EXPLORING THE LINKS BETWEEN SKILLS AND PRODUCTIVITY: FINAL REPORT

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EXECUTIVE SUMMARY

Background

Exploring the Links between Skills and Productivity was commissioned by the East Midlands Development Agency (*emda*) to provide a detailed assessment of the direct and indirect links between skills and productivity. The project used the Treasury's 'five drivers' framework to explore how the interaction between skill, innovation and enterprise can influence regional economic performance.

The East Midland's Regional Economic Strategy describes the regional labour market as being in a low-skill equilibrium. In other words, low levels of skill and business value-added mutually reinforce one another with the result that any move towards a high value-added product strategy is constrained by the availability of skills.

This report is intended to inform the evidence base concerning the relationship between skills and productivity which *emda*, and other organisations, may use to strengthen policy. The evidence provides a unified and simplified message to all of the region's stakeholders (employers, government agencies, *etc.*). In turn, this will contribute to improved communications between and within those organisations with an interest in the economic performance of the East Midlands.

Conceptual and methodological issues

HM Treasury has identified five drivers of productivity:

i. skills;
ii. innovation;
iii. enterprise;
iv. competition; and
v. investment.

The Treasury suggests regional differences in productivity derive in large part from differences in skill levels.

Complementarities and interdependencies exist between the five drivers. It is acknowledged that while skills alone will not drive productivity improvements they are of critical importance to the potential benefits from the other drivers being realised. Hence, skills need to be considered in context rather in isolation. But not all skills are economically valuable; only some will help realise the region's aspirations.

A number of conceptual frameworks outline the linkages between skills and productivity. These include:

- **neoclassical growth theory** which assumes that technological progress is exogenous, that labour, capital and firms are perfectly mobile, and that there are no barriers to technology diffusion;
- **endogenous growth theory** which assumes that technical change is, in part, determined by the growth process itself. Hence growth begets growth; and
- **new economic geography models** which attribute regional variations in growth to spatial agglomeration, specialisation, and clustering which generates a number of positive externalities for a region, such as a relatively skilled labour force, and increasing returns to investments.

Economic theory establishes the nature of the relationship between skills and productivity but its treatment of skill is often cursory. For instance, it has little to say about how skills are utilised – in other words, how skill inputs are most effectively turned into productive outputs. Helpfully there are a number of conceptual frameworks, such as the '4A model' described in the main body of the report, which considers the role of human resource management in turning skill inputs into productive outputs.

Definitions and measurement

Neither skills nor productivity are easily measured. GDP, for instance, is measured in a number of ways using production, income, and expenditure statistics. The measure used in this study is an income based one - gross value-added (GVA) per head – given that these data are more readily available at the regional level.

By skill is meant the capability of a person to undertake a given set of tasks. This proves difficult to measure in practice – though surveys of individuals are beginning to make in-roads by asking detailed questions about the tasks people regularly undertake – and is reliant upon imperfect proxy measures as occupation, qualifications, years of schooling, *etc*.

If measuring the relationship between skills and productivity is difficult at a national level, the problem is amplified at the regional level. Regional economies are open ones. People may live in one region and work in another. Some measures of activity are obtained from corporate headquarters such that the activity is recorded as pertaining to the region where the headquarters is located even though the activity in question may be carried out elsewhere.

Skills and Productivity: What is Already Known

Research which assesses the relationship between skills and productivity can be divided between that which identifies:

i. direct linkages between skills and productivity; and

ii. indirect linkages where the contribution of skill is mediated through, for example, enterprise and innovation.

There is a large literature on the association between skills and productivity much of which involves straightforward comparisons of, typically, the stock of qualifications in the workforce alongside measures of output and productivity. On the whole, these studies indicate that the productivity gap between the UK and other countries is at least partially accounted for by differences in the distribution of skills. A number of studies consider regional differences and conclude that skills are positively associated with productivity: higher skills and higher productivity tend to be found together.

From the studies which address the direct relationship between skills and productivity it is not possible to infer that by raising skill levels in a region by, say, amount *x*, that productivity will increase by amount *y*. Skill is a derived demand stemming from, amongst other things, the use of process and product technologies, entrepreneurship, management practices, and product market strategy. In other words, if the aim is to understand the contribution skills can make to increasing productivity there is a need to address this in a broad context. Research tends to show, at the level of the individual workplace, that product market strategy tends to drive skill demand and, if that skill demand is to be met, human resource strategies need to be effectively embedded within product market strategies.

Innovation is one of the five key drivers of productivity. It may both increase demand for skills as they facilitate the implementation and effective use of various innovations (increased demand) while some innovations replace labour through automation (decreased demand). Over the long run, however, innovation is a determinant of overall employment demand, *i.e.* without innovation there may be fewer jobs than there would be otherwise regardless of their skill levels. There is a significant skill component to successful innovation relating to the generation of ideas and their execution.

Innovation has an impact on productivity and economic performance through entrepreneurial activity. Innovation without entrepreneurial people to take ideas forward and to exploit their business potential will not contribute to productivity or output. Similarly, enterprises without

innovation run the risk of performing more poorly than other businesses and ultimately failing. Entrepreneurship covers a wide range of activity and not all of it succeeds. Entrepreneurship can fail because the ideas on which it is based are no good, the business plan is flawed, or the execution of the business plan is poor. Accordingly not all entrepreneurship is associated with productivity gains, but that which is will be dependent upon the availability of good entrepreneurial skills.

Management is a driver of productivity. Capable and effective management has been found to be essential in the economic performance of countries, regions and firms. Management is responsible for the construction and implementation of product market strategy, managing technical and organisational change, effectively utilising workforce skills, and so on. Hence management skills – of which there are many – are of central importance in understanding organisational performance and, in aggregate, regional and national economic performance. Without good management productivity growth will be held back.

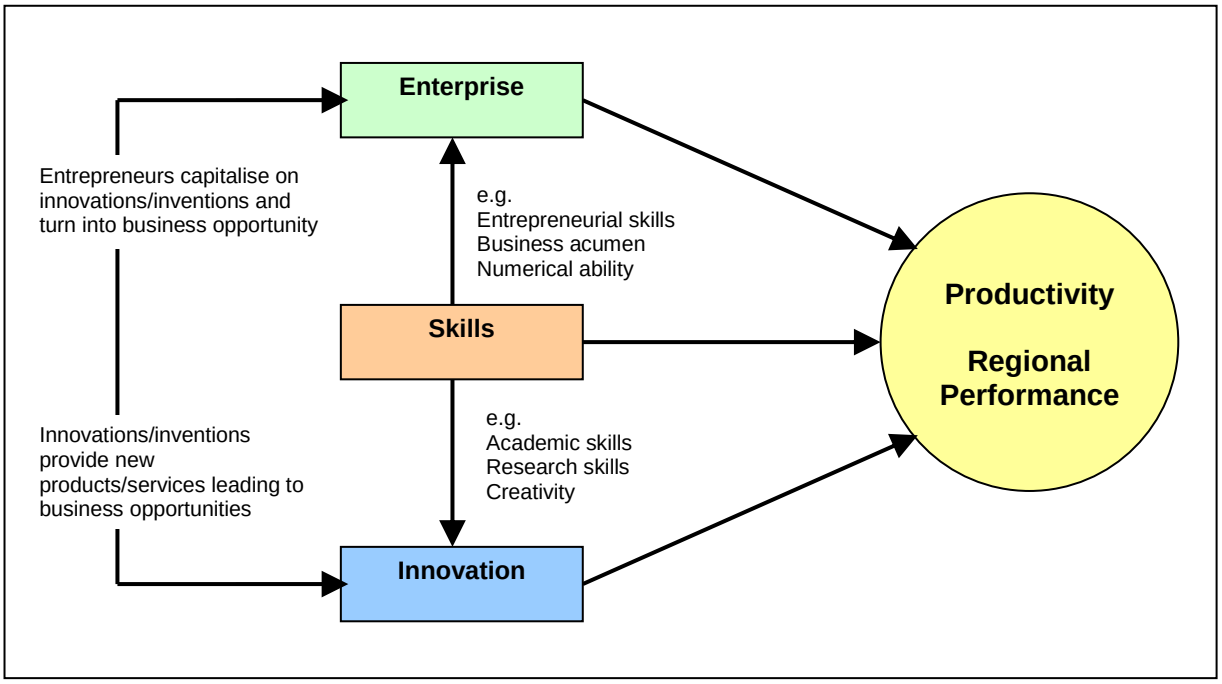
Despite the large volume of evidence which has tried to demonstrate a link between skills and employment there remain substantial uncertainties about the nature of any causal relationship, especially when looking at the activities of employers. The principal problem is that of endogeneity. For example, organisations which produce high value goods with a highly skilled, well-paid workforce may be intrinsically high value organisations regardless of the skills possessed by their workforces. In many respects it is by understanding what goes on within workplaces that a fuller understanding is obtained of the relationship between skills and organisational performance and thereby productivity. Hence the emphasis given in the report to understanding the indirect linkages between skills and productivity, and in particular, the way the effect of skills is mediated through innovation and entrepreneurship. This is outlined in Figure 1 below. The central role of management capability also needs to be emphasised. Management, with its responsibility for product and human resource strategies, is a facilitator of entrepreneurship and innovation and well as being responsible for identifying current and future skill needs, obtaining those skills, and ensuring that they are effectively deployed.

A Holistic Approach to Understanding Productivity Growth

Figure 1 summarises the direct and indirect linkages between skills, innovation and enterprise with productivity. Each productivity driver has direct implications for regional (and firm) productivity. The exploitation of business opportunities by entrepreneurs generates output thus potentially increasing the region's income. Innovations improve business processes leading to greater firm-level productivity which ultimately leads to regional productivity. Skills are found to

increase individual's labour productivity which in turn improves business performance which then may be aggregated to the regional level. The indirect linkages concern the implications that each of the drivers have on the others and the influence of other factors on these drivers. Skills are important in facilitating entrepreneurial activity, in its many forms. Enterprise requires many skills including 'entrepreneurial skills', business acumen and numerical ability. Innovation is also largely influenced by skills: academic skills, research skills and creativity are examples of skills that enhance innovation activity and knowledge creation. Enterprise and innovation also interact. As discussed above, entrepreneurs are necessary to exploit business opportunities presented by innovations. Innovations in turn present business opportunities for entrepreneurs.

Figure 1: The direct and indirect linkages between Skills, Enterprise and Innovation with Productivity and/or Regional Performance



There is also a need to consider externalities at the regional level. As innovation and entrepreneurship gains momentum at regional or sub-regional level there are gains to the economy over and above those which accrue to individual companies simply as a consequence of having a critical mass of experience or knowledge available within companies and in those agencies which support innovation, enterprise, and skills.

Data analysis for the East Midlands

The data examined in this study have been obtained from a number of sources, including the Labour Force Survey (LFS), the National Employers Skills Survey (NESS), ONS Regional Accounts, Global Entrepreneurship Monitor (GEM) and BERR "Business Start-ups and Closures: VAT registrations and de-registrations in 2007. Indicators of skills, sectoral employment, innovation, entrepreneurial activity, and productivity have been examined by region in order to compare the East Midlands to other regions in terms of overall productivity performance and the region's performance in the factors that are believed to drive productivity.

The East Midlands exhibits average productivity performance: GVA per head being is fifth highest amongst English regions. The sectoral distribution of employment in the region is not vastly different to that found in a number of other regions (outside London) with the exception of the manufacturing industry which is found to employ a greater share of the workforce than in all other regions except the West Midlands.

In relation to skills, the East Midlands (as indicated by qualifications) has one of the lowest shares of workers with a degree or equivalent (18 per cent in 2007) and one of the highest shares of workers with no qualifications (11 per cent in 2007). The overall variation between regions in the shares of workers with various qualifications is not great and even having the highest or lowest share does not necessarily mean that one region is significantly different from the others. The exception to this is London which appears to have a much greater share of highly qualified workers compared to all other regions (37 per cent).

The percentage of firms in the East Midlands which are innovation active is amongst the highest of any UK region. In 2007, 68 per cent of East Midlands enterprises were innovation active compared to the UK average of 64 per cent. Similarly, R&D spending by businesses in the region was fifth highest amongst UK regions in 2007. The region also performs relatively well in its rate of early stage entrepreneurial activity.

How do the above influence productivity? Reflecting the discussion above, there is no simple relationship between productivity and with any of its principal determinants: skills, innovation or entrepreneurship. Some regions have higher levels of innovation, entrepreneurial activity, and productivity than the East Midlands, while in other cases, innovation and entrepreneurship are higher but productivity is lower. This highlights the complexity of the relationships between skills, innovation, enterprise and productivity –as set out above - and emphasises that a number of factors must be considered when estimating the magnitude and direction of causality between these factors and productivity.

Conclusion and policy considerations

In general the evidence suggests that skill levels are related to productivity: more highly skilled people produce more high value goods and services more efficiently. But there are substantial gaps in the evidence base, particularly the lack of evidence on causal relationships and the treatment of skills utilisation as a black box.

In light of the evidence that is available and taking a more holistic approach to improving productivity there are a number of considerations that are important for policy. At a minimum policy needs to be directed at ensuring that the current industrial and employment base is able to sustain itself over the medium to long term. From the evidence presented in this report the starting point is ensuring that management have the capability to introduce necessary changes even if these are piecemeal. The evidence points to the importance of policies and practices being bundled together so that if, say, new technologies are being implemented that there is the requisite amount of organisational change and employee training to ensure that the gains from its introduction are fully captured. Successful change requires human resource and production practices to be intertwined if productivity gains are to be obtained.

A skills policy in the East Midlands needs to meet current demand and ensure that demand is sustainable over the long term. While some policy statements have suggested that the East Midlands is in a low skills equilibrium, the economic indicators presented in the main body of the report suggest that relative to the UK as a whole and other English regions (except London and the South East) the region's performance is not far off average. Given this, in the aggregate the existing regional economy is not badly placed to take advantage of future opportunities that may arise.

Regional and sub-regional economies will need to increase their productivity over the medium term to ensure they can compete in the market. This is likely to be relevant for both high and low value sectors in the economy. All jobs will be subject to change resulting from technical and organisational change. Creating sustainable employment is dependent upon ensuring that there is a mix of employment by industrial sector which is able to keep pace with change in the UK and international economy. Productivity or efficiency gains within the region's economy are important in ensuring that this mix can be achieved. Productivity gains, in turn, depend upon ensuring people have the skills to bring about these gains. Skills cannot drive this alone. There needs to be integration of all policies that have a bearing upon productivity: management capability, innovation in products and processes, entrepreneurship, *etc.*

1. INTRODUCTION

1.1. Overview/background of project and goals

The East Midlands Development Agency (*emda*) commissioned the project, *Exploring the Links between Skills and Productivity*, in order to provide the agency with a detailed assessment of the direct and indirect links between skills and productivity. The project also aims to explore how skills, innovation and enterprise interact and boost regional economic performance, through use of the Government's 'five drivers' framework. In this framework, skills are considered to be a derived demand as employers demand particular levels of skills because they require the knowledge or understanding that such skills provide in order to produce goods or services.

One of the challenges for the East Midlands is to increase economic performance by increasing the productivity of the region's workforce. The East Midlands Employment, Skills and Productivity Partnership (esp) is committed to drive action to achieve the common vision of "more people into better jobs in better businesses" through improving the productivity of businesses in the region by raising employer demand for skills.

The skills composition of the East Midlands is described in the Regional Economic Strategy, *A Flourishing Region*, as being characterised by a low skills equilibrium. That is where an economy becomes trapped in a vicious spiral of low value-added and low skills. Enterprises are staffed by low skilled staff producing low quality goods and services to which the training market responds rationally by providing training aimed at the demand for low skills (Finegold and Soskice, 1990; Wilson and Hogarth, 2003). It can prove difficult to break out of this vicious spiral. Certainly supply-side initiatives alone are not sufficient as this can result in people being over-qualified for the jobs they undertake because their skills are under-utilised in their current job (Felstead *et al.*, 2007).

The outputs of this project will be used to inform an evidence base about the relationship between skills and productivity that can be used by *emda* and other relevant agencies and organisations. The evidence base may be used to strengthen arguments when formulating policies. It will also help to give a unified and simplified message to employers in the region, regional and sub-regional agencies, and other interested parties. Ideally, a common evidence base will also help to streamline communications between and within organisations that have an interest in improving the East Midlands' economic performance.

The material reviewed in this report covers two strands of literature:

i) the direct impact of skills on productivity, both at individual and macro levels;

ii) the indirect linkages between skills and productivity, and within the 'five drivers' framework, how skills, enterprise and innovation interact to deliver improved economic performance.

In terms of the actions that *emda* and its partners can take in improving the productivity of the region through increasing skills, there are a number of limitations that should be noted from the start. Firstly, in evaluating the evidence on the linkages between skills and productivity (direct and indirect) caution must be used in trying to apply results found at the national level to the regional situation. Regions are different to countries. Regions are open economies, compared to nations, with goods, services and labour moving in and out of the region quite freely. The degree of openness also varies by sub-region. Attempting to measure the stock of skills in a region and then relating it to the region's output is difficult as the people possessing these skills can, and often do, move freely within and between regions. The highly skilled tend to be more geographically mobile than the low skilled. Suppose people with 'high skills' reside in one region but work in another. This would skew the relationship between skills and productivity within the region that the person works to show higher productivity without the person's skills being resident in the region whereas in the region of residence, the skills stock would appear greater but this individual would make no direct contribution to the region's output.

1.2. Report Outline

The remainder of this report proceeds as follows. **Section 2** outlines conceptual and methodological issues of the relationship between skills and productivity. This includes an overview of various theories and frameworks that relate skills to productivity. Section 2 also outlines various definitions of key terms such as skills and productivity and issues related to measurement. A review of the literature relating to the links between skills and productivity is given in **Section 3**. The first part of the literature review considers evidence on the direct linkages between skills and productivity. Indirect relationships between skills and productivity and the interaction with enterprise and innovation within the 'five drivers' framework are considered in the second part. Data analysis for the East Midlands is provided in **Section 4**. This analysis considers various indicators of skills, innovation and enterprise alongside measures of productivity. Finally, **Section 5** concludes and highlights policy considerations for *emda* and other interested parties and stakeholders in the region.

2. CONCEPTS AND METHODS

2.1. Introduction

The Government's economic policy has a central aim of narrowing the productivity gap between the UK and its main competitors such as the USA, France and Germany (HM/DTI, 2004). In directing its actions and policy towards achieving growth in national productivity, the former Department for Trade and Industry (DTI), now the UK Department for Business, Enterprise and Regulatory Reform (BERR), has identified five key drivers of productivity:

- Skills
- Enterprise
- Innovation
- Competition
- Investment

In particular, skill has been identified as one of the main drivers over which governments and public bodies may exert some influence. HM Treasury has highlighted the existence of productivity gaps between regions of the UK (HM Treasury 2001). Differences in regional productivity have been explained with respect to variations in the skills composition of the country's regions (e.g. Blackaby and Murphy, 1991, 1995; Harris and Trainor, 1997; Campbell *et al.*, 2000; Duranton and Monsasiriotis, 2000; HM Treasury 2001).

