**
	-8.49	***-8.49***	***-7.65***	***-8.19***
Pop dens	1.9e-05**	1.9e-05**	1.5e-05**	1.7e-05**
	6.89	***6.89***	***5.11***	***6.12***
Pop dens^{2}	-1.4e-07**	-1.4e-07**	-1.1e-07**	-1.2e-07**
	-4.92	***-4.92***	***-3.73***	***-4.21***
London time^{L}	-.0453**	-.0453**	-.05**	-.031**
	-8.15	***-8.15***	***-4.51***	***-4.97***
Clusters	.27**	.27**	.258**	.255**
	7.64	***7.64***	***7.22***	***7.17***
British group	-.0274**	-.0274**	-.0269**	-.0269**
	-3.69	***-3.69***	***-3.59***	***-3.60***
USA	.0517**	.0517**	.0502**	.0521**
	4.43	***4.43***	***4.27***	***4.43***
Stand alone	-.12**	-.12**	-.119**	-.119**
	-15.30	***-15.30***	***-15.11***	***-15.08***
Private	.212**	.212**	.209**	.211**
	22.25	***22.25***	***21.92***	***22.05***
Units	-.0169**	-.0169**	-.016**	-.0179**
	-5.31	***-5.31***	***-5.00***	***-5.61***
NW	-.0016	-.0016	-.0155	.0509**
	-0.13	***-0.13***	***-1.07***	***3.28***
Yorks+Hum	9.8e-04	9.8e-04	-.0145	.0682**
	0.08	***0.08***	***-0.97***	***4.37***
NE	-.0023	-.0023	.0011	.0768**
	-0.14	***-0.14***	***0.07***	***4.03***
W Mids	-.0061	-.0061	-.0247	.0448**
	-0.51	***-0.51***	***-1.76***	***3.17***
Wales	-.0323*	-.0323*	-.0312*	.0479**
	-2.30	***-2.30***	***-2.08***	***2.90***

Scotland	.0586**	.0586**	.0437**	.0854**
	3.92	***3.92***	***2.67***	***4.64***
SW	-.0089	-.0089	-.0036	.0312*
	-0.72	***-0.72***	***-0.26***	***2.12***
E Mids	-.0104	-.0104	-.0187	.0353*
	-0.85	***-0.85***	***-1.39***	***2.47***
East	.0097	.0097	.011	.0247
	0.69	***0.69***	***0.75***	***1.59***
SE	.0253*	.0253*	.0263*	.0395**
	2.52	***2.52***	***2.40***	***3.43***
Beds	.0272*	.0272*	.0236	.0439**
	2.19	***2.19***	***1.84***	***3.28***
MFD	.0663**	.0663**	.0633**	.104**
	5.85	***5.85***	***5.15***	***7.71***
Construction	.0743**	.0743**	.0774**	.0725**
	8.08	***8.08***	***8.37***	***7.83***
Whole-Ret	-.0603**	-.0603**	-.0583**	-.061**
	-10.35	***-10.35***	***-9.94***	***-10.42***
Catering	-.707**	-.707**	-.705**	-.707**
	-75.34	***-75.34***	***-74.76***	***-74.81***
Transport	-.173**	-.173**	-.173**	-.176**
	-18.04	***-18.04***	***-17.88***	***-18.17***
Social-Edn	-.375**	-.375**	-.375**	-.376**
	-50.20	***-50.20***	***-49.94***	***-50.03***
Man. etc	-.191**	-.191**	-.191**	-.193**
	-28.64	***-28.64***	***-28.44***	***-28.73***
distpo~t			-5.2e-07	
			-0.06	
London miles^{L}			-.0021	
			-0.22	
Other Cities miles^{L}			-.0077	
			-0.46	
Other Cities times^{L}			-.0072	
			-0.50	
Constant	2.17**	2.17**	2.28**	2.06**
	33.51	***33.51***	***31.54***	***31.63***
Observations	178450	178450	176522	176536
X^2	907458	907458	900199	898407

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. All equations estimated by random effects.
Interpretation: A t statistic denotes significance. Ignore whether positive or negative and focus on absolute value. If this is greater than or equal to 1.96 it is significant at the 5% level, i.e. there is just a 5% chance that the significance is due to 'chance'. If it is greater than or equal to 2.57 then it is significant at the 1% level. The sign on the coefficient is critical. On the cluster variable in the first column it is *positive* (0.270). Thus an increase in this variable *increases* productivity. In addition because the t statistic is above the critical value at the 1% level, we hold this conclusion with a 99% level of certainty.

Table 2 Productivity regressions: Rural Urban Divide

Variable	Britain: Full Sample	Rural	Town	Wales Full Sample	Rural	Town
Log	.75**	.741**	.758**	.712**	.718**	.717**
Employment	**343.40**	**151.43**	**253.83**	**79.42**	**42.90**	**36.60**
Log Capital	.211**	.206**	.211**	.233**	.216**	.249**
	134.10	**58.07**	**98.15**	**36.67**	**18.39**	**17.78**
1998	-.217**	-.227**	-.219**			
	-43.99	**-19.22**	**-33.20**			
1999	-.221**	-.215**	-.225**	-.219**	-.281**	-.213**
	-46.69	**-19.08**	**-35.52**	**-11.92**	**-7.93**	**-5.27**
2000	-.196**	-.189**	-.202**	-.214**	-.205**	-.193**
	-42.19	**-17.02**	**-32.56**	**-12.09**	**-6.07**	**-4.79**
2001	-.144**	-.129**	-.153**	-.151**	-.133**	-.175**
	-31.78	**-11.96**	**-25.17**	**-11.29**	**-5.43**	**-5.36**
2002	-.113**	-.101**	-.12**	-.105**	-.0959**	-.0883**
	-24.84	**-9.36**	**-19.63**	**-7.85**	**-3.93**	**-2.75**
2003	-.0834	-.0691	-.0937**	-.0761**	-.0808**	-.0928**
	-18.75	**-6.56**	**-15.68**	**-5.83**	**-3.42**	**-2.95**
Fulltime	.716**	.692**	.743**	.661**	.622**	.734**
	97.93	**46.54**	**70.75**	**23.04**	**12.89**	**10.54**
High skills^{L}	.0276	-.0069	.0512**	-.103	-.461	.411
	1.94	**-0.17**	**2.93**	**-1.22**	**-1.54**	**1.91**
Low Skills^{L}	-.171**	-.213**	-.176**	-.219	-.471	.33
	-7.67	**-3.36**	**-6.62**	**-1.75**	**-1.33**	**1.00**
Log Pop dens		.0125*	.0107		-.0224	.0623
		2.25	**1.95**		**-0.81**	**0.98**
Pop dens	1.9e-05**			5.2e-05		
	7.07			**1.76**		
Pop dens^{2}	-1.5e-07**			-3.2e-08		
	-5.01			**-0.05**		
London time^{L}	-.0423**	-.0913**	-.0308**	-.0692	-.17	-.101
	-7.55	**-4.40**	**-4.41**	**-1.23**	**-1.54**	**-0.99**
Clusters	.27**	.294**	.279**	.229	.408	-.534
	7.65	**3.37**	**6.13**	**1.49**	**1.54**	**-1.40**
British group	-.0274**	-.0483*	-.0161	.0136	-.0568	-.0434
	-3.69	**-2.08**	**-1.71**	**0.45**	**-0.63**	**-0.75**
USA	.0518**	.0691	.0529**	.0971	.146	.0566
	4.44	**1.90**	**3.59**	**1.93**	**1.14**	**0.54**
Stand alone	-.12**	-.143**	-.0971**	-.0974**	-.153	-.0728
	-15.28	**-6.05**	**-9.65**	**-3.09**	**-1.71**	**-1.14**
Private	.212**	.189**	.218**	.252**	.143*	.178*
	22.23	**9.15**	**16.50**	**7.80**	**2.46**	**2.37**
Units	-.0169**	-.0225*	-.022**	.0327**	-.0017	.0527**
	-5.32	**-2.14**	**-5.61**	**3.15**	**-0.07**	**2.80**
NW	-.0048	-.0769	-.0179			
	-0.38	**-1.18**	**-1.11**			
Yorks+Hum	.0011	-.0542	-.0122			
	0.08	**-1.96**	**-0.70**			
NE	-.0061	-.148	.0012			
	-0.37	**-3.55**	**0.06**			
W Mids	-.0113	-.046	-.0259			
	-0.94	**-1.50**	**-1.64**			
Wales	-.0283	-.0931**	-.0547			

