Defining the knowledge economy

the work foundation

Knowledge economy programme report

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Contents

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Section 1
Defining the knowledge economy

"The weakness or even complete absence, of definition, is actually pervasive in the literature… this is one of the many imprecisions that make the notion of "knowledge economy" so rhetorical rather than analytically useful" (Keith Smith, *What is the Knowledge Economy? Knowledge Intensity and Distributed Knowledge Bases*, Institute for New Technologies Discussion Paper 2002-6, The United Nations University, June 2002).

The purpose of this paper is to fill part of the gap identified in the quote above. The main aim is to explore testable definitions. In other words, do they allow us to measure in a robust way through national and international statistical and survey data the knowledge economy, the knowledge workforce and the knowledge-based firm?

This in turn allows us to answer key questions, such as: how big is the knowledge economy; where and how fast is it growing; what are the practical and policy implications for firms and government. It will allow us to test out some of the claims made for the knowledge economy, for example, that investment in knowledge is overtaking investment in physical capital.

Definition has not been a prominent feature of the debate and the author of the quote above also fails to help the debate on very far by offering a more precise definition of either the knowledge economy or a knowledge worker. Part of the problem is that some of the underlying concepts are inherently difficult to pin down. As one report concluded: *"the science of describing, understanding, and measuring knowledge will always be an imperfect one. The knowledge identified in this forum turned out to be capricious: sometimes sticky, often slippery, rarely tangible, frequently tacit, and extremely heterogeneous"* (report of CERI Washington Forum, June 1999).

As a result, the terms knowledge economy and knowledge worker are often taken as self-evident and in some cases are not tested against hard data.

A number of general definitions of the knowledge economy are set out below. Put more prosaically, we can say the knowledge economy is what you get when firms bring together powerful computers and well-educated minds to create wealth.

Definitions of the knowledge economy

"the role of knowledge (as compared with natural resources, physical capital and low skill labour has taken on greater importance.

Defining the knowledge economy

Although the pace may differ all OECD economies are moving towards a knowledge-based economy" (OECD 1996)

"… one in which the generation and exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the most effective use and exploitation of all types of knowledge in all manner of economic activity" (DTI Competitiveness White Paper 1998).

"the idea of the knowledge driven economy is not just a description of high tech industries. It describes a set of new sources of competitive advantage which can apply to all sectors, all companies and all regions, from agriculture and retailing to software and biotechnology" (*New measures for the New Economy*, report by Charles Leadbeater, June 1999).

" economic success is increasingly based on upon the effective utilisation of intangible assets such as knowledge, skills and innovative potential as the key resource for competitive advantage. The term "knowledge economy" is used to describe this emerging economic structure" (ESRC, 2005).

"the knowledge society is a larger concept that just an increased commitment to R&D. It covers every aspect of the contemporary economy where knowledge is at the heart of value added – from high tech manufacturing and ICTs through knowledge intensive services to the overtly creative industries such as media and architecture" (Kok Report, 2004)

Is the knowledge economy a new or "weightless" economy?

Some have argued that the emergence of a knowledge-based economy is a major departure, a "new economy" offering endless productivity gains, faster non-inflationary growth- and ever-rising stock markets. It was argued that the ICT revolution allowed firms to exploit scientific and technical knowledge bases to give them an unprecedented competitive edge with, for example, constantly falling transaction and processing costs. In turn the new knowledge economy would give rise to new organisational forms within and between companies and a radical shake-up in employment relationships as more and more knowledge workers became portfolio workers, freelancers, or self-employed.

This view took a blow with the dot-com crash and the failure of the predicted changes in employment relationships to emerge (the number of workers with more than one job, for example, has been

falling). Indeed, the term new economy has dropped out of fashionable usage.

In partial reaction to the hype, an opposite view has emerged questioning whether a knowledge economy really exists at all. It is argued that the economy has always been driven by knowledge leading to innovation and technical change and knowledge-based institutions have helped store and share knowledge for centuries. What we see today is essentially more of the same but operating on a bigger scale and at a faster pace.

The truth lies somewhere between the two. David and Foray in a paper published in 2002 describe the move to a knowledge or knowledge based economy as a sea change or "soft discontinuity" rather than a sharp break from the past.

Knowledge as an economic good

The ability to store, share, and analysis knowledge through networks and communities using the new ICT technologies allows firms to exploit the unique properties of knowledge to gain competitive advantage. Perhaps the most important property is that knowledge is the ultimate economic renewable - the stock of knowledge is not depleted by use. Indeed, the value of knowledge to an economy comes from sharing with others.