The Government recognises that increasing the supply of skills alone is not sufficient to raise productivity (Leitch, 2006). First, increased awareness amongst employers regarding the skills they require for success in the market in the longer term is needed if the demand for skills is to be increased. Second, the effective deployment of skills is also necessary to ensure that the potential benefits of employing skilled people are to be realised.

2.2. How do skills drive productivity?

2.2.1. Government policy

HM Treasury (2003) highlights the importance of the five drivers of productivity but acknowledges that complementarities and interdependencies exist between them. No one driver can be considered to have more weight in driving productivity than the other factors. The Skills Strategy White Paper, 21st Century Skills – *Realising our Potential – Individuals, Employers, Nation* - emphasises that the UK needs to improve productivity and its ability to support sustainable development in order to compete in today's global market. It acknowledges that skills alone will not drive productivity improvements but skills improvements are crucial when combined with improvements in the four other key drivers - enterprise, competition, investment and innovation (HM Treasury, 2003, pp. 17-18). This highlights the importance of considering skills in context rather than in isolation.

An association between the level of skill (typically proxied by qualifications) within a labour force and the economic performance of countries/regions has been found in a number of studies. These more macro level observations are the result of the aggregation of the impact of skills on labour productivity and performance at the level of individual businesses and sectors. In a firm, workers' skills have a direct impact on how well they do their jobs and on what jobs/tasks they can perform. According to HM Treasury, higher skill levels enable workers to generate new ideas and to respond and adapt to change.

This individual labour productivity affects the performance of the firm which ultimately contributes to the overall productivity (as measured by GDP or GVA) of the sub-region, region or country in which the firm operates.

According to the former DTI and HM Treasury (2006) skills raise total factor productivity and labour productivity in a number of ways:

- skills enable workers to undertake more complex tasks, to work more effectively and to produce higher value products;
- investment in innovation and technology is more profitable when combined with skilled labour;
- skilled workers are better at adapting and responding to changing work environments and at implementing new technology and processes;
- workers often learn from highly-skilled co-workers. Such effects can spill over to the benefit of wider society.

Leitch (2006) outlines that skills impact on productivity (p. 21):

- directly through increasing human capital in a firm or region or country;
- indirectly through positive spill over effects on the productivity of other workers;
- through other drivers such as innovation and investment.

In setting its ambition for the UK to achieve world class skills, Leitch emphasises that there must be a focus on skills that provide real returns rather than on skills for their own sake.

2.2.2. Theory and Frameworks

There are a number of theoretical frameworks which outline the possible linkages between skills and productivity. Gardiner *et al.* (2004) outline three different theoretical perspectives on regional productivity growth: neoclassical growth theory; endogenous growth theory; and 'new economic geography' models. The main implications of these models for regional productivity growth are detailed in

Table 2.1.

In the first model, neoclassical growth theory, productivity growth depends on growth in the amount of capital per worker and on the exogenous rate of technical progress (or total factor productivity). This model also assumes that labour, capital and firms are perfectly mobile and that there are no barriers to technology diffusion. It also assumes there are no economies of scale, no benefits from the clustering of firms and diminishing rates of return to capital and labour. This model predicts that regional productivity differentials narrow over time as regions that lag behind others close the gap. The validity of the assumptions underlying neoclassical growth models is doubtful as they do not accurately reflect the reality of labour markets and production processes, particularly for regions.

Technical change is determined in part by the growth process in endogenous growth models. In such models, knowledge accumulation generates increasing returns. There are a number of different theories within endogenous growth theory that make different assumptions about the diffusion of knowledge and technology. How regional productivity differentials evolve over time depends on these assumptions.

Within endogenous growth theory, Engelbrecht (2003) distinguishes between two main strands of thought on how human capital (including skills) influences economic growth and productivity. The first framework is associated with Nelson and Phelps (1966) and relates growth to the stock of human capital in two ways: directly, through the effect of human capital on a country's ability to innovate; and indirectly, through human capital's ability to facilitate knowledge adoption.

Table 2.1: Three theoretical perspectives on regional productivity growth

Theory	Explanation of regional productivity differences	Evolution of regional productivity differences
Neoclassical Growth Theory	Regional differences in productivity due to different factor endowments, and especially differences in capital/labour ratios and technology	Assumes constant returns to scale; diminishing returns to factors of production; free factor mobility and geographical diffusion of technology, so that low productivity regions should catch up with high productivity one; i.e. regional convergence in productivity.
Endogenous Growth Theory	Regional differences in productivity due to differences in capital/labour ratios, knowledge base and proportion of workforce in knowledge producing industries	Implications for regional productivity evolutions depend on extent to which low technology regions catch up with high technology regions, and thus on degree of geographical diffusion of technology and knowledge, and flows of knowledge workers. The more knowledge/technology spillovers are localised, and the more knowledge workers move to leading technology regions, the more productivity differences between regions will persist, or even widen.
'New Economic Geography' Models	Spatial agglomeration/ specialisation/clustering are key sources of externalities and increasing returns (labour, knowledge spillovers, specialist suppliers, etc) that give local firms higher productivity	Economic integration (trade, factor flows) increases tendency to spatial agglomeration and specialisation of economic activity, leading to 'core-periphery' equilibria and persistent regional differences in productivity.

Source: Table 1, Gardiner *et al.* (2004).

The second framework, is based on Lucas (1988) and is broadly consistent with the Mincerian wage function literature. This framework assumes that growth is driven by the accumulation of human capital and human capital is treated as an input in the production function. Englebrecht (2003) goes onto evaluate the validity of the Nelson-Phelps theory and a combination of both approaches using data from OECD countries. He found human capital to be positively and statistically significant across the OECD countries in the adoption of technology from abroad.

The final model, 'new economic geography', which flows on from endogenous growth theories, attributes regional variations in growth to the existence of localised increasing returns that arise from spatial agglomeration. These approaches consider advantages generated by localised knowledge spillovers, the scale of local markets and access to particular types of labour pools

and other effects of localised specialisation. Such theories predict increasing regional specialisation and spatial concentration of economic activity.

Economic theory often treats the utilisation of skills as a black box. Tamkin (2005), with a '4A model' relating to human capital, human resource management and organisational performance, demonstrates that it is utilisation which allows the benefit from skills to be turned into productivity gains. In this model, a major factor influencing the capability of organisations is the ability of its workforce as indicated by workforce skills. This ability can be increased through training, mentoring coaching and other means which are matters of human resource management practices. The model acknowledges that skills are only one factor that determines the performance of businesses and that the effective deployment of skills, the attitudes of the workforce and the effective resourcing of roles in an organisation are all key to ensuring optimal business performance. This highlights that skills alone are insufficient; rather the way in which skills are deployed to achieve organisational objectives matters.

2.3. Definitions and measurement

Definitions of output and productivity are outlined in Box 2.1. There are other measures of output and productivity used in the literature and evidence relating to other indicators is also included in this report. Some of the other measures of productivity that feature include labour productivity, which is often assumed to be reflected in individuals' wages and various measures of a business' productivity. Examples of this latter type of productivity include gross value added (GVA) per worker in the firm and number of products produced per worker.

For the purposes of this project, GVA is the preferred measure of output. In the data analysis shown in Section 4 of this report, GVA per head, worker or job is the productivity measure of interest. Data on GVA is available at the regional (NUTS1) and sub-regional (NUTS2) level from the Office for National Statistics in the Regional Accounts.

In the empirical evidence relating to the effects of skills on productivity (however measured) there is much concern over the indicators of both skills and productivity that are used. Definitive direct measures of skills are not readily available in the data. Usually, educational attainment, years of education, or qualification level are used to indicate the level of skills that an individual possesses. There are problems with such measures of skills. Qualifications and education indicators do not necessarily reflect the skills that a person has and uses in work. Such indicators may reflect more about the personal characteristics of an individual rather than their skills. These measures do not readily indicate the quality of skills either. If people do not have a particular qualification it does not necessarily mean that they do not possess any of the skills

that others with the qualification hold. In some cases, qualifications are merely formal certifications rather than true reflections of a person's actual set of skills. In the absence of reliable, comprehensive measures of skills themselves, qualifications and education measures are generally accepted and used in empirical investigations of the relationship between skills and productivity.

Box 2.1: Output and productivity definitions

Output

Gross Domestic Product (GDP) – is an integral part of the UK national accounts and provides a measure of the total economic activity. It is a key accounting measure of the whole economy.

Gross Value Added (GVA) – measures the contribution to the economy (at regional level in this context) of each individual producer, industry or sector. It is used in the estimation of GDP, wherein GDP = GVA + taxes on products – subsidies on products.

Productivity

Total Factor Productivity (TFP) – sometimes called multi-factor productivity This measure apportions growth in output to growth in the input factors of capital, labour and a residual factor (representing technical change). This productivity indicator measures output per unit of inputs (i.e., labour, capital and everything else ('residual').

Labour productivity – most measures of labour productivity are simply measures of output (typically GVA or GDP) divided by some measure of labour (e.g. number of workers). The most common measures of labour productivity are:

- ***output per worker*** – does not account for the intensity of work hence difficulties arise in comparing such a measure across countries.
- ***output per hour worked*** – makes some account for the intensity of work used to produce the output. This is the most commonly used academic measure of productivity because of its comparability across countries and regions. This measure is more difficult to measure due to lack of reliable data on hours worked.
- ***output per job*** – obtained by dividing total output by the total number of jobs in a firm or in an area (e.g. country, region, etc).

There are other firm-level measures of performance or output that are sometimes used in the literature when looking at the relationship between skills and productivity. These include measures of turnover, profit or sales per employee or the number of items manufactured per employee.

Good measures of output are dependent upon accurate accounting by firms and aggregation of the data they provide. It can be difficult to accurately attribute parts of national GVA or GDP to particular regions due to fuzzy boundaries in output, employment and trade within countries. Productivity is also difficult to measure. Human capital theory asserts that hourly wage rates

paid by employers reflect labour productivity; but in practice, wages are affected by a number of other factors so that they do not actually reflect marginal labour productivity. Collective agreements and minimum wage legislation, for example, affect wages and may result in the wage rate not accurately indicating productivity. Again, as is the case for measures of skills, there is compromise over the best indicators of productivity arising from data constraints.

HM Treasury and the former DTI (HM Treasury/DTI, 2004) proposed a number of measures or definitions for each of the five drivers (summarised in Table 2.2).

Table 2.2: Government suggested indicators of productivity drivers

Driver of Productivity	Indicators
Skills	○ International comparisons of overall levels of qualifications ○ Highest qualification of economically active adults ○ Business executive perceptions of management quality
Innovation	○ Publications and citations of research in academic journals ○ Business Enterprise Research and Development as a proportion of GDP ○ Triadic Patents – patents granted in the US, and patents applied for in the EU and Japan ○ Proportion of enterprises with cooperation agreements on technological innovation activities with other enterprises and institutions ○ Proportion of sales accounted for by new or improved patents
Enterprise	○ Fear of failure preventing people from starting a business ○ Venture capital investment as a proportion of GDP ○ Cost and time to register a firm ○ Total entrepreneurial activity ○ Difference between the productivity growth of small and medium sized enterprises and of all firms
Competition	○ Trade in goods and services as a proportion of GDP ○ Product market regulation ○ Competition regime peer review
Investment	○ Hurdle rates – required rate of return for a business to invest ○ Business investment as a proportion of GDP ○ Government investment as a per cent of GDP ○ Perceptions of the quality of infrastructure

Source: HM Treasury/DTI, 2004.

A number of these indicators are relevant only for the UK as a whole rather than for individual regions or local areas. Skills tend to be most often indicated by the highest qualifications of people in the labour force while innovation is usually indicated by business enterprise research and development expenditure and patent numbers. Regional assessment of patents numbers may be difficult due to low numbers. Enterprise, for purposes of regional analysis, is often indicated by total entrepreneurial activity. The use of these indicators for productivity and its

drivers is often directed mainly by which indicators and data are available rather than which indicator is most appropriate for a given objective.

Despite the difficulties associated with measuring skills and productivity a large literature has emerged which has attempted to capture the impact of the former on the latter. The critical findings from this literature are reviewed in the next section.

3. HOW SKILLS RAISE PRODUCTIVITY: A REVIEW OF THE LITERATURE

This section reviews literature on the direct linkages between skills and productivity as well as literature relating to the indirect linkages between skills and productivity through interaction with innovation, enterprise and management.

3.1. Skills and productivity

There is a large literature looking at the associations between skills and productivity. Much of this research involves straightforward comparisons of skills or qualifications levels in the workforce alongside comparisons of output and productivity (GVA per employee or per hour worked, etc.). These simplistic comparisons have indicated, on the whole, that the productivity gaps between the UK and other OECD countries are associated with differences in the distribution of skills in each country's workforce.

Estimating the marginal effects of additional education or skills exactly is not usually possible given the difference in the returns to skills between individuals, though many studies have attempted to precisely quantify such effects. According to calculations produced for the Leitch review[1], it is suggested that improvements in formal qualification levels between 1994 and 2004 made a contribution of 0.2 percentage points to annual productivity growth and increased the employment rate by 0.4 to 0.6 percentage points. The overall annual net benefits of the increase in qualifications are estimated to be between £1.3 billion and £1.5 billion. Similarly, Bassanini and Scarpetta (2001) found that increasing overall educational attainment raises economic performance. Using data on 21 OECD countries from 1971 to 1998, they estimated that an extra year of schooling ultimately raises GDP, in the long run, by around 6 per cent. Evidence from Australia (Dusseldorp Skills Forum (2006), indicates that an additional 0.15 years of schooling (which is estimated to be achieved in the country by 2040) would lead to a 0.62 per cent increse in productivity. Combining this with the contribution that raising skills would make to increased participation in the workforce results in an estimated increase in GDP of approximately 1.10 per cent by 2040. In the longer run, it is estimated that an additional year of education for each worker in Australia's workforce would lead to an increase in productivity of 4 per cent for each worker and hence increase the country's economic performance by 4 per cent overall. The implication here is that increased education (by an additional year) enhances productivity.

[1] See Leitch Review (2006), p. 87.

While the simplicity of attributing an increase of 'x' in productivity to an increase in 'y' of education is an attractive finding resulting from various studies, these exact measures are likely to be unrealistic and may not be relevant outside of the sample for which they were produced. An additional year of schooling may not make any difference to the productivity of some workers while it may have a great impact on others. The starting point is important to consider here. Workers with already high levels of skills may not gain as much from an additional degree as those workers with no qualifications may benefit from even elementary qualifications.

Crafts and O'Mahnoy (2001) estimate the relative contributions that investment in capital, skills and R&D make to the productivity gaps between the UK and each of its main competitors – USA, France and Germany between 1979 and1999. In 1979, the lower skills in the UK accounted for 3 percentage points of the country's productivity gap with the USA and for slightly more of the gap between the UK and France (6 percentage points) and with Germany (5 percentage points). Differences in skills were found make lower contributions to the productivity gap in the 1990s, particularly for the USA. In 1995, accounting for skills differences decreased the productivity gap between the UK and the USA by only 2 percentage points. In 1999, virtually none of the UK's productivity gap with the USA could be attributed to differences in skills between the two countries. Differences between the countries in terms of investment in capital accounted for the greatest fractions of the productivity gaps while R&D typically accounted for the next largest fraction in all three years considered. While there are some methodological limitations involved in Craft and O'Mahony's findings, they do highlight the fact that skills are not the only factor driving UK productivity and that considering skills in isolation will not result in the greatest productivity gains possible.

In their critical discussion of the empirical literature on the effect of human capital on macroeconomic performance, Sianesi and Van Reenen (2003)[2] find the overall evidence that human capital increases productivity is compelling. The evidence is divided on the issue of whether the stock of human capital affects the long-run level of GDP or the growth rate of GDP. Whether it is the level of GDP or growth rate of GDP that is impacted by skills has important implications for developing versus developed economies and for influencing national and regional disparities in productivity and economic performance.

Sianesi and Van Reenen (*ibid.*) also overview the findings of the NIESR matched plant studies. These studies consistently find that, on average, British firms tend to produce lower quality

[2] The paper presents two useful tables summarising a number of studies which examine the role of human capital in various measures of growth and productivity. The text here does not detail all studies considered by Siansei and Van Reenen.

goods and are less productive than their European counterparts. The studies suggest that skill gaps are key factors in the productivity differences between the UK and European firms.

Machin *et al.* (2003) estimated the impact of changes in the stock of educational qualifications on sector productivity, with special interest in vocational qualifications. Using a longitudinal framework with data from the LFS, NES, Census of Production and SBI, they estimated industry level production functions which were augmented to account for educational achievement. They found strong productivity effects resulting from Level 4 qualifications (degree and higher), but less robust, positive effects for Level 2 (good GCSEs) academic qualifications. The authors did not find a systematic and positive impact of vocational qualifications at any level on productivity. They also found evidence of spillovers associated with an increasing proportion of workers holding Level 4 and above academic qualifications. Their descriptive analysis indicated that growth in the stock of human capital, as well as the level of human capital, varied by region.

Using the Employment Prospects in the Knowledge Economy (EPKE) and International Sector Productivity (ISP) datasets, Mason *et al.* (2007) find that human capital (as indicated by educational attainment) plays an important and signficant role in determining the level of productivity. Their results are largely robust to different methods of estimation. In one specification, they find that a one per cent increase in human capital in the UK leads to an increase of approximately 0.09 per cent in productivity. This is the smallest effect found amongst the five countries examined (US, Germany, Netherlands, France and the UK). The US has the highest output returns with a one per cent increase in human capital increasing output by 0.17 per cent. Overall, Mason *et al.* find that human capital levels are strongly related to average labour productivity levels across a wide range of sectors but these emerge in the medium and long terms. They find little evidence of growth in human capital having a short-term impact on productivity growth.

Many of the studies that relate skills to productivity are based on manufacturing data. This limits the generality of findings and prevents conclusions to be transferred to most other sectors or groups of sectors. The literature covering manufacturing productivity and skills is still useful and provides some useful insights. Haskel *et al.* (2003) used data on a sample of manufacturing firms from the ESS, NES and matched to the ABI to investigate the association between skills and productivity in the UK. They found that more productive firms hired more skilled workers. The top 10 per cent of plants hired workers with, on average, two years extra schooling compared to the bottom 10 per cent of plants. Both hard skills (typically formal or accredited qualifications) and soft skills (e.g. interpersonal skills, communication skills, etc.) were found to be positively correlated with total factor productivity. They estimated that the skills gap between the top and

bottom deciles of manufacturing firms in the productivity distribution accounted for about 8 per cent of the TFP gap. The authors highlighted that average productivity within an establishment depends not just on the average level of skills in the firm's workforce but also on the organisation of its human capital. Again this highlights the importance of how skills are deployed.