	-1.98	**-3.39**	**-1.96**			
Scotland	.0525**	.0621*	.0431*			
	3.50	**2.30**	**2.00**			
SW	-.014	-.0494	-.0324			
	-1.12	**-1.86**	**-1.79**			
E Mids	-.0168	-.0727*	-.0429*			
	-1.35	**-2.46**	**-2.37**			
East	.0025	-.0587	-.0195			
	0.18	**-1.78**	**-0.70**			
SE	.0196	-.035	.0021			
	1.91	**-1.00**	**0.16**			
Beds	.0213	-.0768	.0182			
	1.70	**-1.42**	**1.03**			
MFD	.0618	.0059	.0606			
	5.42	**0.17**	**4.30**			
Construction	.0744	.0813	.0629	.067	.139*	-.0331
	8.09	**4.17**	**4.73**	**1.86**	**1.97**	**-0.42**
Whole-Ret	-.0601	-.0734	-.0631	-.115*	-.0871	-.149**
	-10.32	**-5.38**	**-7.99**	**-4.67**	**-1.86**	**-2.77**
Catering	-.706	-.686	-.715	-.688**	-.613**	-.823**
	-75.29	**-35.86**	**-51.99**	**-20.44**	**-9.50**	**-10.51**
Transport	-.173	-.137	-.19	-.185**	-.182*	-.266**
	-18.04	**-6.39**	**-14.59**	**-4.89**	**-2.50**	**-3.43**
Social-Edn	-.375	-.368	-.381	-.365**	-.341**	-.425**
	-50.18	**-21.97**	**-36.87**	**-13.03**	**-6.10**	**-7.16**
Man. etc	-.191	-.17	-.208	-.195**	-.152**	-.237**
	-28.65	**-10.81**	**-22.91**	**-7.11**	**-2.67**	**-4.20**
Objective 1	-.0258			-.0212		
	-3.54			**-0.87**		
Objective 2	-.0122			-.0118		
	-2.87			**-0.26**		
Angl+Cered				-.0403		-.146
				-0.66		**-0.90**
Bla+Mer+Caer				-.0351		-.0579
				-0.68		**-0.88**
Monm+Torf				-.0038		.0955
				-0.07		**1.00**
N Wales				-.0265		.0184
				-0.51		**0.31**
Pow+Pem+Carm				-.0132		-.137
				-0.31		**-1.71**
S. Wales				-.0146		.0345
				-0.32		**0.82**
Constant	2.18**	2.4**	2.07**	1.97**	1.92*	3.12*
	33.66	**11.16**	**20.13**	**4.27**	**2.21**	**2.42**
Observations	178450	34823	96125	11340	3552	2086
X^2	907618	145849	515957	56221.8	10443.7	16607.5

[L]denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. All equations estimated by random effects. *Interpretation*: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 3: Capital Stock & Miscellaneous Regressions

Variable	Capital	Product. Impact	Invento-ries	Insurance	Business rates	Total tax
Log Emplyoment	.736**	.752**	.233**	.244**	.27**	.215**
	333.55	***326.83***	***39.31***	***70.13***	***68.99***	***56.71***
Log Capital		.209**	.375**	.513**	.209**	.234**
		126.07	***94.75***	***231.82***	***82.18***	***95.19***
Log GVAFC			.354**	.143**	.202**	.206**
			73.64	***45.54***	***58.60***	***61.22***
1998	.174**		-.0643**	-.562**	-.0823**	-.216**
	47.01		***-6.44***	***-75.18***	***-10.85***	***-28.84***
1999	.158**	-.215**	-.0749**	-.551**	-.0975**	-.173**
	44.56	***-45.28***	***-7.76***	***-76.77***	***-13.30***	***-23.91***
2000	.148**	-.193**	-.0417**	-.476**	-.0538**	-.141**
	42.65	***-41.85***	***-4.40***	***-67.75***	***-7.47***	***-19.94***
2001	.144**	-.142**	-.0177**	-.377**	-.0444**	-.117**
	42.57	***-31.58***	***-2.30***	***-54.78***	***-6.31***	***-16.92***
2002	.141**	-.11**	-.0494**	-.236**	.0086	-.0956**
	41.90	***-24.57***	***-6.45***	***-34.29***	***1.22***	***-13.76***
2003	.132**	-.0819**	-.0439**	-.0952**	-.023**	-.101**
	40.32	***-18.67***	***-5.61***	***-14.05***	***-3.32***	***-14.80***
Fulltime	.579**	.71**	.191**	.319**	.125**	.207**
	66.65	***92.92***	***11.05***	***33.37***	***11.33***	***19.24***
High Skills^{L}	.119**	.0479**	.0506	-.0338	.0207	-.0103
	7.61	***3.13***	***1.69***	***-1.83***	***1.03***	***-0.52***
Low Skills^{L}	-.0246	-.154**	.0123	.0022	-.233**	-.224**
	-1.02	***-6.57***	***0.26***	***0.07***	***-7.38***	***-7.25***
Log Pop dens	.0165**	.0376**	-.0176**	-.0029	.0409**	.0286**
	6.05	***3.08***	***-4.19***	***-1.18***	***15.08***	***10.85***
Log Pop dens^{2}		-.002				
		-1.95				
London time^{L}	-.0985**	-.0396**	.0496	-.0097	-.0548**	-.0655**
	-6.15	***-6.72***	***1.81***	***-0.65***	***-3.26***	***-4.01***
Clusters	.0368	.227**	.268**	.0391	.151**	.0955
	1.21	***5.92***	***3.36***	***0.77***	***2.81***	***1.81***
British group	-.0504**	-.0228**	-.051**	.0031	-.0883**	-.0725**
	-7.97	***-2.86***	***-3.76***	***0.27***	***-7.82***	***-6.51***
USA	-.006**	.0615**	.0247**	-.0923**	.0174	.0396*
	-0.62	***4.91***	***1.19***	***-5.22***	***0.98***	***2.26***
Stand alone	-.24**	-.119**	-.208**	-.0788**	-.278**	-.262**
	-34.52	***-14.17***	***-13.99***	***-6.72***	***-23.32***	***-22.33***
Private	-.11**	.21**	.227**	-.14**	.0563**	.184**
	-9.51	***20.97***	***6.77***	***-10.31***	***3.62***	***12.15***
Units	-.0695**	-.0224**	.0093	-.0065	.226**	.221**
	-19.96	***-6.54***	***1.26***	***-1.42***	***47.29***	***47.20***
NW	.0095	-.0264	-.0118	-.0195	-.122**	-.118**
	0.58	***-1.85***	***-0.36***	***-0.96***	***-5.63***	***-5.56***
Yorks+Hum	.0883**	-.0249	-.0443	-.0124	-.0979**	-.106**
	4.72	***-1.72***	***-1.33***	***-0.60***	***-4.43***	***-4.90***
NE	.0804**	-.0238	-.147**	-.0278	-.0946**	-.0997**
	3.31	***-1.31***	***-3.69***	***-1.17***	***-3.66***	***-3.96***
W Mids	.0606**	-.0251	.0022	-.0224	-.0867**	-.109**
	3.36	***-1.91***	***0.07***	***-1.16***	***-4.16***	***-5.39***
Wales	.0907**	-.0537**	-.0747*	-.0417*	-.166**	-.143**

	4.53	***-3.53***	***-2.24***	***-2.02***	***-7.43***	***-6.59***
Scotland	-.047*	.0414*	-.0761*	.0065	.0924**	.0832**
	-2.39	***2.51***	***-2.09***	***0.29***	***3.83***	***3.53***
SW	-.0063	-.0204	-.0404	-.0254	-.114**	-.113**
	-0.34	***-1.50***	***-1.29***	***-1.37***	***-5.59***	***-5.74***
E Mids	.0223	-.0276*	-.0586	-.0257	-.113**	-.121**
	1.24	***-2.06***	***-1.91***	***-1.40***	***-5.62***	***-6.21***
East	.0597**	-.0038	.0381	-.0068	-.0545*	-.0586**
	2.77	***-0.25***	***1.11***	***-0.34***	***-2.50***	***-2.76***
SE	.037*	.013	-.0409	-.0187	-.0821**	-.1**
	2.55	***1.21***	***-1.60***	***-1.29***	***-5.08***	***-6.40***
Beds	-.0661**	.0147	-.0415	-.0197	-.0198	-.0463*
	-3.68	***1.12***	***-1.40***	***-1.17***	***-1.04***	***-2.51***
MFD	.0486**	.0502**	.105**	.0472**	-.0202	-.022
	3.57	***4.02***	***3.81***	***2.75***	***-1.11***	***-1.24***
Construction	-.289**	.0671**	.972**	.508**	-.478**	-.149**
	-19.98	***6.92***	***45.43***	***42.17***	***-32.63***	***-10.60***
Whole-Ret	-.419**	-.0709**	2.35**	.665**	.719**	.762**
	-45.54	***-11.58***	***146.58***	***83.88***	***78.11***	***85.38***
Catering	.426**	-.712**	-.26**	-.355**	.671**	.488**
	28.06	***-72.34***	***-11.20***	***-28.67***	***49.63***	***37.02***
Transport	.355**	-.186**	-1.09**	.664**	.107**	.403**
	23.23	***-18.36***	***-32.92***	***50.97***	***7.26***	***28.44***
Social-Edn	.0907**	-.379**	-1.37**	-.0991**	-.144**	-.087**
	7.62	***-48.52***	***-54.79***	***-9.69***	***-12.06***	***-7.53***
Man. etc	.317**	-.215**	1.43**	.103**	.463**	.357**
	31.42	***-30.26***	***82.63***	***11.10***	***45.08***	***35.75***
London miles^{L}	.0107		-.0279	.0092	.0311*	.0346*
	0.76		***-1.18***	***0.71***	***2.12***	***2.43***
Other Cities	-.0445		.0328	.0196	-.0294	-.0412
miles^{L}	***-1.77***		***0.87***	***0.87***	***-1.18***	***-1.70***
Other Cities	.0048		-.0228	-.0226	-.0112	-9.8e-04
times^{L}	***0.23***		***-0.71***	***-1.18***	***-0.53***	***-0.05***
Objective 1	-.0075		-.0214	.0079	-.0219*	-.011
	-1.09		***-1.44***	***0.74***	***-1.97***	***-1.01***
Objective 2	.0011		.0027	.0098	2.9e-04	.0069
	0.30		***0.31***	***1.60***	***0.05***	***1.10***
matfuel		3494**				
		6.00				
buyene~y		1.0e+04**				
		3.01				
buywater		2.2e+05**				
		2.59				
buyrdt~n		1.3e+04*				
		2.19				
others~s		343				
		0.58				
Constant	4.32**	2.12*	-2.47**	-2.81**	-1.51**	-1.28**
	47.57	***32.68***	***-15.74***	***-30.63***	***-14.93***	***-12.93***
Observations	214456	156694	115875	209687	183795	187707
X^2	185848	840179	244008	537569	255088	257115

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. All equations estimated by random effects.
Interpretation: For interpretation of t statistics and coefficients, see Table 1.