Firms also obtain value from sharing knowledge internally and in some circumstances by sharing with suppliers and customers. But they may try to restrict external sharing if that might benefit potential competitors. Hence the difficult balancing act policy makers have in ensuring intellectual property rights are sufficiently strong to provide an incentive for firms to invest in innovative products and processes and yet not so strong they unduly inhibit the diffusion of knowledge.

A distinction is often made between codified or rule based knowledge that can be written down and stored and tacit knowledge that is acquired on the job and resides with the individual as know-how and experience. Some argue that one

of the key distinguishing features of the knowledge economy is deploying new technologies to allow the more systematic exploitation of tacit knowledge. The latter can of course walk out of the door - and firms may make strenuous efforts to retain key workers or impose restrictive clauses in their employment contracts about future employment.

However, despite all these efforts by firms to retain knowledge, knowledge is essentially a public good because knowledge leaks - it is very difficult for a firm to retain knowledge just for their own advantage for any length of time.

As we show below, advanced industrial economies around the globe are steadily moving to the unprecedented position where knowledge based industries and knowledge based organisations will within the foreseeable future generate more than half of total GDP and total employment. They have the most well educated workforces in economic history – and in the foreseeable future quite possibly the majority of the population will have degrees or the equivalent. However, this raises a difficult question – if the knowledge economy is as economically significant as we think it is why have we seen so little impact on underlying growth and productivity performance.

Why do we see the knowledge economy everywhere except in the productivity figures?

Growth theories assign a central place to innovation and skills but with the partial exception of the US, there is little sign of an ICT driven improvement in underlying productivity and growth performance. Given the trends described above, we could revive the Solow paradox by saying we can see the knowledge economy everywhere except in the growth and productivity numbers.

This is not the place to try and resolve the paradox or why the US experience appears to be different to most of the rest of the OECD. We can suggest that while investment in knowledge is necessary it is not sufficient. Hence, increased interest by policy makers in the role of institutional frameworks set by product market regulation, including competition regimes and the right balance in intellectual property rights and the influence of intermediary institutions in promoting science-industry links and improving organisational innovation and management quality.

It may also be that the links between innovation, competitiveness and conventional productivity measures are not well understood in services and even less so in knowledge based services. It is certainly puzzling why a significant part of the UK's productivity gap appears to be accounted for by marketed services, yet highly efficient firms dominate and the UK is a world leader in international trade in services.

We intend to address both of these fundamental questions in the Work Foundation's Knowledge economy programme projects.

A further and more prosaic explanation is that despite public acknowledgement of the importance of knowledge investment relatively few OECD economies have significantly increased their investment in knowledge intangibles over the past decade. The evidence is set out below. Some aspects of such investment - such as investment in R&D - have been identified by the Kok Report and others as a key failing of the Lisbon growth strategy. Given that such investments often have long pay-back times, it may not be too surprising that we have struggled to see much impact on overall economic performance to date.

Investing in knowledge

The OECD has produced a composite indicator of "investment in knowledge" made up of investment in R&D, investment in higher education, and investment in IT software. By this input measure, we can identify three groups of economies:

- High knowledge investment economies of North America, OECD Asia and Japan, investing around 6 per cent of GDP
- Middle knowledge investment economies of Northern Europe and Australia, investing between 3 and 4 per cent of GDP
- Low investment economies of Southern Europe, investing between 2 and 3 per cent. of GDP.

The story of the past decade has been for most of the high investment economies to pull away from the rest. Most high investment economies stepped up their knowledge investment by between 1 and 2 percentage points of GDP while the middle and low investment economies showed relatively little change.

The UK for example increased the share of investment in knowledge by just 0.2 percentage points and Germany and France by 0.3 percentage points respectively

between 1994 and 2002. In contrast, Sweden increased investment in knowledge by 1.7 percentage points, the United States by 1.4 percentage points and Japan by 1.1 percentage points. In 2002 the UK ranked joint 12th out of the 20 OECD economies for which comparable estimates are available, alongside France and just behind Germany.

These figures do not support the claim that investment in knowledge - as defined by the OECD - has outstripped investment in physical capital. Business investment as a share of GDP exceeds investment in knowledge as defined by the OECD by a significant degree even in the high knowledge investment economies.

Moreover, while it may be true that investment in knowledge is growing faster than investment in physical infrastructure in some OECD economies, it is not self-evident this is happening in most economies. In the UK the reverse may be happening as catch-up investment in the physical infrastructure increases as a share of GDP. Investment in knowledge can reasonably claim to be more important in driving innovation, but it has yet to supplant other forms of physical investment as a share of national income.