Harris *et al.* (2005) use data from the Employers' Skills Survey (ESS) (2001) combined with data from the Annual Respondents Database in order to examine the impact of skills on plant level productivity. Using a Cobb-Douglas production function[3] which incorporated skills measures, they found plants with skill gaps to be generally less productive than those plants that did not perceive any gaps. This effect was found to vary by industry. Comparing innovative to non-innovative plants, they found that innovative plants were, on average, 5 per cent more productive as a result of having a more qualified workforce. When looking at regional differences, they found that the region in which a plant is based does not have significant impact on productivity. The overall results lend support to government investment aimed at addressing skills gaps as such investment may potentially increase productivity. They also note that employing people with higher qualifications does not inevitably lead to higher productivity.

Galindo-Rueda and Haskel (2005) merged data from the Annual Business Inquiry (ABI) about firm performance with data from the ESS on workplace skills to look at the impact of skills on firm performance and to compare this to the impact they have on wages. While their results should be treated with some caution due to difficulties matching data, they found interesting relationships that generally support a positive link between skills and productivity. They found that increased levels of workplace educational attainment are associated with improved establishment-level productivity (GVA per employee). Higher level qualifications showed a particularly strong effect on productivity while lower level skills were observed to have little impact. Higher skills were also found to be correlated with higher wages. The authors found that the higher productivity that linked to higher skills was almost totally reflected in greater wages, implying that individuals may make the most gains from investment in skills. Employers must make some gains from higher skills in order to be willing to pay higher wages in the first place.

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[3] The Cobb-Douglas function is frequently used in economics to show the relationship between input factors and the level of production:

$$Y = AL^{á}K^{â}$$

where: Y = value of total production; L = labour input; K = capital input; A = total factor productivity; á and â are the output elasticities of labour and capital, respectively.

Of particular importance for regional productivity is the potential for spillovers. Galindo-Rueda and Haskel (ibid) found evidence of area-based, human capital spillovers in their data. Higher productivity was shown by firms located in areas with higher proportions of the local workforce having Level 4 qualifications or higher. Wages were also found to be higher in areas with greater density of highly educated workers.

Webber *et al.* (2007) used cross-sectional regression analysis on UK firm-level data to identify whether firm level labour productivity rates are affected by factors that vary spatially. Their analysis introduces an 'economic potential' variable which considers the distance to neighbouring areas and the characteristics of surrounding areas. They note that once they controlled for industrial background, high skills had a statistically significant and positive effect on labour productivity (GVA per employee). Low skill workers were found to have a negative effect on labour productivity. Another finding in their paper was that a greater concentration of low skills did not decrease labour productivity in places where the effects of 'economic potential' were high compared to when they were low. They interpret this finding to mean that the returns to decreasing the proportion of the workforce with only low skills are spatially dependent on the 'economic potential' effect. The 'economic potential' index encapsulates the effects on productivity of the agglomeration of population, labour and firms which provide ready access to markets, large pools of labour (with varying skills) and potential spillovers. It also encompasses the effects of peripherality and its cost-penalties and other more straightforward implications. Concentrations of low skilled workers are found to have a greater negative effect on productivity in more peripheral areas. Overall, the authors' findings support government intervention to boost higher level skills (Level 4 NVQ and above) and to reduce the share of the labour force with low skills or no formal qualifications. Webber's findings could have important implications for peripheral rural areas in the East Midlands (e.g. the coastal zone of Lincolnshire).

3.2. Skills and productivity within regions and nations

Productivity in the UK: 3 – the Regional Dimension (HMT 2001) identified key factors underlying regional differentials in productivity. Amongst these factors were regional differences in the provision of the five key drivers discussed earlier. In terms of skills, major variation in the skills of the workforce between and within regions is observed. The report concludes that improving human capital in lagging regions is a key factor in closing the gap between regions but increasing educational attainment locally will not necessarily improve the skills of the local workforce as highly skilled workers are known to have the tendancy to move to wealthier areas. Again, this highlights the importance of the greater geographical mobility of more skilled than less skilled workers.

Boddy *et al.* (2005) looked at the determinants of productivity by English region using firm level data. They found that the regional productivity gap can be explained by:

- industry mix;
- capital used by firms;
- business ownership; and
- the skills of the local labour force.

Both the proportions of the local labour force with high and medium level qualifications had positive effects on productivity. The authors recognise that levels of qualifications in the workforce are relevant in determining productivity and regional productivity differentials. However, they caution that skills are less important than is frequently implied in much of the policy literature.

Cambridge Econometrics (2003) proxied human capital by size of working population, personnel employed in R&D, employment in high tech sectors, total number of students and students in tertiary education in their analysis of the determinants of regional competitiveness across the EU. They found that the main drivers of productivity (GDP per worker or GVA per worker) were innovation and human capital.

Relevant evidence is not limited to the UK and Europe. Rao *et al.* (2002) examined the role of differences in skills and other factors in determining differences in productivity levels amongst manufacturing firms in Canada. Skills were proxied by the proportion of workers with one to three years of non-university post-secondary education and the percentage of workers with a university degree. Their results indicated that differences in university education had a larger effect on productivity differences within industries than did variation in one to three years of post-secondary education. Their results also imply that the longer-term impacts of their two skills indicators, capital intensity and R&D intensity, are considerably greater than the effects in the shorter-term. Skills are also found to influence productivity through their effect on R&D spending. Their results also suggest that the productivity gap between Canada and the US could be narrowed partly through Canada's diminishing its gap in the proportion of its workforce with a university education.

In looking at the degree of disparities in economic prosperity and performance between UK regions and nations, Dickerson (2006) also provided evidence supporting possible explanations for regional differences with particular emphasis on the spatial distribution of industrial sectors and the geographical distribution of skills. Some of the UK's regions which exhibit the lowest

productivity are those regions where skill shortages are most severe. Dickerson decomposes labour productivity differentials (productivity gap: regional output per job) into three components: industry mix; productivity differential; and an allocative (i.e. differential) component. The industry mix measures the contribution that the region's specific sectoral composition makes to the productivity gap with the UK average, assuming that the sectoral productivities in the region are equal to the UK averages for the sectors. The productivity differential arises from sectoral productivity differences between the region and the UK average, assuming that the region's sectoral distribution is the same as the national distribution. Finally, the allocative component is the part of the productivity gap that arises from the region being specialised, relative to the UK average, in sectors that have productivities that vary from the UK average. Using 2004 data, the study finds considerably more variation in the productivity effect than in the other two components of the total productivity gap across the regions. The results suggest that the pure regional productivity effect, that regions have different levels of productivity in each sector compared to the national averages, is the most influential factor for regional productivity gaps.

Esteban (2000) found similar results using various data sets covering a number of different countries. Kamarianakis and Le Gallo (2003) expand on Esteban's approach and find that while spatial and temporal interdependencies are important, the regional productivity component is the main factor explaining regional productivity differentials. In considering the effects of skills on the regional productivity gaps in the UK, Dickerson (2006) suggests that sectoral productivity differences between regions and the UK average may partly result from the skills and occupational composition of employment in the regions. Dickerson suggests that higher wage premia attached to higher qualifications in regions with lower productivity suggest that these qualifications are in demand in these regions and this suggests that improving the skills profile of employment in such regions could serve to increase both regional and national productivity.

SUMMARY – Evidence on the direct linkages between skills and productivity

- The evidence reviewed pertaining to the direct links between skills and productivity, on the whole, indicates that increases in skills or higher levels of skills are associated with greater productivity.
- Overall, those studies with regional dimensions considered find that higher skills were associated with higher productivity. Studies also show that productivity differentials between regions are due mainly to different sectoral productivities. These relate to the different skills and occupational composition of the regional workforce.
- It should be noted that in many cases the results found indicate only statistically significant associations and do not allow for inferences about causality.

3.3. Indirect linkages between skills, innovation, enterprise and productivity

3.3.1. High-end strategies

A number of studies have considered the association between product market strategies and skills and the related implications for performance. Mason (2004) confirms the link between skill demand and product market strategy. A more highly skilled workforce and high-value added product strategy are found to be correlated, and a later paper by Mason (2005) also finds a high degree of path dependence related to a firm's ability to move form low- to high-end strategies. Wilson and Hogarth (2003) also report evidence that the UK is in a low-skills equilibrium. This study reported difficulties in convincing companies that they needed to move up-market while they were still making profits with low-skill, low-value strategies.

Green *et al.* (2003) reported findings from the Employer Perspectives Survey (2002) with particular interest in the relationship between skill requirements and product or service specification. The results showed that the estimated proportion of jobs using graduate skills was greater in firms where the product was deemed 'high spec' than in lower product-specification firms. Due to weak statistical significance, the evidence suggested that the link between product specification and the required skill of individual jobs was weak. The results showed no significant link between technological change and either internal or demographic[4] skills gaps. Product specification was also found to have no link with skill gaps. The data also showed that higher levels of computerisation in firms are associated with higher skills being required. Their findings

[4] Demographic skill gaps are defined as gaps left by workers who retire or leave a company who have skills that are critical to the company's operations.

are also consistent with the idea of technological change being skill-biased as technological change was found to be associated with increases in skills requirements.

3.3.2. Innovation

Moving out of a low skills equilibrium would require a change in employers' product strategies. Such a change involves innovation, at least to some degree. Tether *et al.* (2005) review part of the vast literature that find a positive relationship between workforce skills levels and innovative and productive, high value-added product strategies (Wensley 1999, Wilson and Hogarth 2003, Mason 2004). According to Tether *et al*., increasing the stock of skills may stimulate some employers into upgrading their strategies and moving further up the value chain, but an increased supply of skills alone will not prove optimal. As Wilson and Hogarth (2003) highlight, in a low skills equilibrium, a key barrier to innovation is not workforce skills but management capability and capacity.

Tether *et al.* (ibid) review the literature on how innovation affects the demand for skills and how skills drive innovation. They look at evidence on how skills affect innovation and the reverse relationship of how innovation changes the demand for skills in the workforce. Innovation, particularly technological innovation, creates demand for higher skilled workers. Innovation implemented alongside highly skilled workers can generate greater returns than implementing innovations without addressing the skills of the workforce. On the other hand, many technological innovations have resulted in declining demand for lower skilled workers as some innovations can replace workers through automation of routine tasks or substitution for other tasks. Product innovations are found to favour the creation of jobs while process innovations tend to induce the substitution of human labour with capital and tend to be coupled with higher skills.

Regarding the implications that skills and skill shortages have for innovation, Tether *et al.* refer to the 3rd European Community Innovation Survey which for the period from 1998 to 2000 indicated that a lack of qualified personnel was a middle ranking factor hampering innovation in the UK. Similarly, the Scottish Employers Skills Survey (2004) indicated that firms' inability to attract suitably skilled workers often reduced the firms' innovation performance. The incidence of this barrier to innovation has a number of possible consequences. It may lead to delays in the development of new products, it may cause difficulties in introducing new working practices, and finally, firms may have difficulties in introducing technical change.

Tether *et al.* also look at the literature on 'low skills equilibrium' and how skills and innovation interact in such a situation. In a low skills equilibrium employers do not demand higher skills

because they are engaged in providing low specification products and services. Further, they do not seek to innovate in order to shift from this situation due, in part, to a lack of skilled workers in their organisation. Analogously, workers do not have the incentive to gain high skills in a low skills equilibrium as there is a lack of demand for high skills from employers. The authors, and others, caution that increasing the supply of higher skills is not a sufficient way of breaking out of a low skills equilibrium.

Skills are not only important in driving innovation with the motivation of moving out of a low skills equilibrium, but they are also vital for effectively implementing innovations in the workplace which has implications for productivity. Leiponen (2005) looks at the complementarity of employees' skills and firm innovation. The entire innovating firm is thought to benefit from a strong skill-base. Finnish data were used to construct a panel dataset of 159 manufacturing firms from 1990 to 1996 to estimate firm profitability. The results suggest that significant complementarities exist between technical skills and innovation and between skills and R&D collaboration activities. These complementarities are found to have positive effects on firms' profitability.

Skills also help to determine the extent of innovation that firms can accomplish. Romijn and Albaladejo (2000) investigate key internal and external sources of innovation capability in small and medium sized firms (SME) in the UK. They find that a range of internal factors are relevant. These include owners' technical education and prior working experience in large firms and R&D institutions, technical skills of the workforce, and investments in R&D and training. Amongst the external factors is the firm's interaction with nearby R&D and training institutions.

Laplagne and Bensted (1999) examined labour productivity in Australia over the period 1990-1995. Their data indicated that over this period, the incidence of training and innovation in medium to large Australian workplaces increased while labour productivity increased by an average of 2.2 per cent per year. While this association indicates that productivity and innovation and training are positively correlated, the authors did not tease out the direction of causality. They also found that different types of innovation[5] had different effects on labour productivity growth, and changes in the way work was carried out were found to have greater immediate impact than other forms of innovation.

The idea that innovation is important for regional and national economic performance is widely accepted. Michie and Oughton (2001) suggest that in order to close the income and productivity

[5] The types of innovation considered include: restructure of how work is carried out; change in product/service; new office technology; new plant, machines or equipment; and reorganisation of structure.

gaps that exist between regions and nations, it is necessary to first close the innovation gap. Innovation requires a coordinated effort with investment in knowledge, people and capital being considered together. They find that innovation activity is more variable across regions than between countries and conclude therefore that there must be a set of regional factors that explain this variation. Looking at innovation performance in the EU, they found that variation was greater within countries than between countries. Nearly 70 per cent of the total variation in R&D expenditure was found to be within-country and 30 per cent across-country. Over 70 per cent of the total variation in living standards was similarly found to be accounted for by within-country regional variation.

Griffith *et al.* (2006) compared the role of innovation in productivity across France, Germany, Spain and the UK using data from the Community Innovation Surveys (CIS). They found that the systems driving innovation and productivity were quite similar across the four countries. They measured productivity as sales per employee. They found that product innovation was associated with higher productivity in France, Spain and the UK while process innovation was only associated with higher productivity in France.

Mole and Worrall (2001) find that innovators are more successful in business. Using the West Midlands Business Survey they found that of those firms who reported introducing a new product to the market in the six months to Spring 1996, around 40 per cent indicated an increased in sales of more than 10 per cent in the same period.

The importance of networking in facilitating successful innovation activity is highlighted in a number of studies. Mole and Worrall (2001) conclude that the West Midlands is an innovative region without an 'innovative milieu'. The concept of 'innovative milieu' draws on Camagni (1995) who describes an innovative milieu as having "… strong elements of local entrepreneurship; close interaction and cooperation among firms; and relevant externalities associated with specialised labour markets." Pittaway *et al* (2004) review evidence on the relationship between networking and innovation. Overall the evidence suggests that network relationships with suppliers, customers and intermediaries are important factors affecting innovation performance and productivity. Clusters alone are not considered sufficient and without networking, innovation is observed to occur less often and is less successful.

Expenditure on R&D, and R&D activity rates, are often used to indicate innovation. There is a consensus in the literature that there is a positive and significant link between R&D capital and productivity (Fawcett and Cameron, 2005). The external effects of R&D (spillovers) may take place through four main mechanisms (Fawcett and Cameron, 2005):

i) innovators cannot capture the entire social benefit of their creations (surplus appropriation);

ii) existing knowledge contributes to the capacity to innovate (standing on shoulders);

iii) new innovations/inventions create negative duplication externalities (stepping on toes); and

iv) a new good supersedes an existing one making it redundant (creative destruction).

Of these four mechanisms, i) and ii) can be considered positive externalities where positive gains are made by people other than the original innovator himself and items iii) and iv) are negative spillovers where the net effect is either negative or, at best, nil.

Innovation has also been found to have an indirect impact on productivity or economic performance through entrepreneurial activity. Michelacci (2003) highlights the complementarity of entrepreneurship and R&D (innovation) by demonstrating the lower returns to R&D that are made when entrepreneurship is lacking. In line with Schumpeter (1947), Michelacci suggests that ideas by themselves are not important and that both inventors (or innovators) and entrepreneurs contribute to economic growth. Innovation is found to suffer due to lack of research effort and because of insufficient entrepreneurial skills. Increasing the amount of resources devoted to R&D activity does not inevitably increase economic growth. An increase in research effort may crowd out more socially useful entrepreneurial skills which may result in a negative effect on growth.

3.3.3. Enterprise

The formation of new firms is often the only activity considered to represent entrepreneurial activity but, as Beugelsdijk (2007) points out, entrepreneurship may also include innovative and enterprising behaviour within existing firms. Beugelsdijk uses the European Values Survey (EVS) to construct a regional measure of entrepreneurial culture. He finds that regions which have experienced higher economic growth rates typically have a more entrepreneurial culture. A constraint, admitted by the author, is the lack of many control variables due to poor availability of regional data.

As shown for innovation, skills are also important for entrepreneurial activity. Iparraguirre (2007) found that the proportion of the workforce with Level 4 NVQ or higher has a positive overall effect on labour productivity (GVA per employed person) in the English regions. The author also finds that skills have a positive indirect effect on productivity through positive effects on entrepreneurial activity, start-ups, and investment.

There is a general consensus that not all entrepreneurial activity is necessarily good for the economy. Mueller *et al.* (2008) looks at the link between new firm formation and employment growth asking whether there is a 'wrong type' of entrepreneurship which does not lead to subsequent (or even to negative) employment growth. Using British data they find an overall positive effect of business start-ups on employment in the UK. Separate national analysis indicates a positive relationship for England as well, but this is not found for Scotland and Wales. When looking at the regions, a negative relationship was found for those regions in the bottom quartile for start-ups. This latter finding prompted the authors to attribute the negative effect to firms in such areas being started by individuals with few employment prospects, lower skills and poor market prospects who were likely drawn to starting up a business by the availability of public funds.

Using GEM (Global Entrepreneurship Monitor) data, Wong *et al.* (2005) examine firm formation and technological innovation as separate determinants of growth. They found support for their hypothesis that innovation is positively related to growth in GDP. They did not find evidence that higher levels of overall total entrepreneurial activity (TEA) are associated with higher GDP growth rates. They also found no significant effect of interaction between innovation and entrepreneurial activity in the data. They concluded that higher levels of entrepreneurial activity do not guarantee enhanced economic performance and greater growth. Similar to Mueller *et al.* (op cit) they find that there are different types of entrepreneurial activity and that only some of these enhance economic growth. Contrary to neoclassical growth model, Wong *et al.* found that at the national level, innovation and firm formation are separate phenomena.