Table 4: Energy and Fuel Equations

Variable	Britain User of Energy	Extent of Use	Wales Extent of Use	Britain User of Fuel	Extent of Use	Wales Extent of Use
Log	.0535**	.303**	.292**	.0665**	.314**	.355**
Employment	***9.25***	***96.02***	***22.66***	***11.70***	***91.04***	***24.78***
Log Capital	.144**	.541**	.562**	.138**	.6**	.597**
	34.56	***233.18***	***59.73***	***34.35***	***234.31***	***56.83***
1998				.296**	.1**	.102**
				9.64	***9.98***	***2.62***
1999	-.123**	-.163**	-.0991**	-.227**	-.166**	-.188**
	-5.09	***-21.30***	***-3.08***	***-9.82***	***-17.19***	***-5.01***
2000	-.129**	-.0791**	-.0014**	-.152**	-.095**	-.0797**
	-5.54	***-10.63***	***-0.05***	***-6.74***	***-10.05***	***-2.22***
2001	-.0544*	-.0795**	-.0555*	-.119**	-.161**	-.124**
	-2.33	***-10.92***	***-2.33***	***-5.30***	***-17.40***	***-4.43***
2002	-.112**	-.128**	-.0964**	.0277	-.0176	-.0234
	-4.82	***-17.45***	***-4.05***	***1.18***	***-1.90***	***-0.84***
2003	.0412	-.121**	-.113**	.0527*	-.0175	-.0385
	1.70	***-16.90***	***-4.84***	***2.24***	***-1.91***	***-1.41***
Fulltime	-.0162	.293**	.377**	.108**	.477**	.481**
	-0.87	***28.06***	***8.88***	***6.36***	***40.66***	***10.05***
High Skills^{L}	-.0206	-.208**	-.23	-.0019	-.0806**	.0352
	-0.48	***-9.67***	***-1.73***	***-0.05***	***-3.47***	***0.27***
Low Skills^{L}	.195**	-.119**	-.0497	-.0108	-.0846*	-.0974
	2.95	***-3.51***	***-0.25***	***-0.18***	***-2.39***	***-0.52***
Pop dens^{L}	-.0191**	-.0222**	-.0521*	-.0099	-.002	.0398
	-3.43	***-7.80***	***-2.24***	***-1.92***	***-0.66***	***1.66***
London time^{L}	.069*	.0552**	-.349	.0186	.052**	.19
	2.31	***3.28***	***-0.90***	***0.61***	***2.83***	***0.46***
Clusters	-.32*	.0219	.287	-.418**	-.421**	-.423
	-2.46	***0.37***	***1.15***	***-3.38***	***-6.34***	***-1.55***
British group	.238**	-.0312*	-.0803	.0533	-.0639**	-.12*
	6.91	***-2.41***	***-1.53***	***1.46***	***-4.38***	***-2.07***
USA	-.0161	-.0345	.0091	-.0979	.0369	.0403
	-0.29	***-1.70***	***0.10***	***-1.61***	***1.60***	***0.42***
Stand alone	.434**	-.123**	-.207**	.191**	-.205**	-.331**
	12.70	***-9.09***	***-3.86***	***5.28***	***-13.51***	***-5.53***
Private	.195**	-.0454**	.111	.253	-.0705	.0666
	6.58	***-2.97***	***2.10***	***9.00***	***-4.17***	***1.13***
Units	.0035	.0538**	.0701**	-.0752**	-.078**	-.107**
	0.27	***10.26***	***4.04***	***-7.20***	***-13.68***	***-5.71***
NW	.0665	-.0952**		-.0313	.0049	
	1.32	***-3.87***		***-0.70***	***0.20***	
Yorks+Hum	.0105	-.0718**		-.0085	.029	
	0.21	***-2.91***		***-0.19***	***1.14***	
NE	.0368	-.0779**		-.0114	5.1e-04	
	0.65	***-2.77***		***-0.22***	***0.02***	
W Mids	.0781	-.0661**		.0268	.0085	
	1.67	***-2.89***		***0.64***	***0.36***	
Wales	.192**	-.0637**		.101*	.0022	
	3.80	***-2.62***		***2.32***	***0.09***	
Scotland	.0151	-.0615*		-.0336	.0143	
	0.28	***-2.28***		***-0.69***	***0.51***	
SW	.0789	-.0537*		.0625	.0307	

	1.82	***-2.44***		***1.59***	***1.34***	
E Mids	.0251	-.0883**		-.0361	.0172	
	0.57	***-4.03***		***-0.92***	***0.76***	
East	.137**	-.0594**		.121**	.0681**	
	2.95	***-2.57***		***2.90***	***2.82***	
SE	.0924**	-.0102		.0962**	.0767**	
	2.85	***-0.60***		***3.24***	***4.35***	
Beds	.0134	-.0382		-.003	.0496*	
	0.37	***-1.95***		***-0.09***	***2.41***	
MFD	-.0164	.0033		-.0535	.137**	
	-0.37	***0.16***		***-1.35***	***6.40***	
Construction	.416**	1.02**	1.09**	.58**	2.14**	2.34**
	15.88	***74.69***	***20.29***	***18.86***	***145.65***	***39.02***
Whole-Ret	.4**	1.08**	1.01**	-.0017	.307**	.171**
	25.84	***120.49***	***26.69***	***-0.12***	***31.41***	***4.04***
Catering	.161**	.405**	.357**	-.12**	1.32**	1.37**
	6.30	***29.46***	***7.03***	***-5.23***	***87.31***	***24.20***
Transport	.236**	1.64**	2.07**	-.0217	.168**	.342**
	8.23	***110.94***	***35.11***	***-0.83***	***10.43***	***5.24***
Social-Edn	.254**	.431**	.446**	.205**	.578**	.583**
	12.27	***37.64***	***10.29***	***9.74***	***46.40***	***12.04***
Man. etc	.681**	.748**	.765**	.66**	2.3**	2.4**
	25.58	***70.81***	***17.77***	***23.06***	***202.65***	***50.65***
London miles^{L}	-.0252**	-.0093	.229	.0114	-.0372*	-.277
	-0.92	***-0.62***	***0.65***	***0.42***	***-2.31***	***-0.73***
Other Cities miles^{L}	-.0697	-.107**	.0568	-.0599	-.125**	-.0798
	-1.36	***-4.20***	***0.55***	***-1.28***	***-4.49***	***-0.81***
Other Cities times^{L}	.0408	.0605**	-.0982	.0333	.0883**	.0579
	0.94	***2.81***	***-1.34***	***0.84***	***3.76***	***0.75***
Objective 1	.0074	-.0095	-.0563			
	0.25	***-0.79***	***-1.26***			
Objective 2	-.0067	-.0042	-.102			
	-0.38	***-0.60***	***-1.27***			
Angl+Cered			-.0526			.108
			-0.47			***1.23***
Bla+Mer+Caer			5.2e-04			.182**
			0.01			***2.71***
Monm+Torf			-.109			.0313
			-1.01			***0.45***
N Wales			-.043			.109
			-0.40			***1.60***
Pow+Pem+Carm			-.0777			.127
			-0.95			***1.80***
S. Wales			.0203			.14**
			0.25			***2.75***
Constant	.3	-2.8**	-1.98*	.325	-1.77**	-1.61
	1.47	***-26.78***	***-2.19***	***1.70***	***-15.62***	***-1.80***
Observations	192686	185783	13109	218050	209746	13983
X^2	7352.57	416773	28114.8	9822.8	568932	38943.1

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. Extent of use equations estimated by random effects, the regressions relating to whether or not the service is used by the firm are estimated by binomial probit.
Interpretation: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham hence the comparison is with Cardiff+Newport.