Investment in knowledge across the OECD in 2002

High investment economies	1994	2002	% point change
Sweden	5.1%	6.8%	+ 1.7
United States	5.4%	6.6%	+ 1.2
Finland	4.7%	6.1%	+ 1.4
Korea	4.9%	5.9%	+ 1.0
Denmark	3.7%	5.5%	+ 1.8
Japan	3.9%	5.0%	+ 1.1
Canada	4.5%	4.7%	+ 0.2
Middle investment economies			
Australia	3.9%	4.1%	+ 0.2
Germany	3.4%	3.9%	+ 0.5
Belgium	3.6%	3.8%	+ 0.2
Netherlands	3.4%	3.8%	+ 0.4
France	3.4%	3.7%	+ 0.3
UK	3.5%	3.7%	+ 0.2
Austria	2.3%	3.4%	+ 1.1
Middle investment			
Spain	2.1%	2.8%	+ 0.7
New Zealand	—	2.8%	—
Ireland	2.6%	2.4%	– 0.2
Italy	2.0%	2.4%	+ 0.4
Greece	1.1%	1.9%	+ 0.8
Portugal	1.3%	1.8%	+ 0.5

Note: categories of high, middle and low investment economies are Work Foundation. Belgium is 1999; Korea is 1995; Greece and Italy are 2001.
Source: OECD Factbook 2006, p 131.

Globalisation and the knowledge economy

The development of the knowledge economy and globalisation has been seen as closely related. Global firms have built integrated international production chains, with innovation (for example, R&D facilities) in the US and Europe creating new products that are built in assembly plants in China and shipped back to the West for added value in "knowledge" areas such as design and marketing and providing associated services in Europe and the US. Some basic processing services have been offshored, such as data processing, transcription services and simple consumer services delivered through call centres.

The growth of the knowledge economy is seen as part of the strategic response to the threat to UK jobs of imports from low wage economies and, rather confusingly, also as a necessary response to low wage economies such as China and India investing heavily in knowledge, defined both as the share of GDP devoted to R&D and increasing the numbers of home grown graduates. The implication is that through these investments in knowledge the lower wage economies will capture a much larger share of the "knowledge based" segments of the international production chain in the future unless the Western economies become even more competitive in these areas.

Globalisation is seen as a key driver and determinant of change across the OECD and it would be foolish to deny the importance of the dramatic increase in international trade and investment flows over the past decade. However, globalisation is only one of several influences on economic development and industrial structure in the UK and may not quite deserve the central role that some commentators and policy makers have assumed for the following reasons:

- International trade has not increased as a share of GDP for the UK over the past 20 years and the vast majority of our trade is with other rich OECD economies
- The share of jobs in sectors directly exposed to international competition has gone down rather than up
- Imports from Asia have not greatly increased, as the rises in imports from China have been almost offset by falling imports from Japan as Japanese producers shift production to low wage China

- Despite offshoring of services being widely reported across many industries, we can see little sign of it in the labour market or trade figures: for example, employment in UK based callcentres has gone up rather than down in recent years
- The alleged hollowing out of the labour market with the loss of manufacturing jobs is not primarily a globalisation story, as only between 10 and 20 per cent of jobs lost can be attributed to trade with low wage economies[1].

We therefore see the knowledge economy driven primarily by technological advance and rising domestic prosperity increasing the demand for knowledge based services.

Global competitive pressures are of course important, and overall, the knowledge economy may be increasingly engaged in the global economy for the following reasons:

- The stock of ideas and knowledge is a global stock that firms and organisations can access from around the world via the Internet: globally engaged firms use more knowledge and have access to a wider stock of knowledge through their suppliers and customers
- Global labour markets may be emerging for knowledge workers, with world-class universities competing for the best and brightest. Some argue that knowledge economy firms in the future will increasing turn to Asia for "cheap smarts" rather than rely exclusively on home produced talent
- National measures of R&D effort may be increasing misleading as a guide to overall R&D intensity and as a proxy for innovation: for example, UK firms appear to commission a significant part of their R&D in the US. There are also significant "spill-over" economic benefits from technology transferred from overseas R&D via multi-national FDI into the UK.

The latter may be part of the explanation for why business investment in R&D in the UK as a share of GDP has been slow to respond to the more favourable economic background, new financial incentives and more supportive institutional structures. The OECD has in the past developed measures of total technology intensities that take account of bought in knowledge that suggests the gap between world leaders such as the US, Japan, and Germany and other European economies such

[1] Rowthorn, R.E. and Ramaswamy, R. (1998), "Growth, Trade and De-industrialisation", *IMF Working Paper* WP/98/60

as the UK, France, and the Netherlands is significantly less than if simple R&D intensities are used. This gap may have become more significant as the role of FDI in high and medium tech industries has increased in economies such as the UK and the importance of US markets has been seen as increasingly important for some lead UK based companies in sectors such as aerospace.