Praag and Versloot (2007) reviewed recent evidence on the economic importance of entrepreneurship. They were particularly interested in the contribution of entrepreneurial activity to: employment generation and dynamics; innovation; and productivity and growth. Although Praag and Versloot highlight that the evidence overall shows that entrepreneurs do not invest more in innovation than their counterparts and that they produce fewer innovations, they note that the evidence suggests that the quality of innovations produced by entrepreneurs may be better and that they are more efficient at producing these innovations (i.e. they produce more patents per employee and are cited more frequently). The authors also show that while entrepreneurs are found to lag behind in terms of levels of productivity they show relatively high growth rates of value added and productivity.

Related to the idea of entrepreneurial culture is the notion of 'entrepreneurship capital' (Audretsch and Keilbach, 2005). Entrepreneurship capital is a type of social capital that fosters entrepreneurial activity. Audretsch and Keilbach suggest that a high endowment of this has a

positive effect on regional economic performance. Entrepreneurial capital may serve as a conduit of knowledge spillovers – facilitating the transfer of knowledge from the source to the commercialisation of the knowledge in a firm. The findings of Michelacci (2005) illustrate this mechanism between innovation and entrepreneurship. Audretsch and Keilbach use data from 1992 for 327 regions in West Germany. Output is measured by GVA and knowledge capital is indicated by the number of employees engaged in R&D while the measure of entrepreneurship capital, which involves a number of qualitative aspects that are difficult to assess, is number of business start-ups relative to the region's population. They use lagged values of entrepreneurial capital to address the possibility of reverse causality between this measure and the measure of output. They find that a 10 per cent increase in a region's entrepreneurship capital (start-ups relative to population) increases labour productivity in the region by 1 per cent. Their results also suggest that the impact of increasing entrepreneurial capital by a particular percentage is three to four times as large as the impact of increasing R&D inputs by the same proportion. The results obtained by Audretsch and Keilbach highlight the need to consider the balance between research and entrepreneurship. The authors note that their investigation presents only initial evidence that "supporting entrepreneurship capital in R&D oriented industries and densely populated regions would have a strong and lasting impact on the labour productivity of these regions".

Given the generally plausible idea that some types of entrepreneurial activity can improve national and regional economic performance, enabling the creation of valuable businesses is an important goal. One problem faced in trying to stimulate entrepreneurial activity or to foster an entrepreneurial culture is that of delivering effective entrepreneurial education. Galloway *et al* (2005) used a survey of university students in Scotland, where entrepreneurial education is considered to be relatively well-developed, to evaluate the concept of providing students with 'enterprise skills' and to examine the importance of these skills in the current and developing economic environment. They find that the skills developed through entrepreneurial education are not only applicable for entrepreneurship but also for waged employment. Over the long term, entrepreneurial education is thought to increase the rate of business start-ups by graduates but in the short term students also benefit from enterprise skills through improved employability.

3.3.4. Management, skills and productivity

The relative weakness of the UK's economy compared to countries such as Germany and the USA, especially its manufacturing base, been a long-standing concern over much of the post-

1945 period (Blackaby, 1979). Explanations for this weakness have been offered with reference to the UK's relatively poor:

- product mix;
- use of plant and machinery;
- capacity utilisation;
- innovation and R&D;
- workforce skills capability; and
- industrial / employee relations.

In many respects management have a degree of strategic choice about the decisions they make with respect to the above, albeit the choice may be a constrained one. As such these factors of production are, to different degrees, within management's sphere of influence. While the recent past has seen a number of inquiries into the quality of the UK's management base and its capability to raise productivity, these are in fact long-standing concerns. A study from the 1970s, for instance, which compared the performance of the UK economy with that of the USA, reported that management skills, especially the capacity of managers to motivate staff, accounted for much of the productivity gap (Caves and Krause, 1980).

More recent studies indicate that at the most senior levels in the largest organisations the quality of UK management is considered to be exemplary (Porter and Ketels, 2003), but overall the quality of management and leadership is thought to constrain productivity and competitiveness through the failure to adopt good or best practice in a variety of management activities (NSTF, 1998; AIM, 2004). It is often the collective capability of management within an organisation to deal with, in an inter-related manner, a range of activities that determines performance. In relation to high performance work organisations much of the emphasis is upon human resource practices - such as those which foster trust, commitment and skill formation, and reward practices which increase an individual worker's stakeholding in an organisation - but it is more likely to be the juxtaposition of these practices to a sustainable product market strategy and efficient production processes which brings about relatively high organisational performance (Bosworth, 2005; Guest, 2003; Sung and Ashton, 2005).

Evidence drawn from the *2005 Work and Enterprise Survey* reveals that high performance organisations are characterised by high wage, high skill workforces employed in workplace environments characterised by a high degree of informality, high trust relationships between members of the workforce, visible and accessible business leaders, all of which allowed quick decision making (Work Foundation, 2005). The evidence that skills and performance are related

needs careful assessment because the strategic choices with which management in a single organisation are faced may result in de-skilling or job reductions in some occupations. There is a need to be clear about the precise type or mix of skills which raise organisational performance but the literature is largely silent on this. In aggregate, however, the evidence points to relatively high skills being associated with relatively good organisational performance, but this is association is dependent upon management having in place a number policies and practices which will permit the skills and knowledge possessed by the workforce being utilised for the benefit of the organisation. Hence the emphasis given in this report to management skills or capability being the key driver of productivity performance because it is this group above all others who make the decisions which drive organisational performance (Bloom, 2007).

3.3.5. Methodological limitations

It is necessary to point out that the findings of the literature reviewed in Sections 3.2 and 3.3 above are not without their limitations. In many instances, the analyses have been constrained by the availability of full and appropriate data. A number of studies have focused on cross-sectional data. Such analyses only allow for conclusions to be drawn about a snapshot in time. No inferences regarding the causal links between variables can be made without the use of time series data and appropriate estimation techniques which allow for the relationships between productivity and various drivers to be followed over time thereby permitting the direction of causality to be observed.

The issue of endogeneity is also not fully addressed in all studies reviewed. It may be that more productive regions attract more highly skilled workers rather than the presence of highly skilled workers in a region increasing the level of productivity. Similarly, more businesses may start up in more productive regions rather than the high productivity of a region being caused by greater levels of entrepreneurial activity.

Finally, the set of control variables used in analyses is not always fully complete. This again, is largely due to problems with data availability. It is necessary to control for various other factors when looking at the linkages between skills, innovation, enterprise and productivity, to ensure that all applicable factors in productivity are considered and that no effects are unduly attributed to skills or the other drivers of interest. The full causal relationships between skills, innovation, enterprise and productivity cannot be teased out without consideration of these issues.

SUMMARY – Evidence on the indirect linkages between skills and productivity

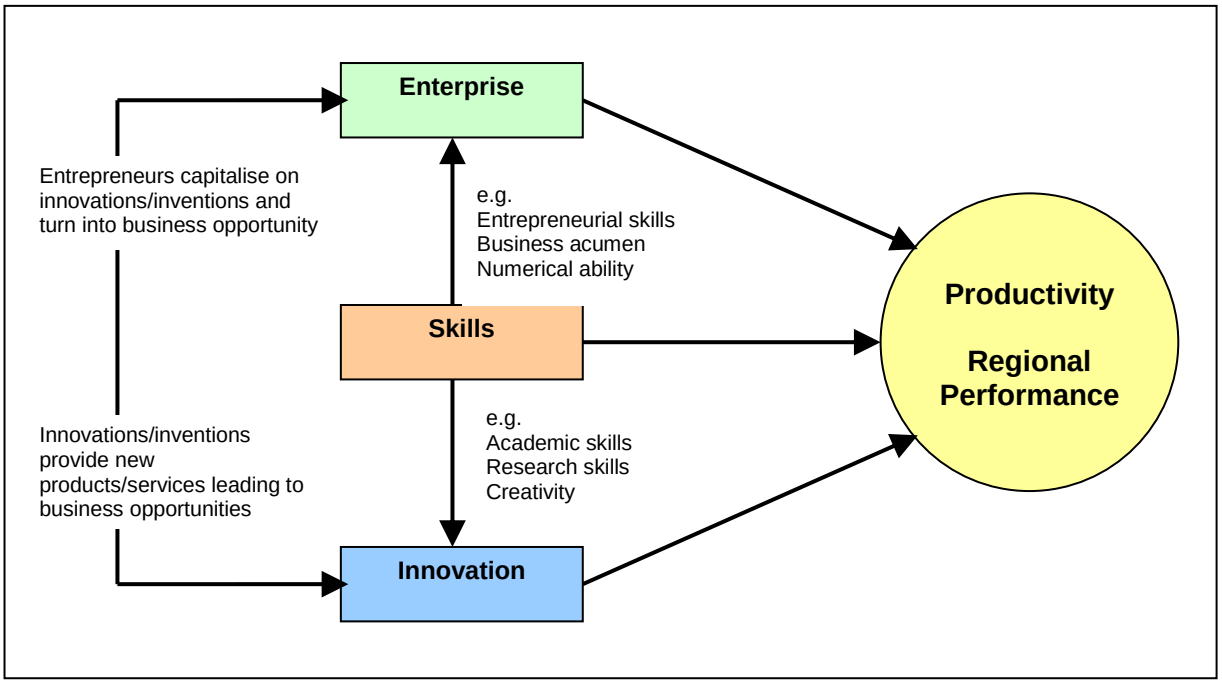
- A link between skill demand and product market strategy has been found in the literature, but motivating firms to move upmarket when they are profitable with low-skill, low-value strategies is a challenge.
- In general, there is agreement that skills enhance the innovative and entrepreneurial activity of individuals and firms. Particular skills are commonly accepted to be more useful in fostering innovation activity as well as entrepreneurial activity.
- Skills are also found to be necessary complements to innovations being implemented in the workplace. Introducing an innovation in a firm is unproductive if the workforce is ill-equipped to optimize its use.
- Innovation and entrepreneurship have been found to be complementary as well, with lower returns to R&D arising when entrepreneurship is lacking. A balance is needed between the skills needed to perform research and to innovate and those entrepreneurial skills that enable people to capitalise on the commercial or business potential of ideas.
- Certain types of entrepreneurial activity, typically that which is undertaken only in response to financial motivations by people without the necessary skills, is found to produce no real benefits in terms of productivity.
- An entrepreneurial culture or milieu has been found to be important in stimulating economically valuable entrepreneurial activity. Defining the characteristics of such a culture is not straightforward and there are many factors to be considered. Ensuring appropriate entrepreneurial education is one way of fostering an enterprising culture.
- The quality of management and leadership in the UK is believed to constrain productivity through failure to adopt good or best practice in various management activities. Management capability is a significant determinant of firm, and ultimately regional, performance.

3.4. Conclusion

Figure 3.1 summarises the direct and indirect linkages between skills, innovation and enterprise with productivity or regional performance. Each of the drivers, skills, enterprise and innovation, have direct implications for regional (and firm) productivity. The exploitation of business opportunities by entrepreneurs generates output thus potentially increasing the region's income. Innovations improve business processes leading to greater firm-level productivity which ultimately leads to regional productivity. Skills are found to increase individuals' labour productivity, which in turn improves business performance, which then may be aggregated to

the regional level. The indirect linkages concern the implications that each of the drivers have on the others and the influence of other factors on these drivers. Skills are important in facilitating entrepreneurial activity, in its many forms. Enterprise requires many skills including 'entrepreneurial skills', business acumen and numerical ability. Innovation is also largely influenced by skills. Academic skills, research skills and creativity are examples of skills that enhance innovation activity and knowledge creation. Enterprise and innovation also interact. As discussed above, entrepreneurs are necessary to exploit business opportunities presented by innovations. Innovations in turn present business opportunities for entrepreneurs. There is also a need to consider externalities at the regional level. As innovation and entrepreneurship gains momentum at regional or sub-regional level there are gains to the economy over and above those which accrue to individual companies simply as a consequence of having a critical mass of experience or knowledge available within companies and in those agencies which support innovation, enterprise, and skills.

Figure 3.1: Representation of direct and indirect linkages between Skills, Enterprise and Innovation with Productivity and/or Regional Performance



4. SKILLS, INNOVATION, ENTREPRENEURSHIP & PRODUCTIVITY IN THE EAST MIDLANDS

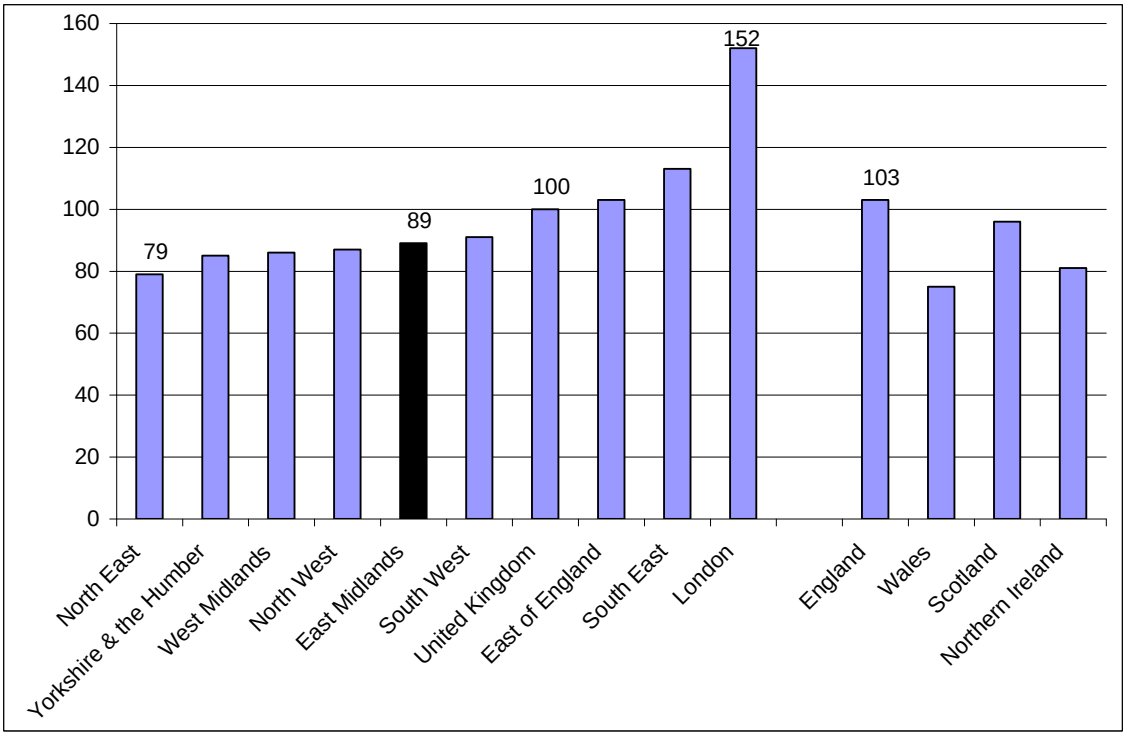
This section looks at data for the East Midlands relating to productivity and skills. Also examined are indicators of innovation and entrepreneurial activity. Where possible, comparisons are made between the East Midlands and other regions in order to assess whether the East Midlands differs in some way.

4.1. Productivity

According to ONS estimates, in 2007 the East Midlands had total GVA of £77.9 billion which was equal to 6.4 per cent of total GVA in the UK. Between 2006 and 2007, the region's GVA grew by 5.9 per cent, just under the total UK growth rate of 6 per cent. Figure 4.1 sets out the 2007 GVA per head indices for the devolved nations and English regions (with the UK equal to 100). Amongst the English regions, the East Midlands ranked fifth in terms of its GVA per head index in 2007. The regional picture of productivity is dominated by high values for London (with an index of 152), with less marked differences between the remaining regions. The East Midlands' index (89) was less than the UK (100) and England (103) average indices. Productivity, according to this measure, is greater in the East Midlands than in the North East, North West, Yorkshire and the Humber and the West Midlands.

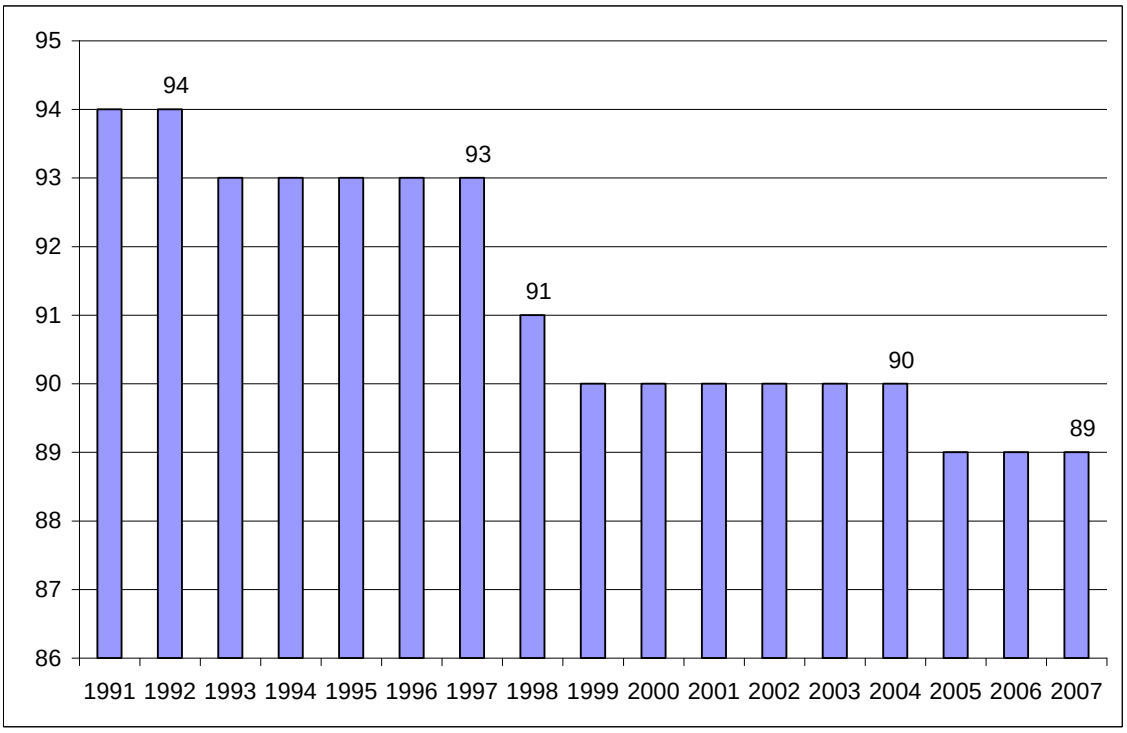
The GVA per head index for the East Midlands from 1991 to 2007 is shown in Figure 4.2a. GVA per head in the East Midlands has fallen from 94 per cent of the UK total in 1991 to 89 per cent in 2007 (a fall of 5 percentage points against the national average). In terms of regional differences, the East Midlands ranked fourth amongst the English regions between 1991 and 1997, fell to sixth between 1998 and 2000, but it has risen again to fifth since 2001. There is also a sub-regional dimension as shown in Figures 4.2b and 4.2c. Figure 4.2b shows GVA per head at the NUTS2 area level for the East Midlands. Leicestershire, Rutland and Northamptonshire has the highest GVA per head in the East Midlands and Lincolnshire the lowest. Figure 4.2c shows analogous data at the NUTS3 area level. Nottingham has the highest GVA per head in the region. It is important to note that regional and sub-regional GVA data are most certainly affected by commuting between regions and sub-regions. This factor is not easily controlled and so the degree of commuting affecting an area should be kept in mind when assessing regional and sub-regional productivity.