Table 5: Buying Road Transport and Other Services

Variable	Britain User of Other S.	Extent of Use	Wales Extent of Use	Britain User of Road Tran	Extent of Use	Wales Extent of Use
Log	-.0068	.269**	.306**	-.131**	.249**	.237**
Employment	***-1.08***	***92.98***	***25.23***	***-40.35***	***52.06***	***11.99***
Log Capital	.179**	.656**	.613**	.094**	.689**	.674**
	39.06	***307.00***	***69.19***	***38.21***	***198.56***	***47.21***
1998	.081**	-.118**	-.0496	-.0238	-.227**	-.0212
	2.74	***-13.46***	***-1.44***	***-1.74***	***-16.96***	***-0.39***
1999	-.0104	-.202**	-.127**	-.0209	-.175**	-.073
	-0.40	***-24.08***	***-3.85***	***-1.61***	***-13.61***	***-1.40***
2000	-.0063	-.102**	-.0811*	-.0344**	-.076**	.0609
	-0.25	***-12.37***	***-2.56***	***-2.73***	***-6.03***	***1.21***
2001	.0533*	-.0901**	-.0574*	.0641**	-.187**	-.045
	2.14	***-11.17***	***-2.31***	***5.11***	***-15.15***	***-1.17***
2002	.0021	-.0951**	-.0782**	-.0106	-.15**	-.0901*
	0.08	***-11.71***	***-3.14***	***-0.84***	***-12.11***	***-2.32***
2003	-.0029	-.0985**	-.0224	.0254*	-.149**	-.0541
	-0.11	***-12.29***	***-0.92***	***2.01***	***-12.19***	***-1.43***
Fulltime	.057**	.313**	.379**	.205**	.864**	.892**
	2.93	***31.92***	***9.35***	***17.69***	***54.12***	***13.48***
High Skills[L]	.0271	.17**	.346**	.013	-.0531	.262
	0.58	***8.68***	***3.00***	***0.56***	***-1.70***	***1.48***
Low Skills[L]	-.0318	-.168**	-.0278	.123**	.0609	.226
	-0.43	***-5.41***	***-0.16***	***3.32***	***1.23***	***0.85***
Log Pop dens	.0062	.0382**	.0948**	-.0025	-.0156**	-.0364
	1.09	***15.06***	***4.48***	***-0.87***	***-3.84***	***-1.08***
London time[L]	.033	-.105**	-.433	.0299	-.0011	-.984
	0.93	***-6.81***	***-1.20***	***1.68***	***-0.04***	***-1.72***
Clusters	-.0757	-.0084	.133	.23**	.1	-2.38**
	-0.52	***-0.15***	***0.56***	***3.20***	***1.11***	***-6.20***
British group	.0087	-.121**	-.0541	-.041*	-.17**	-.084
	0.20	***-9.72***	***-1.07***	***-2.52***	***-9.07***	***-1.09***
USA	-.184**	.0348	-.176*	-.0222	-.091**	-.0848
	-2.81	***1.76***	***-2.12***	***-0.85***	***-3.10***	***-0.69***
Stand alone	.118**	-.347**	-.286**	-.0903**	-.435**	-.476**
	2.75	***-26.82***	***-5.53***	***-5.40***	***-22.28***	***-6.03***
Private	.178**	-.176**	-.196**	.0567**	.0757**	.144
	5.94	***-12.38***	***-3.94***	***3.97***	***3.16***	***1.74***
Units	-.0469**	.0607**	.0974**	-.0929**	-.0486**	.099**
	-3.88	***12.64***	***6.04***	***-19.69***	***-6.06***	***3.72***
NW	-.0199	-.0099		-.034	-.0358	
	-0.39	***-0.46***		***-1.34***	***-1.05***	
Yorks+Hum	-.0307	-.0061		.0037	-.0702*	
	-0.61	***-0.28***		***0.15***	***-2.03***	
NE	-.0675	-.0092		-.0866**	-.138**	
	-1.19	***-0.37***		***-3.00***	***-3.43***	
W Mids	.0563	-.0033		.0063	-.0974**	
	1.18	***-0.16***		***0.26***	***-3.02***	
Wales	.129*	-.0423		.0808**	-.189**	
	2.52	***-1.95***		***3.24***	***-5.48***	
Scotland	-.0446	.0368		-.0951**	-.132**	
	-0.80	***1.55***		***-3.44***	***-3.48***	

SW	-.028	-.0022		-.044	-.0568	
	-0.62	***-0.11***		***-1.92***	***-1.82***	
E Mids	.0204	-.0154		-.0071	-.0363	
	0.45	***-0.80***		***-0.31***	***-1.18***	
East	.0585	.0217		-.007	-.0557	
	1.22	***1.05***		***-0.29***	***-1.68***	
SE	.0459	.0043		.021	.02	
	1.30	***0.28***		***1.17***	***0.82***	
Beds	.026	.0124		.0119	.02	
	0.65	***0.70***		***0.57***	***0.71***	
MFD	-.0711	.121		.0264	.229	
	-1.55	***6.59***		***1.25***	***7.82***	
Construction	.0582*	-.442**	-.38**	.175**	.747**	.988**
	2.21	***-35.57***	***-7.50***	***12.76***	***37.33***	***12.21***
Whole-Ret	.121**	.501**	.383**	.385**	1.84**	1.66**
	7.06	***61.54***	***10.78***	***42.50***	***139.16***	***29.01***
Catering	-.177**	-.448**	-.376**	.0175**	-.857**	-.598**
	-6.70	***-35.47***	***-7.86***	***1.27***	***-40.79***	***-7.64***
Transport	.128**	.362**	.236**	.0075	1.66**	1.48**
	3.70	***27.02***	***4.30***	***0.53***	***75.46***	***16.66***
Social-Edn	.0147	-.134**	-.0915*	.0906**	.0315	.0286
	0.65	***-12.78***	***-2.24***	***8.12***	***1.80***	***0.43***
Man. etc	.151**	-.644**	-.609**	.808**	1.58**	1.92**
	6.12	***-67.59***	***-15.22***	***70.95***	***104.39***	***30.39***
London miles^{L}	.0168	.0366**	.326	.0074	-.0454*	.677
	0.54	***2.70***	***0.98***	***0.47***	***-2.09***	***1.29***
Other Cities miles^{L}	-.0856	.0609**	-.111	-.0337	-.204**	-.344**
	-1.65	***2.60***	***-1.15***	***-1.26***	***-5.48***	***-2.20***
Other Cities miles^{L}	.0937	-.0625	.155	.0355	.13	.0849
	2.13	***-3.14***	***2.28***	***1.56***	***4.09***	***0.78***
Objective 1	.0064	-4.8e-04	-.0013	-.0343	-.063	.0179
	0.21	***-0.04***	***-0.03***	***-2.34***	***-3.42***	***0.27***
Objective 2	-.0198	-.0086	.153	-.0287	-.019	.057
	-1.09	***-1.26***	***2.02***	***-3.25***	***-1.77***	***0.47***
Angl+Cered			.269			.0343
			2.55			***0.20***
Bla+Mer+Caer			.269			.192
			2.96			***1.32***
Monm+Torf			.27			-.0166
			2.63			***-0.10***
N Wales			.286			-.0141
			2.77			***-0.08***
Pow+Pem+Carm			.215			.014
			2.78			***0.11***
S. Wales			.16			.105
			2.07			***0.85***
Constant	.309	-.395	-.39	.236	-4.05	-1.15
	1.40	***-4.11***	***-0.47***	***2.10***	***-26.40***	***-0.87***
Observations	218050	212525	14124	217853	167461	11407
X^2	5209.95	618321	34980.8	15566.1	332592	23438

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. Extent of use equations estimated by random effects, the regressions relating to whether or not the service is used by the firm are estimated by binomial probit.
Interpretation: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend

+Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 6: Cost of Waste and Water Demand Equations

Variable	Britain User of Waste S.	Extent of Use	Wales Extent of Use	Britain User of Water	Extent of Use	Wales Extent of Use
Log	-.0027	.375**	.327**	.044**	.312**	.269**
Employment	**-0.81**	**83.44**	**17.84**	**12.17**	**79.37**	**16.94**
Log Capital	.0665**	.581**	.585**	.0805**	.557**	.579**
	26.42	**177.65**	**44.51**	**29.74**	**193.38**	**50.45**
1999	.0537**	-.214**	-.109*	-.0679**	-.179**	-.0871*
	4.18	**-18.62**	**-2.26**	**-4.74**	**-18.72**	**-2.23**
2000	-.0331**	-.0997**	.0182	-.121**	-.109**	-.0187
	-2.67	***-8.86***	***0.39***	***-8.74***	***-11.75***	***-0.50***
2001	.0688**	-.0822**	.0631	-.0096	-.165**	-.135**
	5.57	***-7.49***	***1.78***	***-0.69***	***-18.17***	***-4.75***
2002	.003	-.0487**	-.0054	-.0148	-.148**	-.0968**
	0.24	***-4.41***	***-0.15***	***-1.06***	***-16.24***	***-3.41***
2003	.0731**	-.14**	-.0856*	.0573**	-.108**	-.0393
	5.84	***-12.93***	***-2.47***	***4.04***	***-12.10***	***-1.41***
Fulltime	.0557**	-.0163	.131*	.0464**	-.135**	-.0582
	4.63	***-1.10***	***2.17***	***3.66***	***-10.29***	***-1.11***
High Skills	-.192**	-.067*	.0489	-.111**	-.055*	-.248
	-7.78	***-2.23***	***0.27***	***-4.13***	***-2.08***	***-1.59***
Low Skills	-.0961*	.0236	.392	-.0147	-.0222	-.0856
	-2.46	***0.49***	***1.43***	***-0.35***	***-0.53***	***-0.36***
Log Pop dens	-.0048	-.0088*	-.113**	6.1e-05	.0036	-.0584*
	-1.51	***-2.27***	***-3.50***	***0.02***	***1.04***	***-2.11***
London time^{L}	.0605**	.0203	-.296	.101**	.0333	.246
	3.30	***0.87***	***-0.56***	***5.15***	***1.60***	***0.53***
Clusters	-.0583	.241**	1.65**	.0016	.355**	1.48**
	-0.76	***2.75***	***4.67***	***0.02***	***4.76***	***4.91***
British group	.164**	-7.6e-04	-.0646	.157**	.0213	-.0837
	10.33	***-0.04***	***-0.88***	***8.37***	***1.36***	***-1.36***
USA	-.0218	-.036	.147	-.0704	-.0044	-.0066
	-0.87	***-1.24***	***1.19***	***-2.38***	***-0.18***	***-0.06***
Stand alone	.197**	-.0535**	-.253**	.208**	-.005	-.174**
	12.06	***-2.82***	***-3.38***	***10.92***	***-0.31***	***-2.74***
Private	-.0028	-.117	.0828	-.0814**	-.288**	-.0197
	-0.17	***-5.61***	***1.14***	***-4.35***	***-15.79***	***-0.32***
Units	-.0885**	.0213**	.0585*	-.0658**	.0707**	.106**
	-17.25	***2.91***	***2.40***	***-10.95***	***11.22***	***5.09***
NW	.0045	-.0198		.0559	-.0787**	
	0.16	***-0.58***		***1.83***	***-2.63***	
Yorks+Hum	-.0019	-.072*		.0035	-.154**	
	-0.07	***-2.13***		***0.12***	***-5.14***	
NE	-.0621*	-.0467		.0345	-.106**	
	-1.99	***-1.22***		***0.99***	***-3.11***	
W Mids	4.3e-05	-.108**		.0304	-.134**	
	0.00	***-3.44***		***1.07***	***-4.80***	
Wales	.155**	-.0725*		.229**	-.131**	
	5.73	***-2.19***		***7.58***	***-4.47***	
Scotland	-.0581	-.0576		-.0814*	-.101**	
	-1.94	***-1.55***		***-2.46***	***-3.07***	
SW	.0248	-.0219		.0154	-.129**	
	1.00	***-0.72***		***0.57***	***-4.79***	