Figure 4.1: GVA per head index, 2007 (UK=100)



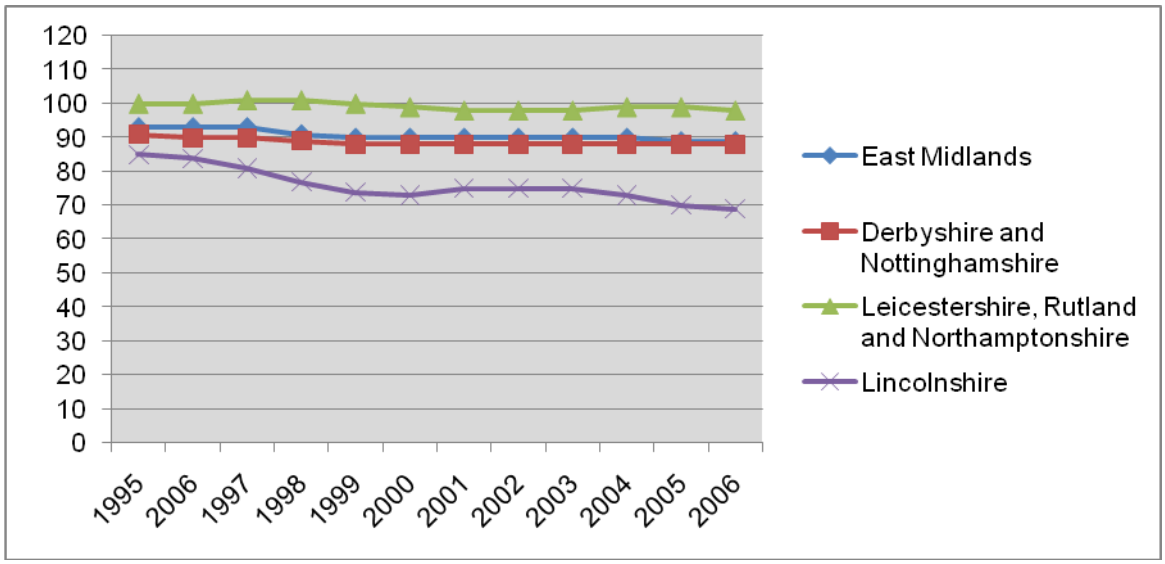
Source: ONS, Regional Accounts (NUTS1), First Release, 12 December 2008.

Figure 4.2a: GVA per head index for the East Midlands, 1991-2007 (UK=100)



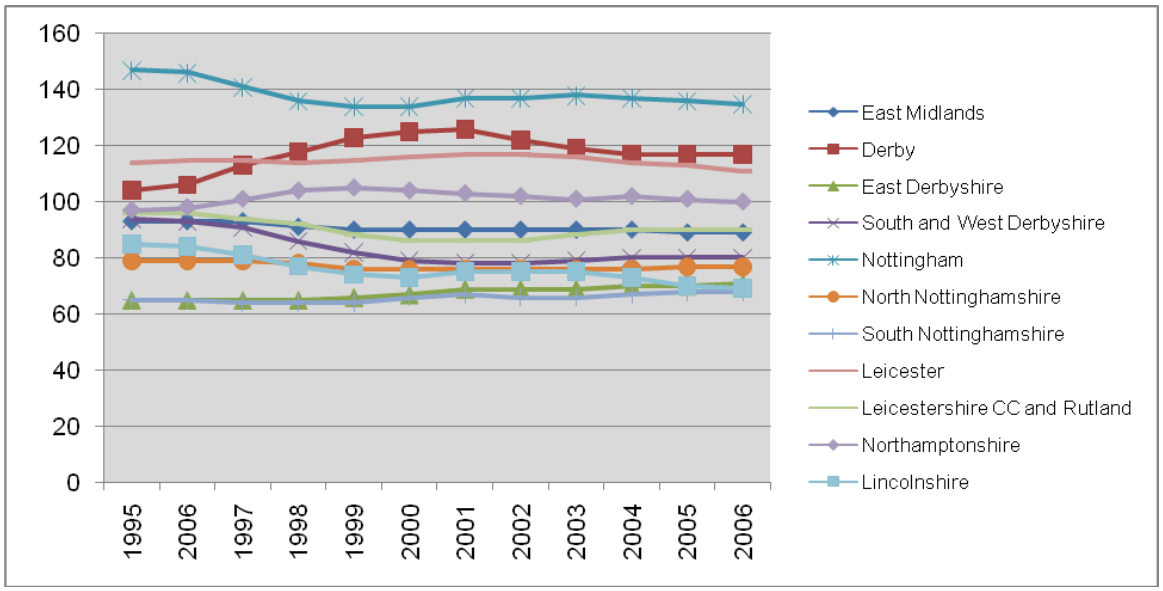
Source: ONS, Regional, sub-regional and local GVA (NUTS1) December 2008.

Figure 4.2b: GVA per head index for the East Midlands and NUTS2 areas, 1991-2007 (UK=100)



Source: ONS, Regional, sub-regional and local GVA (NUTS2) December 2008.

Figure 4.2c: GVA per head index for the East Midlands and NUTS3 areas, 1991-2007 (UK=100)



Source: ONS, Regional, sub-regional and local GVA (NUTS3) December 2008.

4.2. Sectoral variation within regions

Section 3 demonstrated that the sectoral distribution of activity within a region may have an impact on its overall productivity performance. For instance, large concentrations of employment in low-productivity or low-value sectors will likely skew the overall productivity of a region negatively in comparison to other regions with a more even distribution amongst sectors or with greater concentrations in high-value, high-productivity sectors.

Table 4.1 shows the distribution of employment by region and sector for 2001 and 2007. In 2001, the largest proportion of employment in the East Midlands, outside of public administration, education and health, was in manufacturing (21.4 per cent). The West Midlands was the only other region with such a high concentration. For most other regions in England, distribution, hotels and restaurants accounted for the greatest shares of employment (excluding the public sector). Energy and water accounted for the lowest proportion of employment in many regions, including the East Midlands where 1.3 per cent of employment was in this sector.

In 2007, the relative shares of employment were similar to those observed for 2001, with the exception of employment in distribution, hotels and restaurants which was 20.2 per cent compared to 18.9 per cent in 2001 (an increase of 1.3 percentage points). This sector accounted for the greatest share of employment (excluding the public sector) in the region in 2007. The share of employment in manufacturing in the East Midlands in 2007 was greater than the share observed for all other regions and as in all other regions the share of employment in manufacturing in the East Midlands decreased between 2001 and 2007 from 21.4 per cent to 16.9 per cent (a change of 4.5 percentage points).

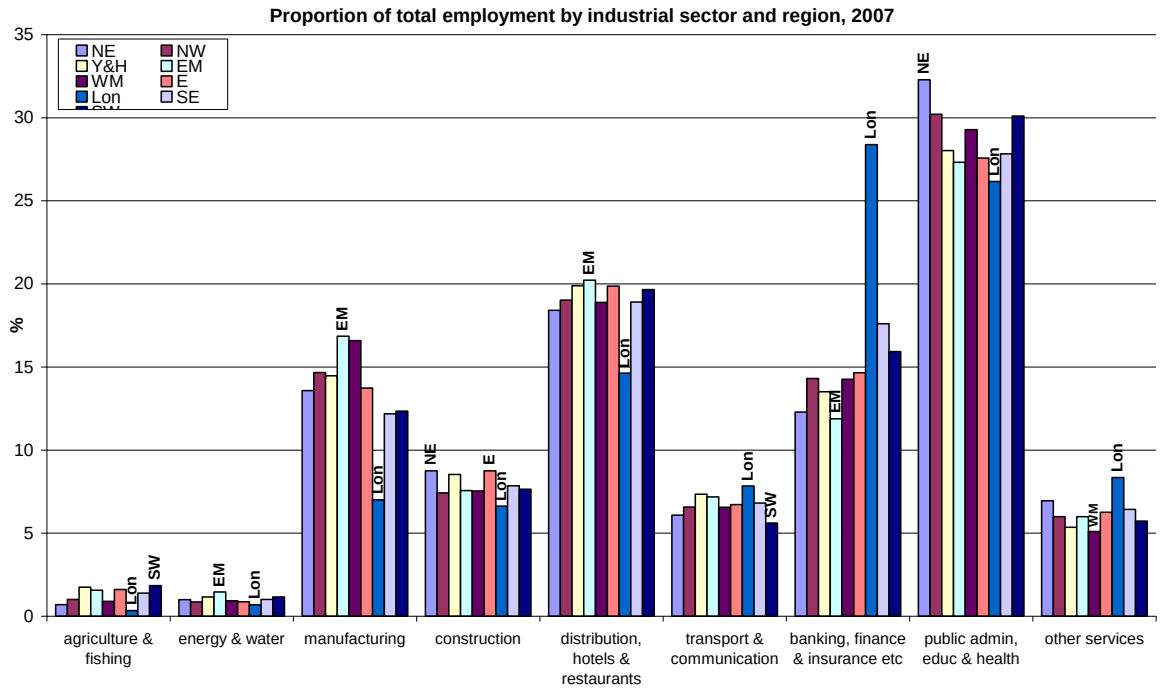
Figure 4.3 illustrates the industrial sector shares of employment for each region in 2007. The East Midlands does not appear to differ much from many other regions in terms of its sectoral distribution of employment, particularly in 2007. The exception is manufacturing in which the East Midlands and the West Midlands have higher than average shares of employment. Higher performing regions (London, the South East, the South West, and the East of England) do not follow any pattern of sectoral distribution that differs distinctly from the lower productivity regions. London is the only region which is distinct from all others. London has the lowest shares of employment in agriculture & fishing, energy & water and manufacturing than in all other regions of England, but London differs mostly from other regions in its share of employment in banking, finance, insurance, *etc.*

Table 4.1: Proportion of total employment by industrial sector and region, 2001 and 2007 (%)

2001	NE	NW	Y&H	EM	WM	E	Lon	SE	SW
agriculture & fishing	0.8	0.9	1.1	**1.4**	1.3	1.3	0.2	1.7	2.0
energy & water	0.9	0.8	1.0	**1.3**	1.0	0.8	0.4	0.9	1.2
manufacturing	18.9	17.8	18.7	**21.4**	23.4	17.7	8.1	14.1	15.0
construction	6.5	6.6	8.0	**7.3**	6.6	7.8	5.9	7.7	7.0
distribution, hotels & restaurants	17.6	20.1	19.8	**18.9**	19.2	20.0	16.2	20.0	21.7
transport & communication	7.2	6.9	6.3	**7.5**	6.9	7.3	8.9	7.4	5.1
banking, finance & insurance, etc	11.1	13.4	13.0	**12.1**	12.1	15.2	27.3	17.8	15.3
public admin, educ & health	31.1	28.6	27.1	**24.8**	25.0	24.2	24.9	24.5	27.1
other services	6.0	5.1	5.1	**5.4**	4.5	5.7	8.0	5.9	5.5
2007	**NE**	**NW**	**Y&H**	**EM**	**WM**	**E**	**Lon**	**SE**	**SW**
agriculture & fishing	0.7	1.0	1.7	**1.6**	0.9	1.6	0.3	1.4	1.8
energy & water	1.0	0.9	1.2	**1.5**	0.9	0.9	0.7	1.0	1.2
manufacturing	13.6	14.7	14.5	**16.9**	16.6	13.7	7.0	12.2	12.3
construction	8.8	7.4	8.5	**7.6**	7.5	8.8	6.6	7.9	7.6
distribution, hotels & restaurants	18.4	19.0	19.9	**20.2**	18.9	19.9	14.6	18.9	19.7
transport & communication	6.1	6.6	7.3	**7.2**	6.6	6.7	7.8	6.8	5.6
banking, finance & insurance, etc	12.3	14.3	13.5	**11.9**	14.3	14.7	28.4	17.6	15.9
public admin, educ & health	32.3	30.2	28.0	**27.3**	29.3	27.6	26.2	27.8	30.1
other services	6.9	6.0	5.4	**6.0**	5.1	6.3	8.3	6.4	5.7

Source: LFS spring quarters (Apr-Jun), 2001 and 2007

Figure 4.3: Proportion of total employment by industrial sector and region, 2007



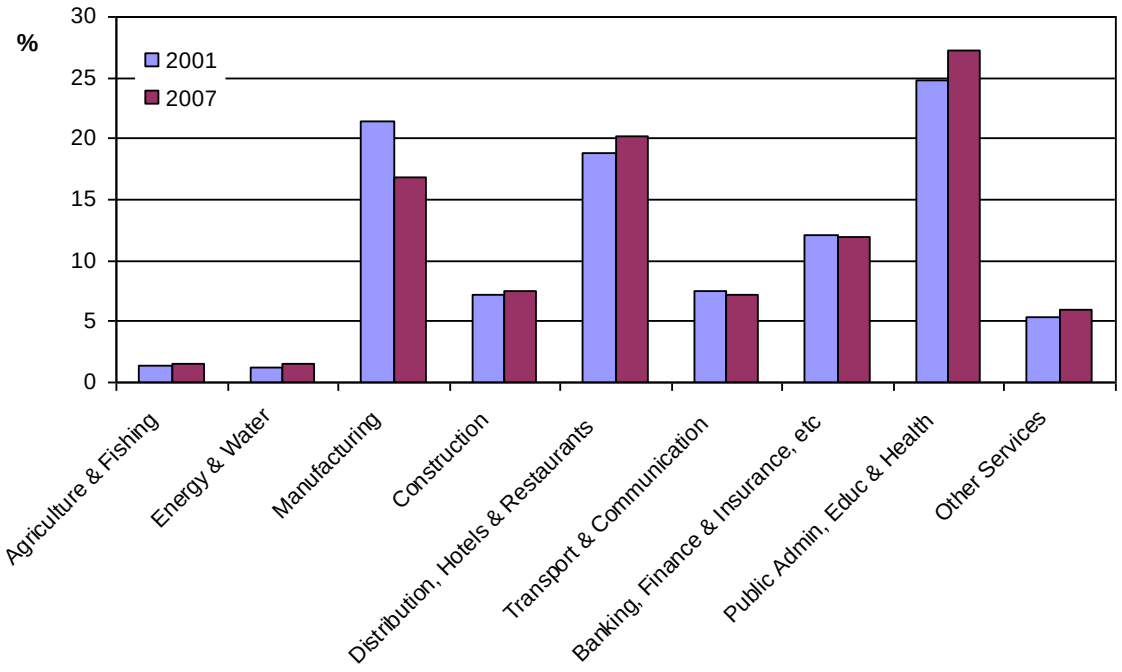
Source: LFS Apr-Jun quarter 2007

The share of employment in regions with higher productivity (South East, South West, East of England) is similar to that in the East Midlands for most sectors, except that the East Midlands has a noticeably larger share of employment in manufacturing than is observed in these higher

productivity regions. The lower productivity regions (North West, Yorkshire & Humberside, West Midlands) also have greater shares in manufacturing than the higher productivity regions.

The sectoral distributions of employment in the East Midlands for 2001 and 2007 are compared in Figure 4.4. The greatest changes are evident for manufacturing (decreasing share; a change of 4.5 percentage points) and public administration, education and health (increasing share; a change of 2.5 percentage points). Shares of employment also decreased in the transport and communication sector (by 0.3 percentage points) and in banking, finance and insurance, etc. (by 0.2 percentage points).

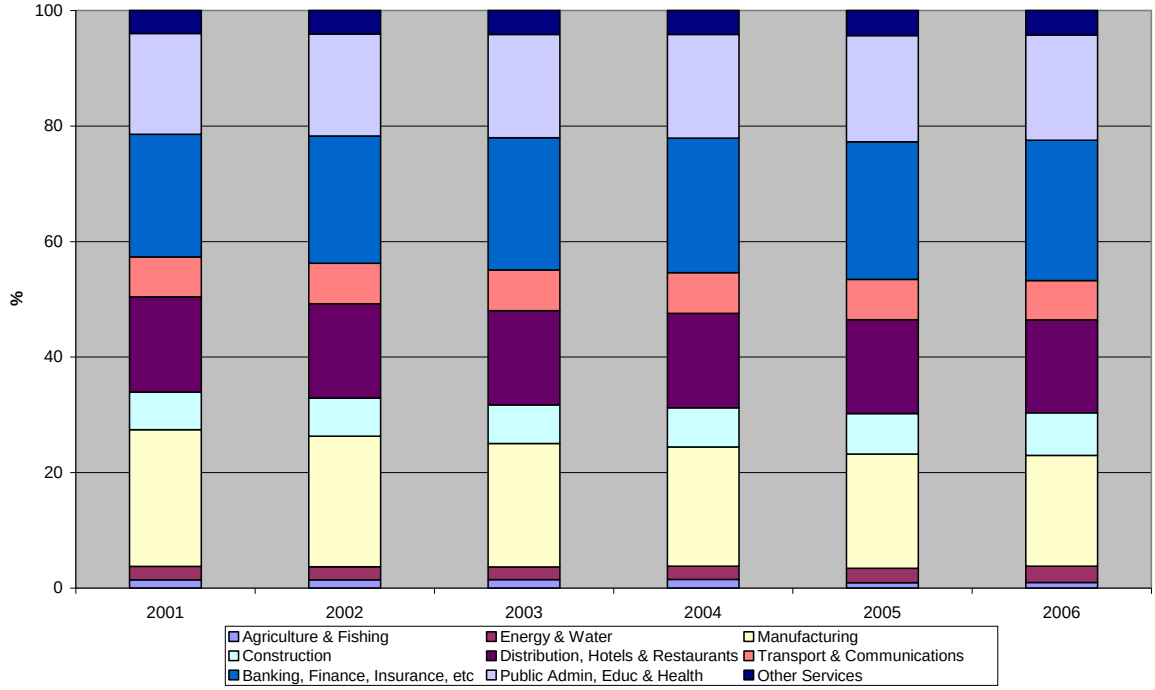
Figure 4.4: Proportion of total employment in East Midlands by industrial sector, 2001 and 2007



Source: LFS, Spring quarters (Apr-Jun) 2001, 2007

Figure 4.5 shows GVA by industry in the East Midlands from 2001 to 2006. The banking, finance, insurance, etc. sector contributed the greatest share of GVA in 2006. This share has increased – by 3 percentage points - since 2001 despite an overall decline in this sector's share of the region's total employment. The share of GVA contributed by public administration, education and health has also increased between 2001 and 2006 (by approximately 1 percentage point).