E Mids	.0036	-.0909**		.0036	-.162**	
	0.15	***-3.02***		***0.14***	***-6.06***	
East	.0349	-.0832**		.0826**	-.158**	
	1.34	***-2.63***		***2.90***	***-5.62***	
SE	.045*	-.0619**		.0387	-.113**	
	2.35	***-2.62***		***1.87***	***-5.40***	
Beds	-.0072	-.0716**		.0095	-.0952**	
	-0.33	***-2.65***		***0.40***	***-3.96***	
MFD	-.0551*	-.122**		.0076	-.197**	
	-2.41	***-4.26***		***0.30***	***-7.87***	
Construction	.388**	1.29**	1.25**	.217**	.317**	.317**
	26.51	***69.20***	***16.97***	***14.26***	***18.71***	***4.79***
Whole-Ret	.456**	1.55**	1.34**	.415**	1.4**	1.27**
	48.77	***122.80***	***25.55***	***41.61***	***126.08***	***27.51***
Catering	.556**	1.4**	1.16**	.559**	1.55**	1.46**
	35.49	***75.49***	***16.83***	***32.19***	***93.79***	***24.05***
Transport	.076**	.232**	.0909	.111**	.41**	.449**
	5.16	***10.92***	***1.08***	***6.93***	***22.15***	***6.22***
Social-Edn	.365**	1.1**	1.2**	.395**	1.23**	1.33**
	30.37	***68.72***	***20.12***	***30.04***	***87.76***	***25.48***
Man. etc	.664**	1.23**	1.19**	.77**	.936**	.884**
	58.17	***85.35***	***20.41***	***57.60***	***73.30***	***17.18***
London miles^{L}	-3.0e-04	.0048	-.211	-.0225	.038*	-.359
	-0.02	***0.23***	***-0.43***	***-1.28***	***2.06***	***-0.85***
Other Cities Miles^{L}	.0164	-.0332	.187	-.0614*	.0525	.298*
	0.58	***-0.96***	***1.30***	***-1.98***	***1.71***	***2.42***
Other Cities times^{L}	-.0228	.0313	-.224*	.04	-.0407	-.232**
	-0.95	***1.07***	***-2.23***	***1.52***	***-1.56***	***-2.66***
Objective 1	-.0206	.0034	-.111	-.0186	-.0017	-.112*
	-1.33	***0.20***	***-1.76***	***-1.07***	***-0.12***	***-2.09***
Objective 2	-.0087	.0099	-.31**	-.0054	.0072	-.126
	-0.93	***0.97***	***-2.78***	***-0.52***	***0.83***	***-1.32***
Angl+Cered			.0288			9.1e-04
			0.18			***0.01***
Bla+Mer+Caer			-.0772			-.0608
			-0.58			***-0.53***
Monm+Torf			-.305**			-.0473
			-2.02			***-0.37***
N Wales			-.0957			.0425
			-0.62			***0.33***
Pow+Pem+Carm			-.176			-.0298
			-1.51			***-0.31***
S. Wales			-.0752			.0717
			-0.66			***0.74***
Constant	-.928	-5.87	-1.58	-.594	-5.57	-5.27
	-7.88	***-40.63***	***-1.28***	***-4.62***	***-43.53***	***-4.89***
Observations	192728	147608	11017	192686	161140	11955
X^2	9979.28	262808	15362.6	13226.7	282827	17150.9

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. Extent of use equations estimated by random effects, the regressions relating to whether or not the service is used by the firm are estimated by binomial probit.
Interpretation: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 7: Internet Buying & Selling

Variable	Britain Selling	Wales Selling	Britain Buying	Wales Buying
Log	.0728**	.123**	.0226**	.0288
Employment	**17.84**	**7.09**	**6.01**	**1.84**
Log Capital	.0865**	.0527**	.0984**	.108**
	28.09	**4.30**	**34.55**	**9.58**
1999	-.176**	-.34**	-.428**	-.463**
	-13.43	**-6.19**	**-34.45**	**-9.04**
2001	-.0661**	-.158**	-.26**	-.32**
	-5.25	**-3.71**	**-22.05**	**-8.03**
2002	-.11**	-.165**	-.22**	-.296**
	-8.60	**-3.84**	**-18.52**	**-7.37**
2003	-.0866**	-.135**	-.135**	-.164**
	-6.77	**-3.18**	**-11.43**	**-4.18**
Fulltime	.403**	.736**	.343**	.423**
	24.89	**10.80**	**23.71**	**7.26**
High Skills	.101**	.0685	.144**	.209
	3.34	**0.32**	**5.23**	**1.02**
Low Skills	-.0318	-.241	-.09*	-.214
	-0.66	**-0.74**	**-2.06**	**-0.70**
Log pop dens	-.0015	.0326	-.0039	.0178
	-0.39	**1.12**	**-1.16**	**0.65**
London time	.0187	.121	.0634**	.0729
	0.87	**0.25**	**3.17**	**0.16**
Clusters	-.435**	-.918*	-.228**	-.24
	-4.70	**-2.43**	**-2.69**	**-0.72**
British Group	.0302	-.0836	-.0199	.0197
	1.95	**-1.35**	**-1.30**	**0.32**
USA	.0124	-.227*	.0673**	.025
	0.51	**-2.22**	**2.83**	**0.25**
Stand Alone	-.064**	-.162**	-.0584**	.015
	-3.89	**-2.57**	**-3.63**	**0.24**
Private	.0965**	-.0367	-.0832**	-.103
	4.76	**-0.51**	**-4.72**	**-1.67**
Units	-.0941**	-.142**	-.0325**	-.0437*
	-16.49	**-6.63**	**-6.03**	**-2.25**
NW	-.0729		-.0582	
	-2.28		-1.92	
Yorks+Hum	-.0288		.0054	
	-0.91		**0.18**	
NE	-.178**		-.0933**	
	-4.80		**-2.69**	
W Mids	-.0095		.0179	
	-0.32		**0.64**	
Wales	-.0508		.0129	
	-1.65		**0.45**	
Scotland	-.0919**		-.0225	
	-2.62		**-0.68**	
SW	-.0276		.0519	
	-0.96		**1.92**	
E Mids	.0177		.0136	
	0.62		**0.51**	
East	.0318		.075**	

	1.06		**2.64**	
SE	.0321		.138**	
	1.42		**6.52**	
Beds	.0155		.103**	
	0.59		**4.25**	
MFD	.0175		.0331	
	0.67		**1.34**	
Construction	-.401**	-.347**	-.641**	-.785**
	-18.21	**-4.79**	**-32.72**	**-11.18**
Whole-Ret	.237**	.226**	-.145**	-.0663
	21.06	**4.92**	**-14.16**	**-1.60**
Catering	-.0284	.38**	-.605**	-.31**
	-1.53	**5.94**	**-33.67**	**-5.26**
Transport	.0792**	-.0329	-.291**	-.497**
	4.58	**-0.49**	**-17.69**	**-7.79**
Social-Edn	-.232**	-.344**	-.325**	-.352**
	-15.05	**-6.04**	**-24.25**	**-7.38**
Man. etc	.192**	.194**	-.366**	-.4**
	15.56	**4.05**	**-31.22**	**-8.86**
London Miles	.0293	-.0664	-5.6e-04	.117
	1.53	**-0.15**	**-0.03**	**0.27**
Other Cities	.0092	-.225	-.0224	-.0103
Miles	**0.29**	**-1.69**	**-0.76**	**-0.08**
Other Cities	.0074	.0095	.0391	.0544
Time	**0.27**	**0.10**	**1.54**	**0.63**
Objective 1	-.0221	.12	-.0163	.086
	-1.25	**1.90**	**-1.00**	**1.47**
Objective 2	-.0192	.0876	-.0198*	.142
	-1.79	**0.87**	**-1.98**	**1.50**
Angle+Cered		.127		-.0156
		0.83		**-0.11**
Bla+Mer+Caer		.0238		.136
		0.19		**1.14**
Monm+Torf		.0892		.247
		0.62		**1.82**
N. Wales		.0135		.136
		0.09		0.97
Pow+Pem+Carm		.277*		.162
		2.53		**1.57**
S. Wales		.0651		.107
		0.61		**1.07**
Constant	-2.07**	-1.63	-1.25**	-2.55*
	-13.99	**-1.44**	**-9.68**	**-2.39**
Observations	157207	12091	158874	12091
X^2	15924.7	1303.9	13475.5	855.604

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. Equations relate to whether (coded 1) or not (coded 0) the firm uses the internet for buying or selling, i.e. incidence of use. Estimated by binomial probit. *Interpretation*: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 8: Compute Services and Telecommunications Services.