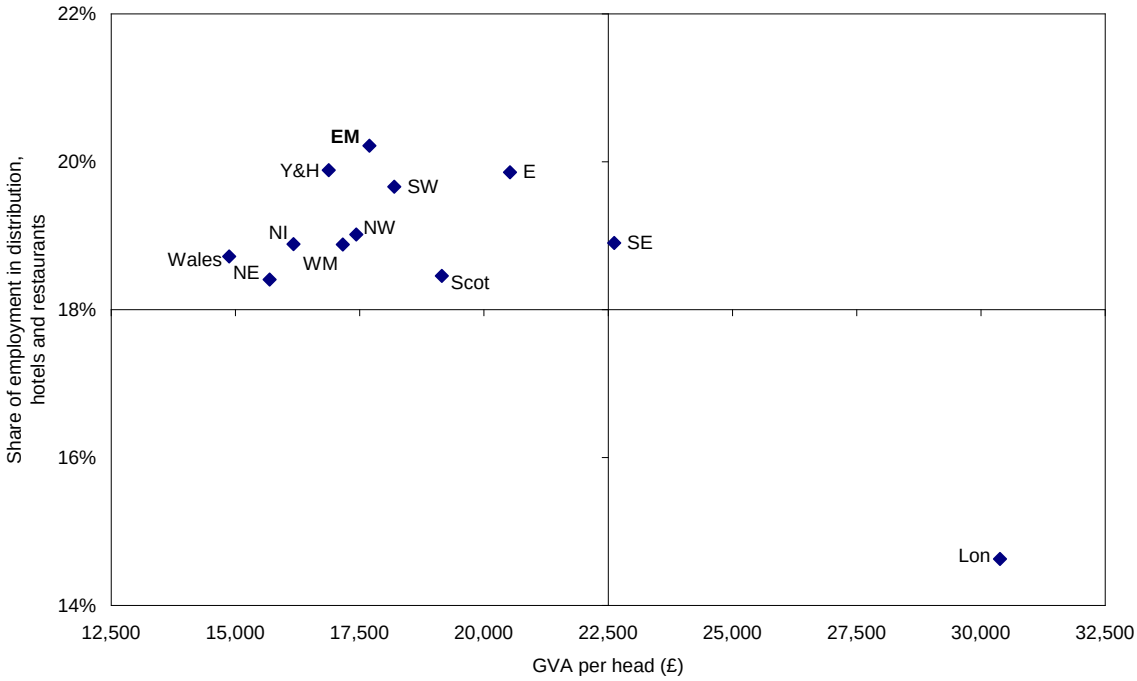
Figure 4.5: Gross Value Added (GVA) by industry in East Midlands, 2001-2006



Source: ONS Regional Accounts (NUTS2)

Banking, finance, insurance, etc. and distribution, hotels & restaurants may be considered two of the more high value sectors in the UK, at least in terms of the scale of the overall shares of GVA but not necessarily in terms of productivity. From Figure 4.5, manufacturing (accounting for 19 per cent of GVA in 2006) is of higher value than distribution, hotels and restaurants (16 per cent of GVA). Given the region's higher proportion of employment in manufacturing relative to most other regions, this figure may be considered somewhat misrepresentative of the regional economy as a whole. Examining the share of employment in distribution, hotels and restaurants and GVA per head by region (Figure 4.6), no clear relationship between the two variables is apparent. The East Midlands has a greater share of its employment concentrated in this sector than any other region, yet the region ranks in the middle according to overall regional productivity. In comparison, London has the lowest concentration of employment in the distribution, hotels and restaurants sector yet the capital has the highest overall productivity. Yorkshire and the Humber and the South West both have marginally lower concentrations of employment in distribution, hotels and restaurants than the East Midlands but Yorkshire and the Humber has lower regional productivity and the South West has greater productivity than the East Midlands.

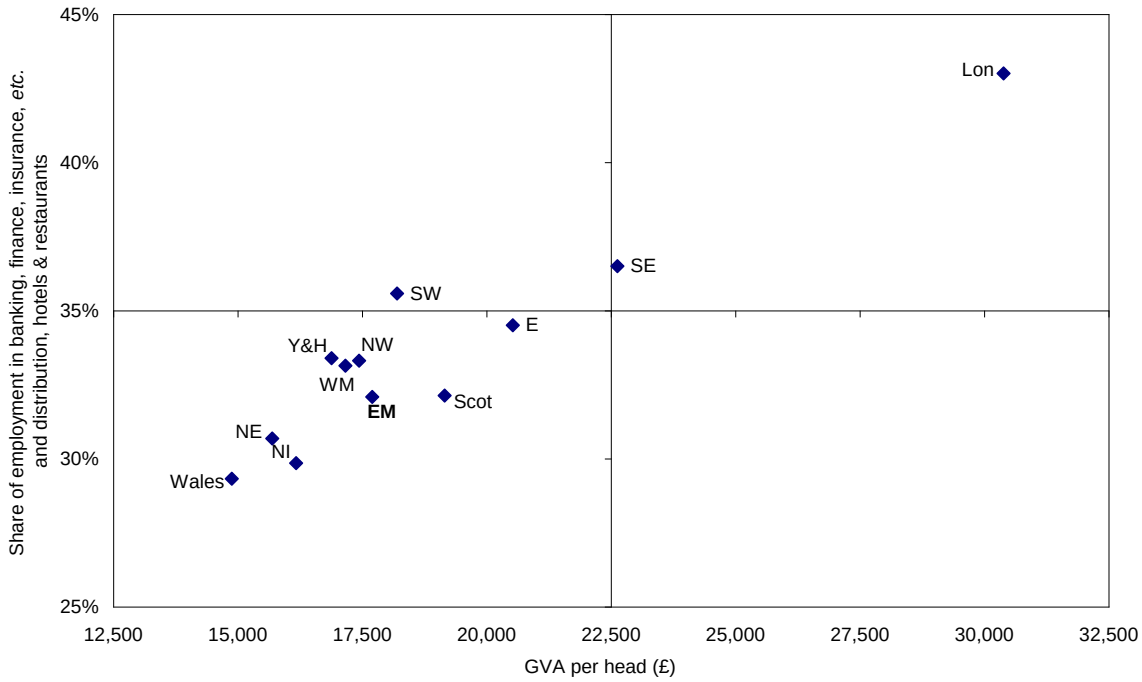
Figure 4.6: Share of employment in distribution, hotels and restaurants (%) by GVA per head (£), 2007



Source: Employment shares – LFS, Spring quarter (Apr-Jun) 2007; GVA per head – ONS Regional Accounts (NUTS1)

When the shares of employment in both distribution, hotels and restaurants and banking, finance, insurance, etc. are combined, a clearer relationship is observed between these shares and regional productivity (Figure 4.7). While there are deviations, for most regions, greater shares of employment in these two sectors is associated with higher total GVA per head. Relative to the East Midlands, the main exceptions observed are for the North West, the West Midlands and Yorkshire and the Humber. These three regions have greater proportions of employment in distribution, hotels and restaurants and banking, finance, insurance, etc. than does the East Midlands yet productivity is marginally greater in the East Midlands. Figure 4.7 reflects the higher productivity nature of businesses in banking, finance, insurance, etc. than in many other industrial sectors.

Figure 4.7: Share of employment in distribution, hotels and restaurants and banking, finance, insurance, etc. (%) by GVA per head (£), 2007



Source: LFS, Spring quarter (Apr-Jun) 2007; ONS regional Accounts (NUTS1).

4.3. Workforce skills

As skills are often proxied by formal qualifications, the distribution of the workforce in each region by highest level of qualification is shown in Table 4.2 for 2001 and 2007 and Figure 4.8 illustrates the shares by region in 2007. The percentage of the workforce with a degree or equivalent increased between 2001 and 2007 in all regions. In the East Midlands, the share of the workforce with a degree or equivalent increased by 4.1 percentage points; from 14.1 per cent in 2001 (2nd lowest in the UK) to 18.2 per cent in 2007 (lowest in the UK). This was lower than the increase for the UK as a whole (which increased by 4.8 percentage points).

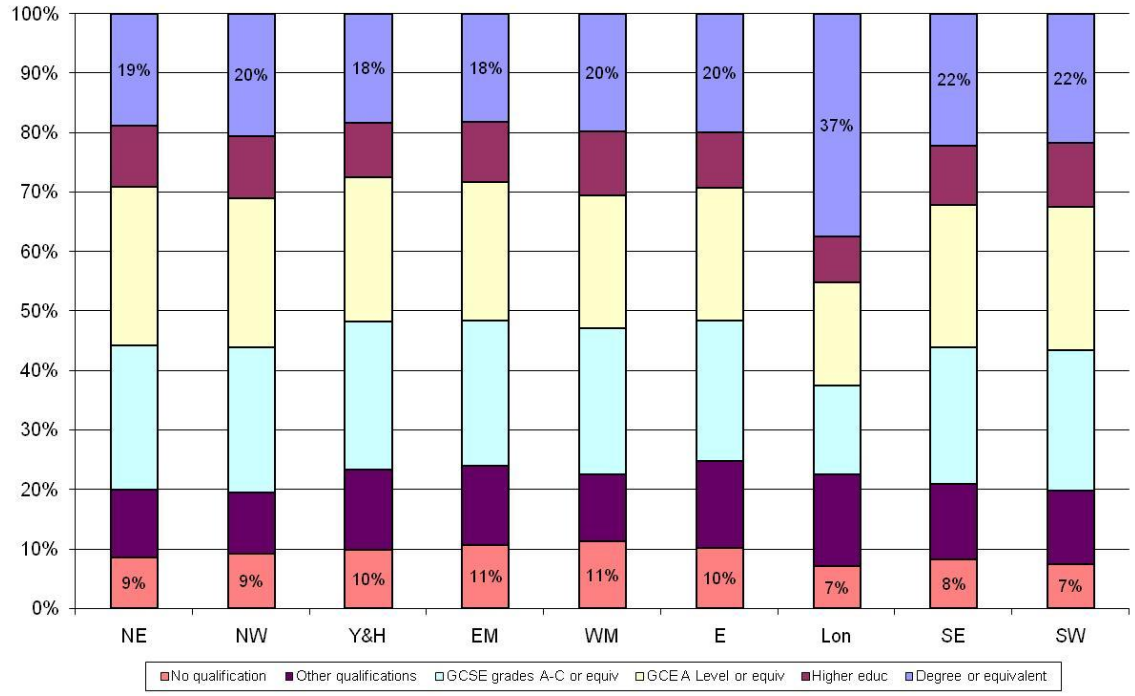
Table 4.2: Share of workforce (%) by highest qualification and region, 2001 and 2007

2001	Degree or equivalent	Higher educ	GCE A Level or equiv	GCSE grades A-C or equiv	Other qualifications	No qualification
NE	13.4	10.0	24.7	25.1	12.6	14.2
NW	15.5	10.6	25.6	24.4	11.3	12.6
Y&H	14.5	10.0	26.3	21.7	14.3	13.2
EM	**14.1**	**8.0**	**24.7**	**23.5**	**14.7**	**15.0**
WM	14.4	9.5	23.7	24.5	14.2	13.8
E	15.2	8.7	24.6	24.8	14.4	12.3
Lon	30.2	7.2	20.6	17.5	15.1	9.4
SE	18.2	8.7	23.8	24.1	14.1	11.0
SW	17.1	10.2	24.3	25.3	13.4	9.8
Wales	14.7	10.9	22.2	24.1	12.0	16.0
Scotland	16.6	14.5	31.5	15.1	10.3	12.0
N.I.	15.9	8.7	25.8	21.7	8.6	19.3
UK	17.5	9.7	24.7	22.4	13.3	12.4
2007	**Degree or equivalent**	**Higher educ**	**GCE A Level or equiv**	**GCSE grades A-C or equiv**	**Other qualifications**	**No qualification**
NE	18.8	10.4	26.6	24.2	11.4	8.6
NW	20.5	10.5	25.0	24.4	10.3	9.2
Y&H	18.3	9.2	24.2	24.9	13.5	9.9
EM	**18.2**	**10.1**	**23.2**	**24.5**	**13.3**	**10.7**
WM	19.8	10.7	22.3	24.6	11.3	11.3
E	19.9	9.4	22.3	23.6	14.7	10.1
Lon	37.4	7.7	17.5	14.8	15.5	7.1
SE	22.1	10.0	24.0	23.0	12.6	8.3
SW	21.7	10.7	24.1	23.7	12.3	7.5
Wales	19.7	9.8	24.0	23.3	11.5	11.7
Scotland	21.5	15.1	27.5	16.3	9.6	10.0
N.I.	21.0	8.2	25.4	21.6	7.1	16.6
UK	22.3	10.2	23.5	22.1	12.3	9.5

Source: LFS Apr-Jun quarter, 2001 and 2007

As shown in Table 4.2, in all regions people with no qualifications account for the lowest proportion of the workforce. Between 2001 and 2007, the share of the workforce with no qualifications declined in all regions (a change of 2.9 percentage points, from 12.4 per cent of the workforce in 2001 to 9.5 per cent in 2007). The situation in the East Midlands has also improved (i.e. seen a decline) between 2001 and 2007 in terms of the share of its workforce with no qualifications. While the East Midlands had the highest share of its workforce with no qualifications in England (and third highest in the UK) in 2001, the percentage point decrease between 2001 and 2007 was the second highest in the UK (a change of 4.3 percentage points). In 2001, 15 per cent of the East Midlands workforce had no qualifications but this had fallen to 10.7 per cent by 2007 (4th highest in the UK).

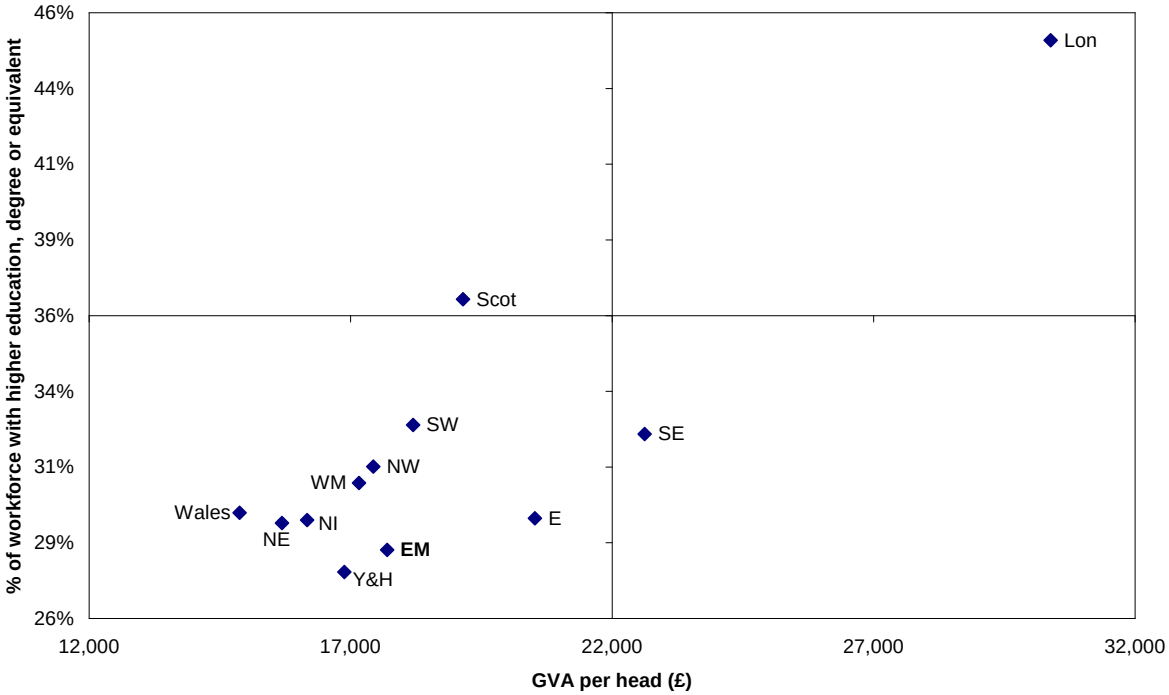
Figure 4.8: Share of workforce by highest qualification level and region, 2007



Source: LFS Apr-Jun quarter 2007

By taking higher education and a degree or equivalent as indicators of relatively 'high skills', the relationship between high skills and regional productivity may be considered (Figure 4.9). London is an anomaly relative to the other regions in terms of both the high concentration of its workforce with high skills and its high productivity performance. Even though the East Midlands, as shown above, has the second lowest share of its workforce possessing high skills the region's productivity is not so low relative to the other regions. The share of the workforce in the South West which has high skills is 4.1 percentage points greater than in the East Midlands, but GVA per head is only £497 higher. On the other hand, the proportion of high skills in the South East is 3.8 percentage points higher than in the East Midlands but GVA per head is significantly greater, £4,926, than in the East Midlands. These two comparisons illustrate that a straightforward relationship between high skills and high productivity is not necessarily valid. Underlying the relationship are more complex factors such as the actual skills of workers relative to their formal qualifications and the utilisation of skills in the workplace. Without understanding these more complex interactions between skills and productivity, it is impossible to improve regional performance through simply increasing the concentration of high skills in the workforce.