Variable	Britain User of Computer S.	Extent of usage	Wales Extent of usage	Britain User of Telecoms	Extent of usage	Wales Extent of usage
Log	.0184**	.366**	.374**	.019**	.276**	.252**
Employment	***4.89***	***103.95***	***24.74***	***3.36***	***103.98***	***22.34***
Log Capital	.122**	.629**	.606**	.199**	.545**	.527**
	43.08	***241.51***	***55.09***	***47.86***	***277.90***	***63.72***
1998	-.364**	-.613**	-.44**	-.0683*	-.188**	-.0956**
	-22.90	***-60.21***	***-10.32***	***-2.47***	***-27.08***	***-3.17***
1999	-.12**	-.351**	-.214**	-.132**	-.145**	-.0836**
	-7.68	***-36.39***	***-5.34***	***-5.38***	***-21.70***	***-2.89***
2000	-.162**	-.275**	-.135**	-.155**	-.0635**	-3.1e-04
	-10.73	***-29.06***	***-3.50***	***-6.56***	***-9.71***	***-0.01***
2001	-.0854**	-.264**	-.201**	-.0886**	-.0569**	-.0569**
	-5.66	***-28.61***	***-6.78***	***-3.76***	***-8.89***	***-2.63***
2002	-.0909**	-.175**	-2.1e-04	-.118**	-.0492**	-.0075
	-5.97	***-18.84***	***-0.01***	***-4.97***	***-7.66***	***-0.35***
2003	-.0552**	-.208**	-.128**	-.053*	-.0678**	-.0521*
	-3.59	***-22.80***	***-4.42***	***-2.21***	***-10.75***	***-2.46***
Fulltime	.221**	.606**	.691**	.172**	.502**	.606**
	17.65	***49.91***	***13.41***	***9.99***	***56.32***	***16.08***
High Skills[L]	-.0238	.0989**	.175	-.0381	.0897**	.184
	-0.83	***4.01***	***1.15***	***-0.86***	***4.85***	***1.65***
Low Skills[L]	-.165**	-.188**	-.383	-.0612	-.128**	-.332*
	-3.60	***-4.82***	***-1.67***	***-0.87***	***-4.40***	***-1.96***
Log Pop dens	.0117**	.0335**	.041	.0033	.0233**	.0299
	3.34	***10.34***	***1.59***	***0.60***	***9.49***	***1.53***
London time[L]	.0049	-.062**	-.156	.0513	-.0705**	-.644
	0.23	***-3.33***	***-0.35***	***1.62***	***-4.95***	***-1.93***
Clusters	-.123	.223**	-.994**	-.229	.15**	-.154
	-1.43	***3.30***	***-3.39***	***-1.75***	***3.09***	***-0.71***
British group	.0122	-.151**	-.0325	.107**	-.114**	-.0228
	0.59	***-10.57***	***-0.53***	***2.78***	***-10.84***	***-0.50***
USA	-.169**	-.0306	.0606	-.0899	.0562**	.0342
	-5.31	***-1.35***	***0.60***	***-1.43***	***3.38***	***0.45***
Stand alone	-.0345	-.384**	-.237**	.313**	-.271**	-.202**
	-1.65	***-25.73***	***-3.79***	***8.16***	***-24.48***	***-4.29***
Private	-.0045	-.312**	-.327**	.295**	.0604**	.0024
	-0.26	***-18.20***	***-5.37***	***11.50***	***4.65***	***0.05***
Units	-.0755**	-.0141*	.0716**	-.0887**	.0658**	.154**
	-12.38	***-2.47***	***3.65***	***-8.22***	***15.11***	***10.27***
NW	.0043	-.0045		.054	-.0055	
	0.15	***-0.17***		***1.19***	***-0.29***	
Yorks+Hum	.0511	-.0088		.0719	-.019	
	1.78	***-0.34***		***1.58***	***-0.97***	
NE	1.0e-05	-.0197		.0309	-.0273	
	0.00	***-0.64***		***0.61***	***-1.19***	
W Mids	.0207	.04		.0405	.0087	
	0.77	***1.63***		***0.96***	***0.48***	
Wales	.194**	-.0198		.184**	-.0326	
	6.75	***-0.75***		***4.00***	***-1.64***	
Scotland	.043	.0484		.0313	.0533*	
	1.36	***1.67***		***0.63***	***2.47***	

SW	.0413	.0323		.0588	.0202	
	1.60	***1.36***		***1.47***	***1.14***	
E Mids	.0259	.001		.0299	-.0086	
	1.01	***0.04***		***0.75***	***-0.49***	
East	.11**	.0744**		.134**	.046*	
	3.98	***2.96***		***3.09***	***2.43***	
SE	.0734**	.087**		.0796*	.06**	
	3.55	***4.71***		***2.53***	***4.32***	
Beds	.0476*	.0744**		-.0178	.0575**	
	2.00	***3.49***		***-0.50***	***3.57***	
MFD	.028	.175**		.023	.187**	
	1.12	***7.99***		***0.55***	***11.53***	
Construction	-.0648**	-1.05**	-1.08**	.277**	-.134**	-.187**
	-3.99	***-69.73***	***-17.34***	***10.81***	***-11.69***	***-3.95***
Whole-Ret	.0442**	.118**	.014	.241**	.286**	.131**
	4.08	***12.04***	***0.32***	***15.65***	***37.88***	***3.94***
Catering	-.362**	-1.66**	-1.48**	-.218**	-1.01**	-.981**
	-23.03	***-105.40***	***-24.70***	***-9.68***	***-85.59***	***-21.91***
Transport	-.154**	-.671**	-.76**	.0292	.0193	-.0151
	-8.64	***-41.31***	***-11.19***	***1.04***	***1.55***	***-0.29***
Social-Edn	-.176**	-.809**	-1.02**	.0498*	-.433**	-.512**
	-13.15	***-63.38***	***-20.35***	***2.50***	***-44.70***	***-13.42***
Man. etc	-.0956**	-.892**	-.873**	.42**	-.681**	-.655**
	-7.40	***-78.34***	***-17.94***	***16.70***	***-77.18***	***-17.56***
distpo~t	1.2e-05	4.1e-06	3.3e-04	1.5e-05	1.8e-05	-3.9e-05
	0.59	***0.26***	***1.14***	***0.44***	***1.59***	***-0.18***
London miles^{L}	-.0074	.0175	.164	-.0453	.0213	.467
	-0.41	***1.07***	***0.41***	***-1.64***	***1.71***	***1.53***
Other Cities miles^{L}	-.0234	-.0429	-.0524	-.017	-.0268	-.157
	-0.76	***-1.50***	***-0.44***	***-0.35***	***-1.23***	***-1.73***
Other Cities times^{L}	.0047	.0215	.0754	.0179	.0077	.0439
	0.18	***0.88***	***0.85***	***0.43***	***0.41***	***0.65***
Objective 1	-.027	-.0265	.044	-.0039	-.0083	.0845*
	-1.56	***-1.87***	***0.86***	***-0.14***	***-0.80***	***2.21***
Objective 2	-.0135	-.0123	.238*	-.0055	-.0075	.143*
	-1.29	***-1.49***	***2.55***	***-0.33***	***-1.27***	***2.03***
Angl+Cered			.242			.105
			1.64			***0.95***
Bla+Mer+Caer			.277*			.159
			2.41			***1.84***
Monm+Torf			.362**			.163
			2.75			***1.64***
N Wales			.249			.108
			1.95			***1.12***
Pow+Pem+Carm			.149			.0837
			1.54			***1.15***
S. Wales			.209*			.118
			2.18			***1.63***
Constant	.118	-3.24**	-4.31**	-.294	-2.45**	-1.43
	0.84	***-26.17***	***-4.11***	***-1.35***	***-26.22***	***-1.81***
Observations	215710	186794	12497	215710	207855	13736
X^2	11114.6	472684	26359	9342.15	534694	32028.2

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. Extent of use equations estimated by random effects, the regressions relating to whether or not the service is used by the firm are estimated by binomial probit.

Interpretation: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 9: Location Variables for Stand Alone British Firms, Group British Firms and Multinationals.

Variable	Britain: Stand Alone	British group	MNE	Wales Stand alone	British group	MNE
1998	.338**	.0879**	-.725**	.414**	.148**	-.948**
	27.46	***7.06***	***-46.75***	***8.05***	***2.78***	***-13.57***
1999	.424**	-.0072	-.735**	.408**	.124*	-.903**
	35.89	***-0.60***	***-49.27***	***8.21***	***2.40***	***-13.68***
2000	.532**	-.125**	-.745**	.605**	-.13**	-.827**
	46.03	***-10.57***	***-51.38***	***12.83***	***-2.58***	***-13.69***
2001	.436**	-.0793**	-.618**	.567**	-.0522	-.905**
	38.26	***-6.78***	***-44.73***	***14.45***	***-1.23***	***-18.05***
2002	.457**	-.0972**	-.626**	.602**	-.0993*	-.886**
	39.47	***-8.18***	***-44.38***	***15.08***	***-2.29***	***-17.46***
2003	.0577**	-.0883**	.0179	.0502	-.0873*	.0215
	5.09	***-7.42***	***1.44***	***1.33***	***-2.02***	***0.52***
High Skills[L]	-.138**	.17**	-.0556*	-.8**	.442**	.534**
	-6.73	***8.19***	***-2.11***	***-5.61***	***2.96***	***2.73***
Low Skills[L]	.0925**	.0509	-.333**	.871**	-1.11**	.138
	2.84	***1.53***	***-7.92***	***4.09***	***-4.87***	***0.46***
Log Pop dens	-.104**	.0855**	.0658**	-.445**	.336**	.228**
	-38.02	***30.29***	***17.65***	***-19.17***	***14.59***	***8.57***
London time[L]	.164**	-.0962**	-.174**	-.281	.222	-.0637
	10.25	***-5.71***	***-8.33***	***-0.69***	***0.54***	***-0.13***
Clusters	-.752**	.248**	1.09**	1.01**	-1.51**	.0078
	-11.22	***3.56***	***12.67***	***3.30***	***-4.39***	***0.02***
NW	.0475*	.017	-.0654*			
	1.98	***0.70***	***-2.11***			
Yorks+Hum	-.0175	.11**	-.119**			
	-0.73	***4.57***	***-3.79***			
NE	-.011	-.0041	.0968**			
	-0.40	***-0.15***	***2.73***			
W Mids	-.0196	.035	.0426			
	-0.88	***1.55***	***1.48***			
Wales	-.04	-.0234	.194**			
	-1.70	***-0.97***	***6.42***			
Scotland	.0783**	-.0334	-.0435			
	2.96	***-1.26***	***-1.29***			
SW	.102**	-.0249	-.142**			
	4.71	***-1.12***	***-4.90***			
E Mids	.0232	.0739**	-.146**			
	1.09	***3.42***	***-5.14***			
East	-.0377	.0753**	-.0293			
	-1.67	***3.22***	***-0.94***			
SE	.0208	-.0167	.0042			
	1.25	***-0.96***	***0.19***			
Beds	.0909**	-.0475**	-.0963**			
	4.73	***-2.36***	***-3.68***			
MFD	-1.33**	.908**	.639**			
	-71.77	***49.02***	***27.55***			
Construction	-.0615**	.121**	-.201**	-.0261	.329**	-.631**
	-4.70	***9.06***	***-9.89***	***-0.50***	***5.92***	***-7.41***
Whole-Ret	-.148**	.0835**	.152**	-.085*	.245**	-.225**
	-17.36	***9.36***	***13.31***	***-2.28***	***5.93***	***-4.60***
Catering	.216**	-.127**	-.314**	.354**	-.112	-.541**

	14.93	***-8.47***	***-14.34***	***6.56***	***-1.86***	***-7.36***
Transport	-.379**	.375**	.0689**	-.333**	.595**	-.341**
	-28.28	***27.78***	***3.75***	***-6.18***	***10.44***	***-4.37***
Social-Edn	.165**	-.122**	-.193**	.293**	-.23**	-.271**
	15.09	***-10.59***	***-12.28***	***6.61***	***-4.47***	***-4.84***
Man. etc	-1.06**	.754**	.651**	-1**	.843**	.526**
	-117.07	***82.78***	***56.36***	***-27.43***	***21.17***	***12.01***
London miles^{L}	-.171**	.0966**	.165**	.148	.0623	.0201
	-11.98	***6.44***	***8.78***	***0.39***	***0.16***	***0.05***
Other Cities	.0693**	.0919**	-.334**	1.38**	-1.03**	-.808**
Miles^{L}	***2.81***	***3.60***	***-9.68***	***12.97***	***-9.68***	***-6.26***
Other Cities	-.0633**	-.0762**	.295**	-1.15**	.742**	.842**
times^{L}	***-3.03***	***-3.54***	***9.99***	***-16.36***	***10.34***	***9.38***
Objective 1	.0108	-.0063	-.0153	-.36**	.359**	.0085
	0.79	***-0.45***	***-0.88***	***-7.40***	***7.10***	***0.14***
Objective 2	.0534**	-.0339**	-.0374**	-.774**	.697**	.197
	6.48	***-4.12***	***-3.61***	***-9.03***	***7.76***	***1.82***
Angl+Cered				-.945**	.573**	.52**
				-7.51	***4.46***	***3.44***
Bla+Mer+Caer				-.687**	.422**	.38**
				-6.59	***3.90***	***2.96***
Monm+Torf				-.57**	.486**	.155
				-4.81	***4.00***	***1.07***
N Wales				-.812**	.55**	.33*
				-6.58	***4.46***	***2.26***
Pow+Pem+Carm				-.847**	.602**	.3**
				-9.33	***6.66***	***2.80***
S. Wales				-.406**	.323**	.111
				-4.55	***3.47***	***0.99***
Constant	1.1**	-1.35**	-1.8**	2.76**	-4.24**	-.936
	11.25	***-13.37***	***-13.76***	***2.98***	***-4.38***	***-0.83***
Observations	255819	255819	255819	16122	16122	16122
X^2	69716.4	35795	22976.2	3578.49	1983.27	1823.16

^{L}denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. All equations are estimated by binomial probit. *Interpretation*: For interpretation of t statistics and coefficients, see Table 1. The sample covers all the years, hence the larger firms will be represented more than once. There were two alternatives. Just include each firm once, although then there was the problem of which year to include. Alternatively we could estimate the regression in single years, thus losing observations. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

Table 10: Industry Regressions for Wales

Variable	Constr-Uction	Whole-retail	Catering	Transport	soc-Edn	Manufac-turing +
Log	.728**	.738**	.695**	.718**	.618**	.74**
Employment	***22.10***	***32.55***	***22.51***	***18.78***	***27.87***	***40.31***
Log Capital	.235**	.217**	.188**	.244**	.27**	.246**
	9.57	***15.78***	***6.77***	***7.98***	***17.08***	***19.38***
1998	-.161*	-.201**	-.32**	-.288**	-.274**	-.155**
	-2.21	***-3.59***	***-4.37***	***-2.89***	***-5.19***	***-4.82***
1999	-.25**	-.242**	-.26**	-.353**	-.192**	-.143**
	-3.74	***-4.44***	***-3.85***	***-3.96***	***-3.98***	***-4.58***
2000	-.259**	-.211**	-.161*	-.237**	-.278**	-.138**
	-3.93	***-3.89***	***-2.15***	***-2.89***	***-5.97***	***-4.54***
2001	-.156**	-.0996*	-.0876	-.233**	-.147**	-.154**
	-2.93	***-2.18***	***-1.93***	***-4.08***	***-5.47***	***-6.03***
2002	-.141**	-.0306	-.0244	-.0838	-.0848**	-.144**
	-2.75	***-0.67***	***-0.55***	***-1.48***	***-3.14***	***-5.62***
2003	-.0362	-.0357	-.018	-.127*	-.0496	-.107**
	-0.72	***-0.81***	***-0.42***	***-2.24***	***-1.90***	***-4.19***
Fulltime	.0607	.762**	.68**	.617**	.479**	.483**
	0.38	***13.94***	***7.92***	***4.37***	***8.76***	***4.64***
High Skills[L]	.0124	-.146	-.378	-.294	.161	-.0832
	0.04	***-0.63***	***-1.11***	***-0.70***	***0.66***	***-1.03***
Low Skills[L]	-.312	-.268	-.45	-.681	-.136	-.146
	-0.64	***-0.76***	***-0.93***	***-1.03***	***-0.38***	***-1.13***
Log Pop dens	.0209	-.0101	-.0366	.0561	.0234	.0236
	0.53	***-0.44***	***-1.01***	***1.16***	***0.88***	***1.24***
London time[L]	-.252	-.245	-.258	-.0429	.0216	-.102
	-1.14	***-1.90***	***-1.23***	***-0.19***	***0.13***	***-1.19***
Clusters	.266	-.554	1.05*	.0407	.0697	-.654
	0.41	***-1.31***	***2.45***	***0.03***	***0.23***	***-1.17***
British group	-.0051	-.0644	-.105	-.0202	.0629	.0134
	-0.03	***-0.65***	***-0.64***	***-0.14***	***0.37***	***0.40***
USA		.108	.0926	-.211	.425	.0907
		0.55	***0.23***	***-0.44***	***0.86***	***1.78***
Stand alone	-.101	-.222*	-.367*	-.118	.0466	-.05
	-0.52	***-2.18***	***-2.40***	***-0.80***	***0.27***	***-1.35***
Private	.3*	.448	.451**	4.7e-04	.34**	.377*
	1.96	***1.74***	***5.33***	***0.00***	***7.84***	***2.34***
Units	.0476	.0078	.0729	.0017	.113	.0197
	1.09	***0.36***	***1.79***	***0.04***	***4.28***	***0.92***
Angl+Cered	.164	-.107	-.174	.111	-.0864	-.0594
	0.80	***-0.99***	***-0.97***	***0.52***	***-0.78***	***-0.60***
Bla+Mer+Caer	.0462	-.0362	-.358*	-.0763	.0924	-.0933
	0.31	***-0.45***	***-2.41***	***-0.46***	***1.01***	***-1.45***
Monm+Torf	.0646	-.0461	-.417**	-.0133	.0956	-.0041
	0.46	***-0.61***	***-3.09***	***-0.08***	***1.07***	***-0.06***
N Wales	.0794	-.086	-.206	-.0667	-.0167	-.0231
	0.64	***-1.11***	***-1.49***	***-0.48***	***-0.20***	***-0.41***
Pow+Pem+Carm	.0839	-.0893	-.27	.0263	.0301	.0343
	0.60	***-1.11***	***-1.77***	***0.17***	***0.33***	***0.47***
S. Wales	-.0496	-.0821	-.198*	-.0068	.0232	-.0299
	-0.54	***-1.51***	***-2.10***	***-0.07***	***0.38***	***-0.61***
Constant	3.43	2.64*	2.22	.753	1.45	1.75*