Figure 4.9: Share of workforce with higher education or a degree or equivalent and productivity by region, 2007

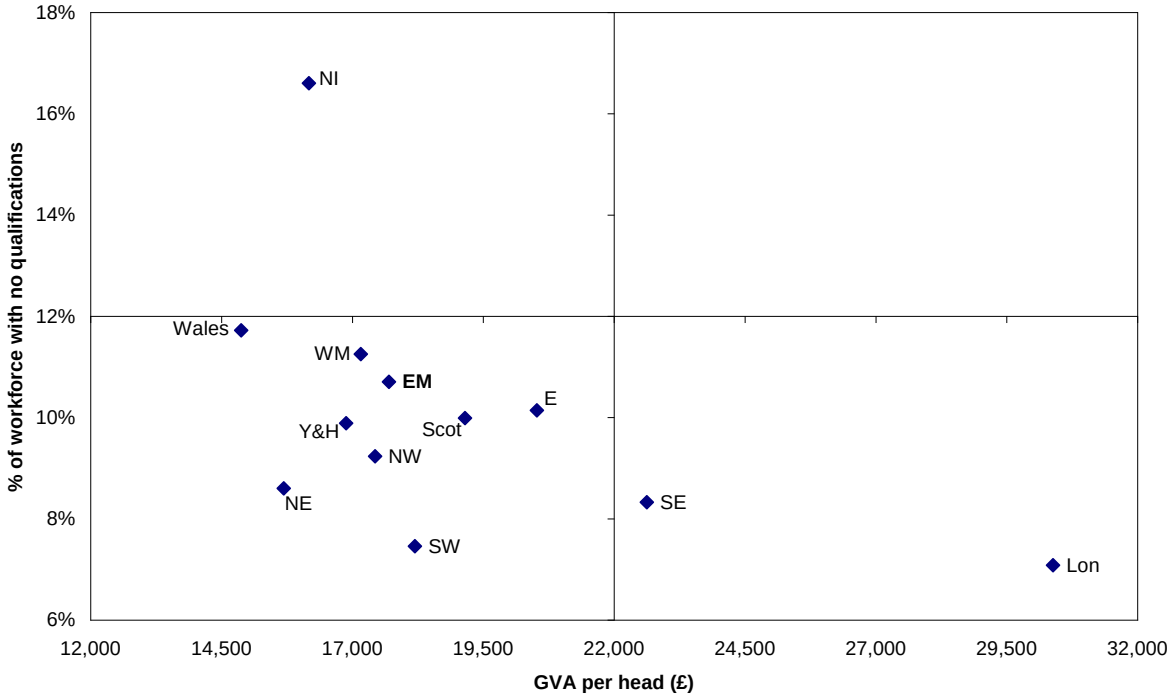


Source: LFS Apr-Jun quarter 2007 and ONS Regional Accounts (NUTS1)

The association between 'low skills', as indicated by "no qualifications", and GVA per head is considered in Figure 4.10. Again, no clear linear relationship is found between the share of a region's workforce with low skills (no qualifications) and overall regional productivity (GVA per head). The East Midlands has the fourth highest percentage of low skilled people in its workforce, but other regions with lower proportions of low skills have lower productivity (e.g. Yorkshire & Humberside, North West, and North East) while others with lower shares of low skilled workers have higher regional productivity (e.g. South West, East of England, South East). London has the lowest proportion of its workforce with no qualifications within the UK and it also had the highest regional productivity yet inferring from this that decreasing the share of a region's workforce with low skills will inevitably result in greater productivity is not appropriate. As discussed earlier (Section 4.2) London's sectoral composition is markedly different from that of other regions. Even where other regions have similar proportions of low skilled workers, there is a considerable discrepancy in productivity levels. The proportion of low skilled workers in the South East is only 0.3 percentage point lower than in the North East yet productivity in the South East is more than 44 per cent higher than GVA per head in the North East. This illustrates

that it is not simply the relative shares of the workforce with various levels of skills that influences regional productivity.

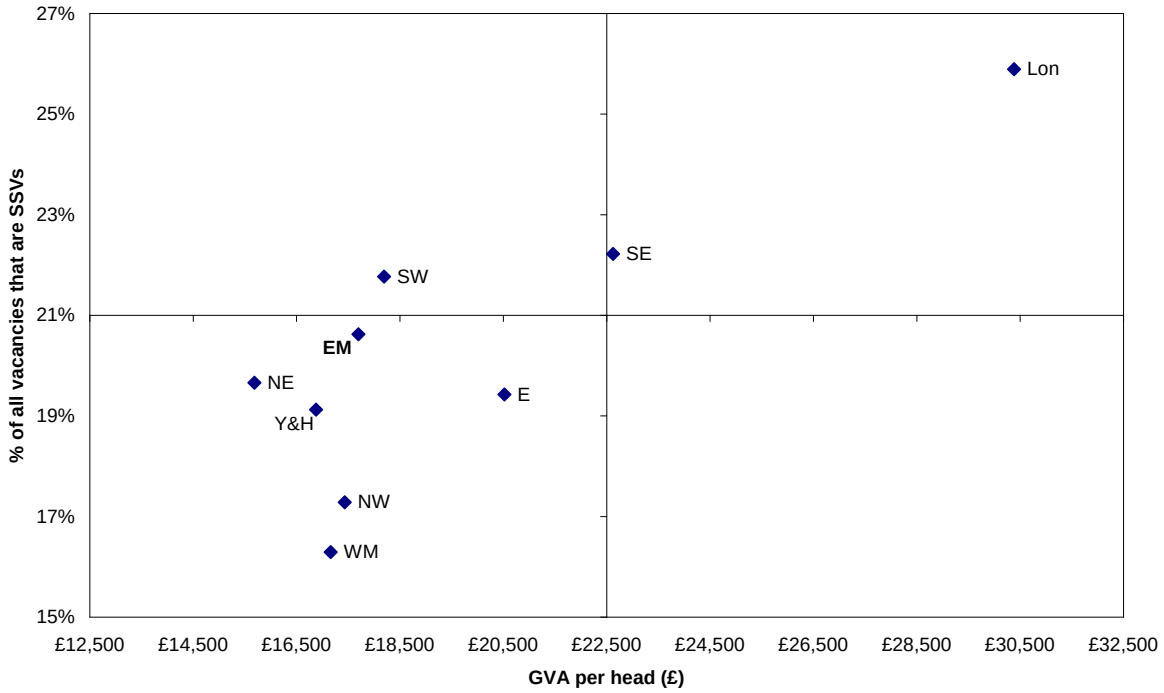
Figure 4.10: Share of workforce with no qualifications and productivity by region, 2007



Source: LFS Apr-Jun quarter 2007 and ONS Regional Accounts (NUTS1)

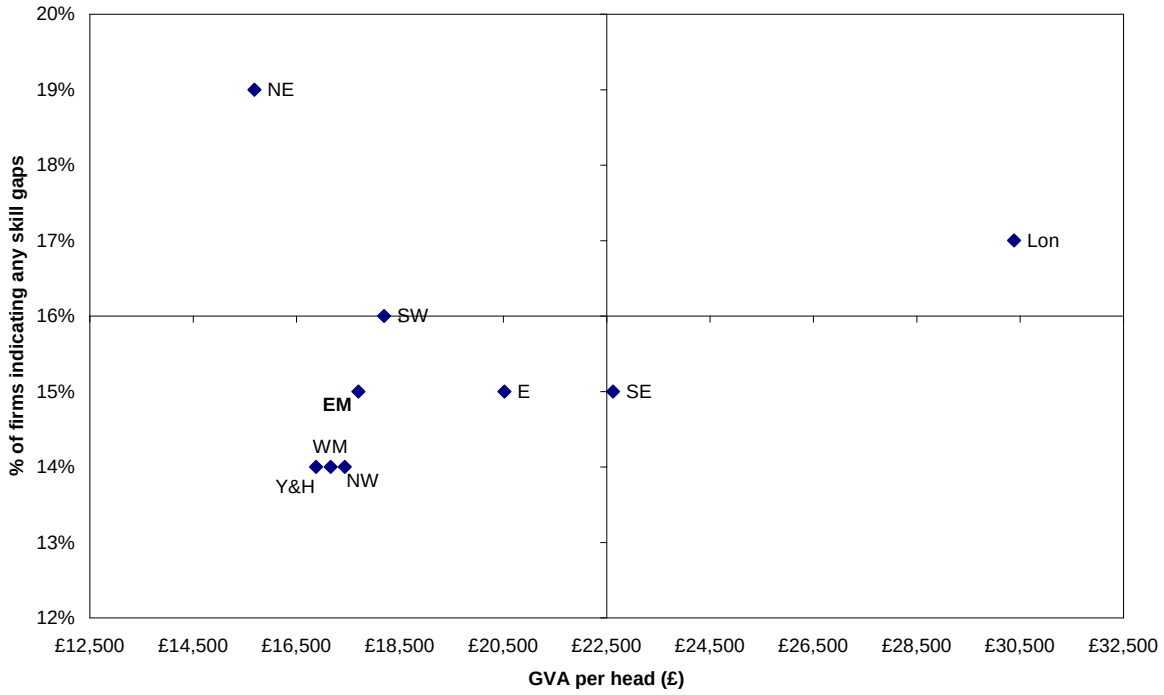
Skill shortages and skill gaps can constrain growth in an economy simply because the skills employers require are not available. Figure 4.11a shows the relationship between the percentage of employers reporting skill-shortage related vacancies (SSVs) – that is, they have problems recruiting people with the skills, qualifications or experience they require - and GVA per head in the regions. Figure 4.11b replicates 4.11a using skill gaps – the extent to which employers report that at least some of their employees lack full proficiency to carry out their current job – instead of SSVs. The data reveal that the best performing regions with respect to GVA – especially London – are more likely to report skill mismatches. The evidence indicates that high performance is likely to result in a degree of mismatch possibly resulting from the relative dynamism of high performing regions. This in turn suggests that skills supply needs to keep ahead of demand if growth is not be constrained by a shortage of skills.

Figure 4.11a: Relationship between skill shortage vacancies and GVA per head by region, 2007



Source: NESS 2007, ONS Regional Accounts (NUTS1)

Figure 4.11b: Relationship between skill gaps and GVA per head by region, 2007



Source: NESS 2007, ONS Regional Accounts (NUTS1)

4.4. Innovation

The UK Innovation Survey is a source of indicators regarding the nature of business activities related to innovation and the effects of product and process innovation on market position, internal processes and costs. The main indicator used in the survey is "innovation active" which is used to denote a business that has engaged in any of the following (DIUS, 2008):

- introduction of a new or significantly improved product (good or service) or process for making or supplying them;
- innovation projects not yet complete, or abandoned;
- expenditure in areas such as internal R&D, training, acquisition of external knowledge or machinery and equipment linked to innovation activities.

Table 4.3 summarises the main innovation indicators by region as observed in the UK Innovation Survey 2007. In the East Midlands 68 per cent of enterprises were considered 'innovation active' in 2007. This compares favourably to the UK average of 64 per cent (i.e. a 4 percentage point advantage). Of the innovation active firms in the East Midlands, 25 per cent were product innovators and 12 per cent were process innovators. The majority of innovation active firms were strategic innovators (31 per cent) as opposed to broader innovators (71 per cent).

Table 4.3: Main indicators of innovation by region, percentage of all enterprises, 2007[6]

	NE	NW	Y&H	**EM**	WM	E	Lon	SE	SW	Wales	Scot	NI	**UK**
Innovation active	61	67	65	**68**	64	69	55	64	66	65	63	57	64
of which													
Product innovator	22	23	20	**25**	24	27	20	23	25	21	20	20	22
Goods	15	15	13	**19**	17	18	11	14	14	14	12	13	14
Services	17	18	16	**18**	17	21	18	19	21	16	16	16	18
Process innovator	13	11	12	**12**	14	13	9	11	12	12	12	11	12
Ongoing or abandoned activities	8	10	8	**11**	12	13	10	11	11	8	7	6	10
Innovation related expenditure	52	58	57	**59**	54	61	46	56	56	54	54	47	55
Strategic innovator	33	30	30	**31**	29	36	30	34	31	28	30	25	31
Broader innovator	66	70	67	**71**	65	72	58	66	68	68	65	61	66
Either product or process innovator	25	25	25	**28**	28	30	22	26	27	24	23	22	26
Both product and process innovator	10	9	8	**9**	10	9	7	9	9	9	9	8	9

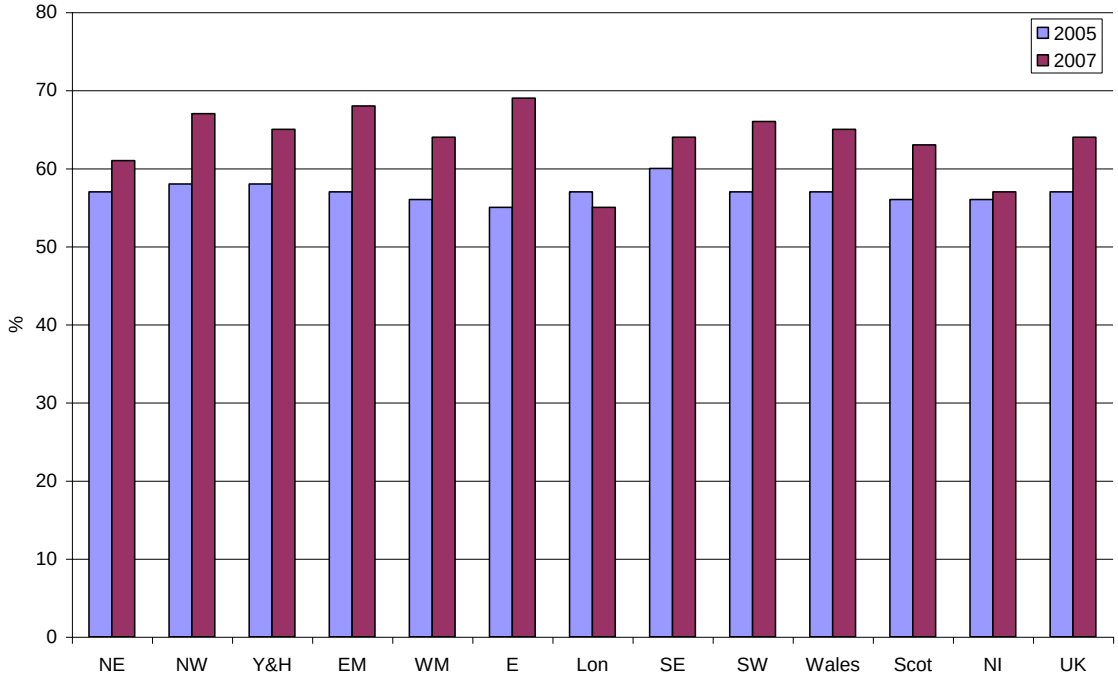
Source: DIUS (2008), Table 1.3, p. 13.

Figure 4.12 illustrates the percentage of firms indicating that they undertook innovation activity in 2005 and 2007 by region. The share of firms indicating such activity increased for all regions

[6] Descriptions of these various types of innovation activities may be found in the following text.

except London. The East Midlands showed a relatively large increase from 57 per cent in 2005 to 68 per cent in 2007 (i.e. by 11 percentage points compared to a 7 percentage-point increase in the UK). In 2007, the region had the second highest rate of innovation activity. The East of England had the highest rate – 69 per cent.

Figure 4.12: Innovation activity by region, 2005 and 2007 (%)



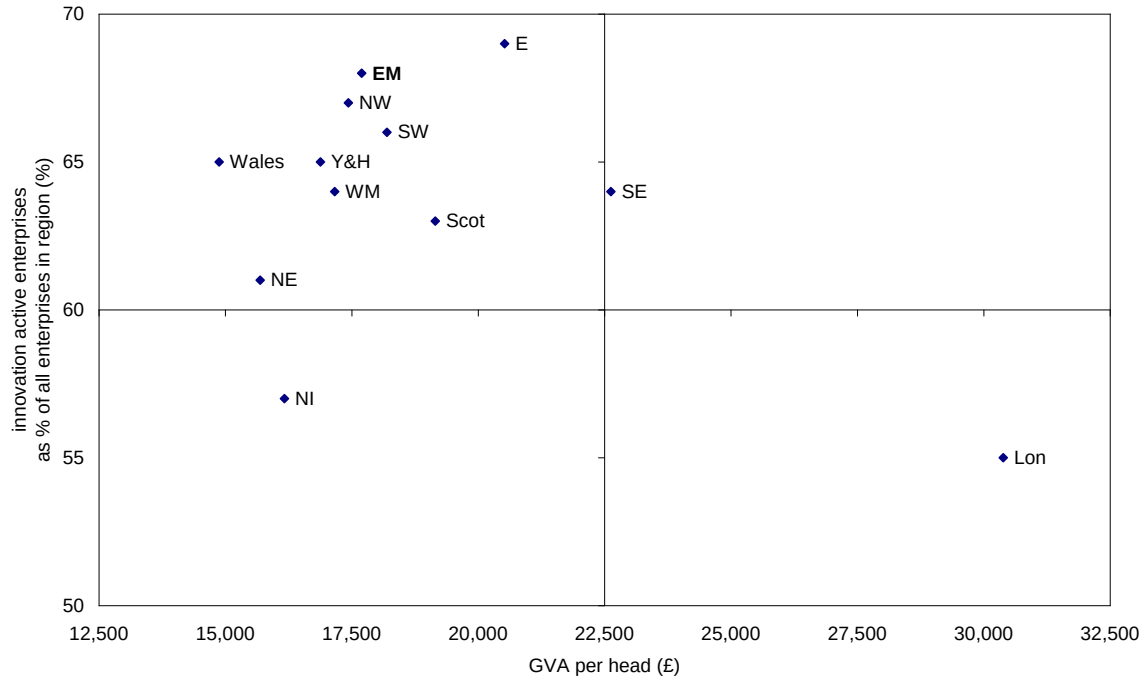
Source: Figure 2.3, p. 45, DIUS (2008)

Overall, based on the information obtained in the last two waves of the UK Innovation Survey, the East Midlands is found to be performing relatively well in terms of the share of enterprises that undertake at least some form of innovation activity. In comparison, London has relatively lower rates of innovation activity however, this region is much better off in terms of GVA per head. Figure 4.13 shows the innovation active rate of enterprises and GVA per head by region. From this figure, there is no clear relationship between the proportion of enterprises that are innovation active and productivity in the regions. In a number of cases, regions with lower innovation activity rates than the East Midlands have higher productivity (South West, Scotland, South East and London).

The absolute numbers and shares of businesses that undertake innovation activity is not necessarily ideal simply because it is high. The quality of innovation and the sectors in which innovation is taking place affects the impact that innovation has on firm performance, regional performance and regional GVA. Some sectors, particularly manufacturing, have long been

associated with higher degrees of innovation activity compared to other sectors such as the various service sectors. With its relatively high proportion of employment in manufacturing, the East Midlands overall rates of innovation may simply reflect the region's sectoral distribution.

Figure 4.13: Innovation active enterprises as percentage of all enterprises and GVA per head by region, 2007



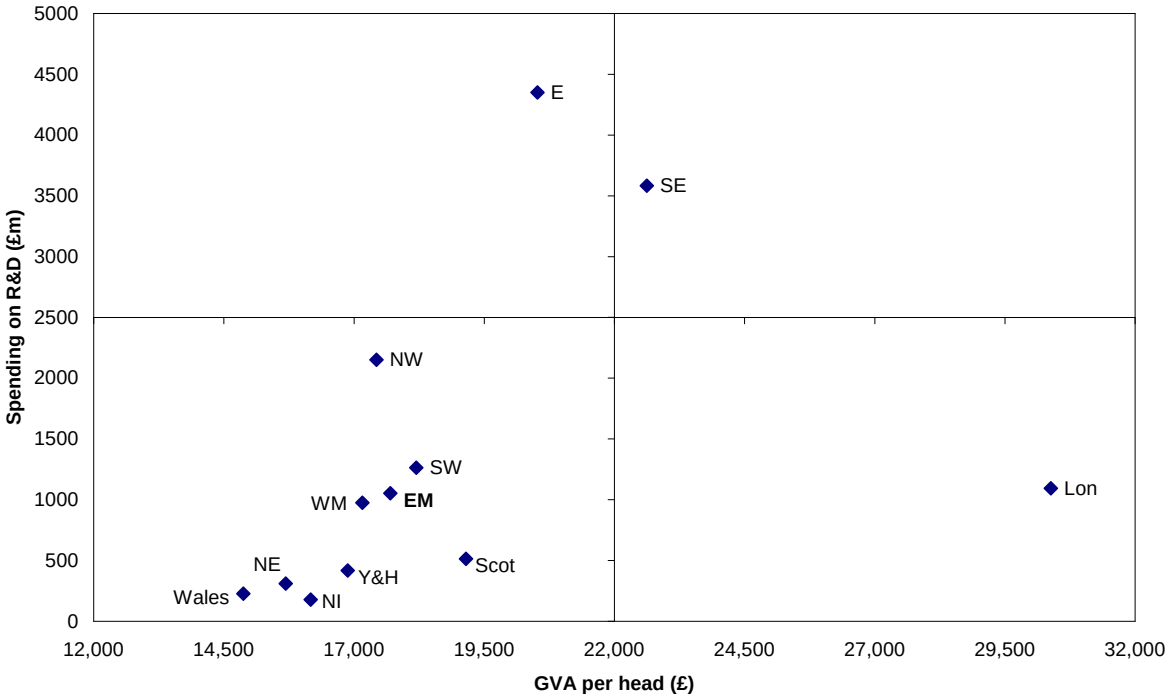
Source: DIUS (2008) and ONS Regional Accounts (NUTS1)

Research and development (R&D) activity and expenditure are also often used to indicate levels of innovation in businesses. Figure 4.14 shows ONS figures for enterprise spending on R&D and GVA per head by region in 2007. As with the measures of innovation, a definite direct relationship between productivity and the level of R&D spending is not evident. The East Midlands again appears near the middle of the distribution of regions according to both productivity and R&D spending. Regions with higher productivity than the East Midlands (South West, East of England, South East) also have higher levels of spending on R&D. London, with by far the highest level of GVA per head, had only £50 million more R&D spending by enterprises than the East Midlands. Enterprises in the North West, on the other hand, spent over £1 billion more on R&D than those in the East Midlands but the North West had lower productivity overall.

It may not be simply levels of R&D spending that may contribute to regional productivity performance. It is likely that there could be lagged effects of R&D spending on economic performance in a region as businesses need time to integrate innovations into their operations. It is important to understand how enterprises' expenditure on R&D activity is exploited by them

so that business opportunities arise and are translated into improved business performance and ultimately increased regional productivity.

Figure 4.14: Enterprise spending on R&D (£m) and GVA per head by region, 2007



Source: ONS dataset rdbd7, Breakdown of R&D performed within UK businesses by Government Office Region; ONS Regional Accounts (NUTS1)

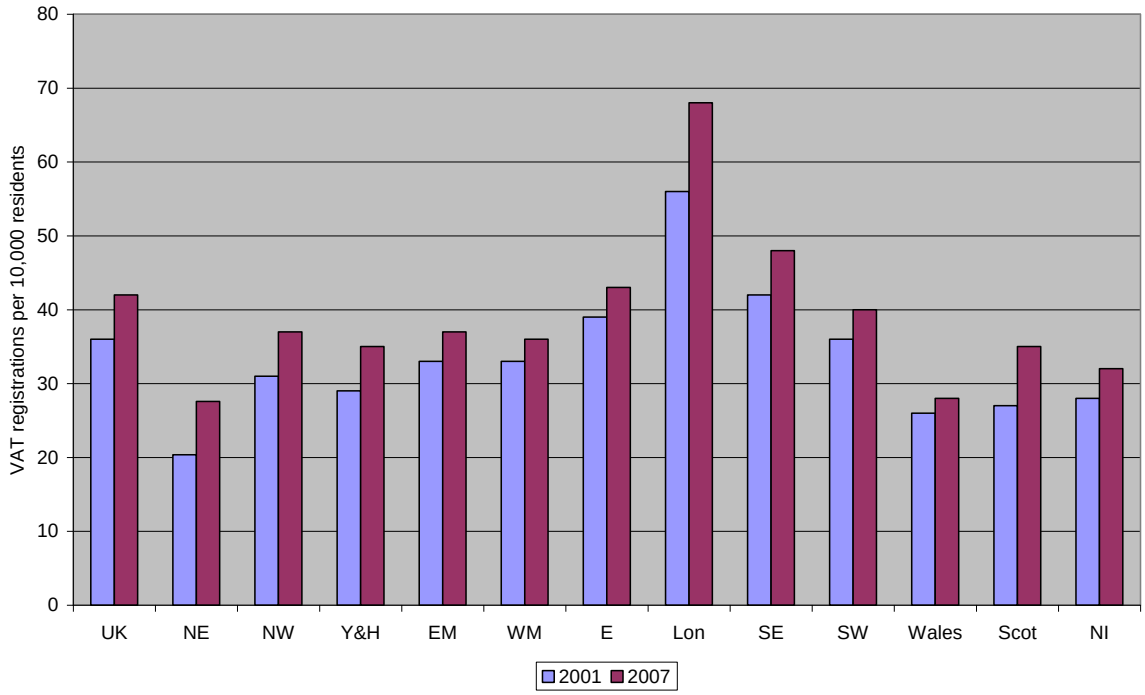
4.5. Entrepreneurial Activity

As has been discussed in Section 3.3 (which reviews the literature on the indirect linkages between productivity and skills), there is evidence that entrepreneurial activity has a positive effect on regional productivity. In the literature however, there are a number of caveats to such a finding. In particular, the literature emphasises that there are different types of entrepreneurial activity, some of which has positive effects on economic performance whilst other types have no impact or even negative effects. Distinguishing between 'good' and 'bad' entrepreneurial activity in regional level data is difficult due to limitations in the data availability. This section sets forth various indicators of regional entrepreneurial activity and looks at the association between these indicators and regional productivity.

Figure 4.15 shows the business start-up rates by region for 2001 and 2007. The business start-up rate is calculated as the number of VAT registrations per 10,000 residents. The start-up rate has increased in all regions of the UK between 2001 and 2007 (by 6 percentage points). The East Midlands has not performed too badly in terms of business start-ups relative to other parts of the UK (its start up rate has increased by 4 percentage points). In 2007, the East Midlands had

the fifth highest start-up rate (equal to that in the North West) with 37 VAT registrations per 10,000 residents compared to a national average of 42). The start-up rate was higher in London, the South East, East of England, and South West.

Figure 4.15: VAT registrations per 10,000 residents by region, 2001 and 2007.

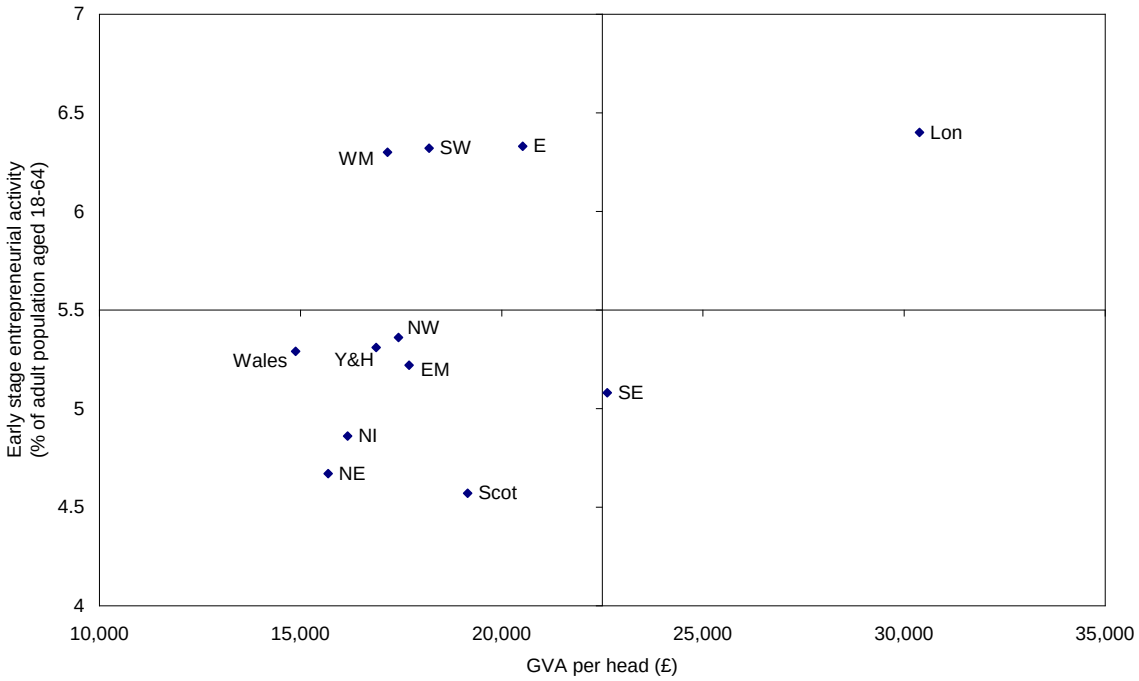


Source: BERR (2008) "Business Start-ups and Closures: VAT Registrations and De-registrations in 2007", Table 1-e.

Figure 4.16 shows the early stage entrepreneurial activity rate against GVA per head by region in 2007. In the East Midlands, 5.22 per cent of the adult population aged between 18 and 64 years were involved in early stage entrepreneurial activity[7] in 2007. This is higher than the activity rate in the North East, Northern Ireland, Scotland and the South East. Of those regions with lower rates of early entrepreneurial activity, only Scotland and the South East have higher regional productivity than the East Midlands. While early stage entrepreneurial activity is greater in Wales, Yorkshire and the Humber, the West Midlands and the North West, these regions have lower overall productivity than the East Midlands. London, with the highest GVA per head, had only marginally higher early stage entrepreneurial activity than the West Midlands, the South West, and the East of England.

[7] Total early stage entrepreneurial activity (TEA) is defined as the percentage of adults involved in a nascent firm, a new firm or both.

Figure 4.16: Early stage entrepreneurial activity and regional productivity, 2007



Source: Global Entrepreneurship Monitor (GEM) data and ONS Regional Accounts (NUTS1).

As with many of the variables considered above, qualifications, innovation activity, R&D expenditure, a direct relationship between the rate of entrepreneurial activity and overall productivity in a region is not entirely clear. The aspects of entrepreneurial activity that are likely to impact on firm and regional performance include a number of characteristics that are not easily measured such as entrepreneurial attitudes held by management and workers within organisations, the quality of entrepreneurial activity and business start-ups, and the surrounding enterprising culture and infrastructure. These factors influence the rate of business activity as well as the success of business which feed into the overall productivity performance of regions.

4.6. Conclusion

Through the above data analysis, one main message is apparent – the influence of skills, innovation and enterprise on regional productivity is not straightforward. Associations between these three drivers of productivity and regional performance are observed in some cases but it is obvious that there are more complex relationships driving the interaction between these factors and productivity. All three factors have impacts on each of the others and upon productivity. There are also other factors and characteristics of the workforce, businesses, management and the region that must be taken into account to tease out any true relationships between productivity, skills, enterprise and innovation. More complete data relating to these factors and other control factors would be necessary in order to estimate the magnitude and causal

directions between productivity and these many other drivers. That said, a number of conclusions emerge from the review of the statistics which are summarised in the box below.

SUMMARY – Data analysis for the East Midlands

- Between 1991 and 2007 the GVA per head index in the East Midlands has fallen relative to the UK average and in 2006-7 GVA growth was slightly less than the UK average.

- In considering some of the main indicators of skill, innovation, enterprise and productivity, the East Midlands is found to be similar to a number of other regions in the UK (outside London). London is distinctive on several of the indicators – notably in relation to skills and productivity – and this skews the UK average picture.

- However, in sectoral terms the East Midlands is distinctive in having a greater than average share of total employment in manufacturing. This may be one factor accounting for the region's relatively favourable performance on several innovation activity indicators.

- The East Midlands has shared in the main trends characterising the changing skills structure of the workforce (as proxied by qualifications) in recent years – notably the increasing share of the workforce with high level skills and the decreasing share with no qualifications.

- Although the East Midlands has a relatively small share of its workforce with high level skills (vis-à-vis other UK regions), this is not directly reflected in proportionately lower productivity than in some other regions. This indicates that it is not simply the relative shares of the workforce with various levels of skills that influence productivity.

- While the data analysis reveals some small direct associations between skills, innovation and enterprise, there are many exceptions. Overall, the data analysis highlights the complexity of the relationships between skills, innovation, enterprise and productivity and emphasises that other factors must be considered when trying to estimate the magnitude and causal direction between these factors and productivity. Inferring causal relationships between any of the drivers and productivity without accounting for the other drivers and other factors such as management, regional characteristics, sectoral distribution, and firm level activity, is inappropriate and likely to lead to ineffective policy action aimed at increasing productivity

5. CONCLUSION

In general the evidence suggests that skill levels are related to productivity: more highly skilled people produce more high value goods and services more efficiently. But there are substantial gaps in the evidence base:

i. it is difficult to establish a causal relationship between skills and productivity in part because of an absence of longitudinal data but also because of the problem of endogeneity. It is not known, for instance, whether some workplaces are just intrinsically more productive than others rather than the fact they have a relatively high skilled workforce;

ii. even where it is possible to establish a relationship between skills and productivity it is not always clear what skills result in an increase in productivity. In this sense, skills are often treated as a black box.

In looking beyond the econometric evidence it is possible to take a more holistic approach to understanding the relationship between skills and productivity and from this highlight the implications of this for the East Midlands.

Often there is at least an implicit assumption that employment in a given area needs to move into higher value activities and in doing so make a break with the existing trajectory of the labour market. More convincingly, there are arguments for ensuring that the economy has a suitable supply of skills which will sustain its existing industrial and employment base over the medium to long term.

Over time all sectors in the economy are subject to change resulting from a need to improve competitiveness which manifests itself in mergers and takeovers, organisational change, change in production processes, development of new products, *etc.* The impact of these on employment and skills is uncertain, hence the importance of building 'adaptive capability' (Martin, 2005) – in the skills base and amongst employers and labour market institutions - to deal with change. If, in aggregate, the economy successfully introduces these changes then there may well be positive spillovers which results in higher levels of employment and skills than would otherwise occur. The evidence in relation to the East Midlands suggests that it has been successful in keeping pace with these changes insofar as productivity and employment have increased over the recent past in line with the situation nationally. It is important to be cognisant of the region's performance to date and its performance relative to other regions in designing policies aimed at improving productivity in the East Midlands.

In assessing how skills can be used to foster further productivity gains in the East Midlands it needs to be borne in mind that skills are a derived demand stemming from, amongst other things, the entrepreneurial and innovative actions of economic agents in the region (employers,

individuals, and governmental agencies). As summarised in Figure 3.1, the key drivers explored here, skills, enterprise and innovation, have both direct and indirect implications for regional (and firm) productivity. Improvements in each of these drivers at the firm-level may enhance firm performance and thus ultimately result in greater regional productivity. These drivers and others also interact and influence the impact of each on productivity. Other factors also affect the impact of skills, innovation and enterprise on productivity. It is important to consider too the effects of externalities at the regional level.

The evidence presented in this report clearly points to productivity gains being dependent upon:

- **management capability:** constructing an appropriate product market strategy, being able to identify skill needs to support that strategy, sourcing skills, and ensuring they are effectively deployed;
- **innovation:** creating an environment where new ideas – no matter how big or small – can flourish and stand a realistic chance of being acted upon;
- **entrepreneurship:** being able to construct an appropriate business plan to exploit economically valuable ideas, and being able to deliver to that plan.

As this report has shown, all three are inter-related and all have a skill dimension attached to them. The East Midlands data indicate that the region fares relatively well compared to other regions in England in terms of innovation and entrepreneurial activity. Raising productivity levels further or increasing the rate of productivity growth in the region will be dependent upon tackling management capability, innovation, and entrepreneurship simultaneously as a set of inter-dependent issues. At the same time, as suggested in the evidence and highlighted in the data analysis, other factors, including sectoral distribution, firm level activity and other regional characteristics, must also be considered. Thus, there appears to be a need for integrated delivery of policies, rather than initiatives that tackle one particular issue in isolation. The esp can play an important role here in working to achieve a joined-up approach.

HM Treasury (2001) are of the view that differences in economic performance across the regions should in part be addressed through regional and sub-regional economic policy. This policy needs to be based on 'building on the indigenous strengths in each locality, region and country.' HM Treasury recommended that the best approach to achieving success would be taken from within the regions themselves and that the Government should work to enable regional and local initiatives to succeed. The evidence presented in this report suggests that policies need to be sensitive to particular sectoral and local circumstances. There is a role here for *emda* to take a medium- and longer-term strategic role, helping local authorities and SSCs to work together.

Some of the key policy issues to be considered for the East Midlands include:

i. skill supply needs to be targeted at ensuring the region has the skills to meet current and future skill needs otherwise, from a regional perspective, there may well be a wasted effort if skills are then exported to other regions and the individuals do not return to the region later to utilise the skills that they initially acquired in the region and further developed elsewhere;

ii. establishing current and future demand needs to based, at least in the first instance, upon identifying what needs to be done to sustain the existing industrial base into the future such that it maintains employment and productivity growth at least equal to the national average;

iii. identifying current and future demand is not without difficulty especially where employers are overly focussed on current needs such that they run the danger of being insufficiently prepared to meet the changes necessary to sustain their current product market position in the future;

iv. sustainability relates to ensuring that human resource policies within firms are aligned or integrated into their wider product market strategies to ensure that skills and the effective utilisation of those skills is not relegated to a secondary or tertiary activity within organisations;

v. previous evidence suggests that some employers will not be adequately prepared to meet the demands which will be made of them in the future. It is in the field of management capability, and the related areas of entrepreneurship and innovation, that assistance may be required. There are various ways of achieving this, such as increasing the possibility for positive knowledge spillovers to exist in the region, possibly through networks of firms or other avenues. Knowledge spillovers are more likely to occur in some sub-regions than others (e.g. in the three cities as opposed to peripheral rural areas). These sub-regional differences need to be addressed;

vi. policy interventions needs to be tailored to sectoral and sub-regional circumstances;

vii. moving the region towards a high wage, high skill economy comparable to the best performing areas in Europe can be facilitated by foreign direct investment, but may be more likely and sustainable if developed out of the existing industrial base. It is for this reason, amongst others, that improving the management capability is a key goal.

The above points are predicated upon developing a skills policy for the East Midlands that meets current demand, and ensuring that the demand is sustainable over the long term. While policy

statements point to the existence of a low-skills equilibrium in the region – and this may be more the case in some sub-regions than others – the economic indicators provided in Section 4 suggest that relative to the UK as a whole and the other regions in England except for London and the South East, the region's performance is at worst, in many cases, about average. This suggests that, in aggregate, the existing regional economy is not badly placed to take advantage of opportunities that are likely to arise in the future.

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