	1.91	***2.27***	***1.36***	***0.37***	***1.10***	***2.53***
Observations	739	2645	1196	668	2116	3324
X^2	4977.27	13163.3	3641.07	3299.57	5036.11	12421.1

[L]denotes the variable has been logged. Figures in italics underneath the coefficient estimate, denote t statistics, **/* denotes significance at the 1%/5% level, X^2 relates to the log likelihood test statistic. All equations estimated by random effects. *Interpretation*: For interpretation of t statistics and coefficients, see Table 1. S. Wales=Swansea+ Neath & Port T+ Bridgend +Vale Glamorgan+ Rhondda, N. Wales=Conwy+ Gwynedd +Denbigh +Flint +Wrexham, hence the comparison is with Cardiff+Newport.

APPENDIX 3: Analysis of Travel to Work Area Data

Figure 25: GVAFC in TTWAs

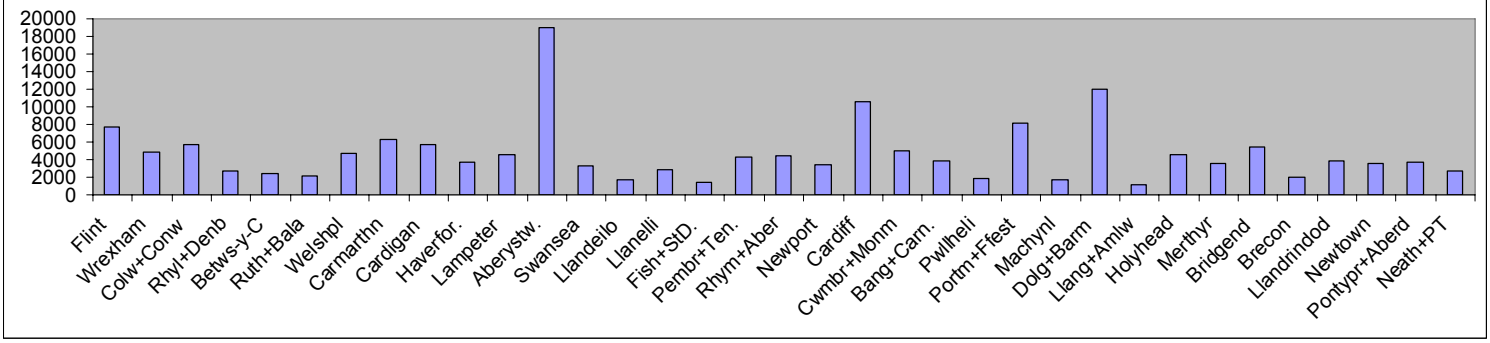


Figure 26: Capital Stocks in TTWAs

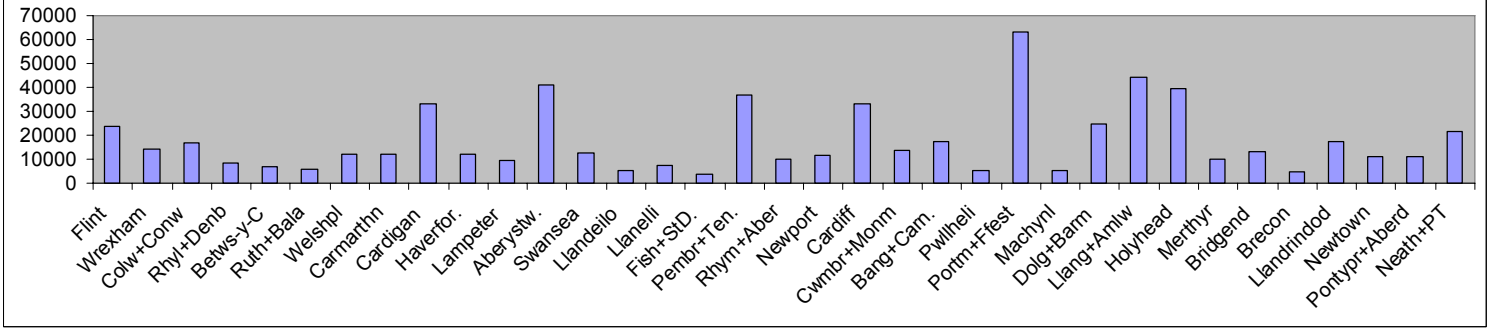
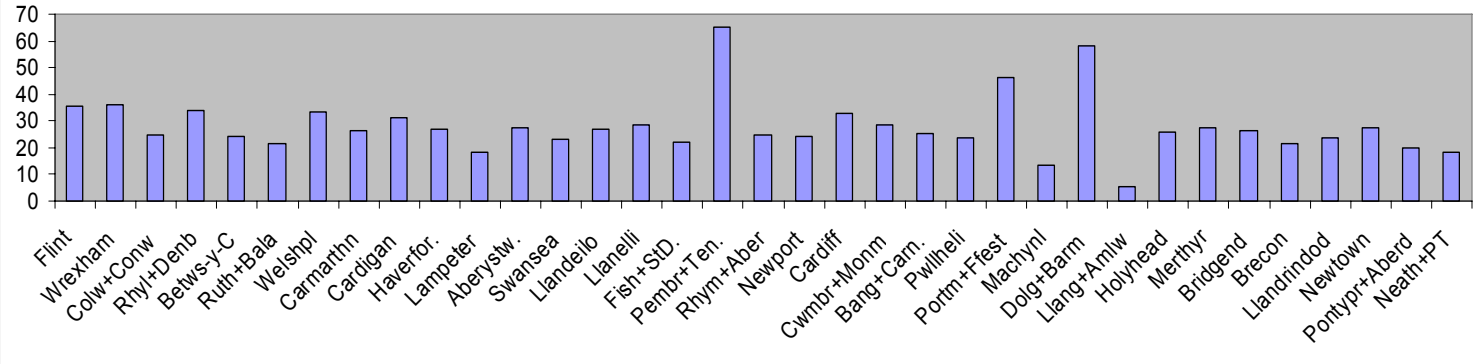


Figure 27: Labour Productivity TTWAs



Figures 21 to 23 show data on GVAFC, capital stock and labour productivity for Welsh travel to work areas (TTWAs). These are not generally analysed in working with the ARD. There are three reasons this is so. Firstly, “the local authority is a relevant administrative boundary for the purpose of this [type] of analysis” (Galindo-Rueda and Haskel, 2005). Certainly for policy purposes they are more relevant than TTWAs. Secondly, more data is available at the level of the local authority than the TTWA. Thirdly, being as they are defined by the ONS as capturing 75% of workers residing in the area boundary, those boundaries are not fixed, but change over time. Indeed with a new motorway for example, or even IT developments such as broadband, they may change rapidly. The differences between TTWAs and local authorities can be substantial, e.g. the whole of London is one, massive, TTWA. Whilst at the other end of the spectrum, some TTWAs are very small indeed in terns of population. The TTWAs we use below are based on the 1998 definition. On the other hand many TTWAs coincide closely with local authority areas.

There are substantial differences, but, even more so than with local authorities, the figures are subject to the impact of one or two very large firms. Hence for example, Portmadoc and Ffestiniog, has relatively few firms but these include a small railway and a power station. Aberystywth also contains the University. Despite this we can see the prosperity of Cardiff followed by Newport relative to e.g. Swansea.

Wales is characterised by smaller TTWAs than England. The average number of firms in England is 1185 with a coefficient of variation of 5356. In Wales the respect figures are 614 and 566. Only 6 TTWAs in Wales have a number of firms which exceeds the English average. These are Flint, Colwyn and Conwy, Swansea, Newport, Cardiff and Bridgend. However, if Wales has a relatively large number of small TTWAs, almost half of the firms in our sample lie in these 6 TTWAs. Nonetheless, the smaller TTWAs are deserving of attention, analysis and specifically designed policies.