The knowledge economy is also emerging as a key driver of the restructuring of international trade in some advanced economies towards high value added services. Over the past decade we have seen a boom in UK exports of services associated with the knowledge economy such as financial services, computer services, business services, and royalties and licence fees.

Between 1995 and 2005 exports of these services grew by over 100 per cent in current terms compared with just over 50 per cent for more traditional service exports such as transport and travel. By 2005 such exports accounted for nearly 70 per cent of total service exports compared with just over 50 per cent in 1995. In current terms, knowledge based service exports were worth £76 billion in 2005.

The figures are set out in the table below. As part of the follow up we will be looking at how far the same pattern is seen in other OECD economies. However, it appears that the UK is well placed to take advantage of rising world demand for such services compared with some other economies. The UK certainly makes a disproportionate contribution to the relative success of European economies in world markets in services.

Uk exports of knowledge based services 1995-2005

Exports £ billions	1995	2005
Business services	10.9	30.7
Financial services	8.6	24.8
Computer services	0.8	5.8
Communications	1.0	3.0
Cultural/media	0.7	2.0
Government	1.4	2.0
Royalties/licences	3.9	7.3
Knowledge services	27.3	75.6
Non knowledge services	23.3	35.5
Total services	50.6	111.1

Note: all figures current prices, balance of payments basis. Totals may not sum due to rounding.
Source: Office for National Statistics

Defining the knowledge economy

Why we need to define and measure the knowledge economy

Some might argue that the knowledge economy is so clearly self-evident that a more precise definition is unnecessary and that knowledge is such a difficult concept to pin down that any measures are bound to be unsatisfactory or even misleading.

However, without measurable definitions, the knowledge economy will remain a vague concept. The impact of the knowledge economy on industrial organisation, institutional structures, employment and society would remain more a matter of assertion and intuition rather than demonstrable proof based on hard facts. It would not be possible to answer basic questions about how big the knowledge economy really is, how many people work in it whether it is growing and at what rate, and how the UK compares with similar OECD economies. And it would be hard if not impossible to offer a set of practical evidence based policy recommendations to policy makers in both the corporate and public sector.

However, developing better definitions of the knowledge economy will be challenging. As the remainder of this paper shows, none of the definitions and measures that have been used so far is completely satisfactory. As the programme proceeds we will need to start to break new ground in moving beyond the current statistical constraints.

Section 2
Measuring the knowledge economy

If the term knowledge economy is to be useful we need to identify distinctive features that we would not expect to find – or at least not in such abundance - in the rest of the economy. A clear distinctive feature is the central role of the use of new information and technologies in allowing knowledge and information to be used in ways that underpin the knowledge economy concept. The rapid fall in price and vast increase in computing power has been a key underlying driver in creating networked systems able to store, analyse and handle knowledge and information flows.

We can summarise the key features of knowledge economy and knowledge economy organisations as follows:

- The knowledge economy represents a "soft discontinuity" from the past – it is not a "new" economy operating to a new set of economic laws
- The knowledge economy is present in all sectors of the economy, not just the knowledge intensive industries
- The knowledge economy has a high and growing intensity of ICT usage by well-educated knowledge workers
- A growing share of GDP devoted to knowledge intangibles compared with physical capital
- The knowledge economy consists of innovating organisations using new technologies to introduce process, organisational and presentational innovation
- Knowledge economy organisations reorganise work to allow them to handle, store and share information through knowledge management practices.

In the rest of this section below we look at three ways in which the knowledge economy might be defined more precisely in ways that are measurable and therefore, in principle, testable against hard data:

- Industry sector definitions of knowledge intensive industries and services
- Occupational based definitions of knowledge workers
- Innovation related definitions of the share of innovating firms.

Knowledge intensive sectors

The knowledge economy is often thought of and sometimes defined in terms of knowledge intensive industries based ICT production or usage and/or high shares of highly educated labour. Industrial definitions initially focused on manufacturing and often used R&D intensity as an indicator to distinguish between high, medium and low-tech sectors. The definition has steadily expanded to include service industries that invest little in R&D but are intensive **users** of ICT technologies and/or have a highly skilled workforce using the benefits from technological innovation.

The OECD identifies high and medium tech manufacturing; high value added "knowledge intensive" market service industries such as finance and insurance and telecommunications; and business services. The current OECD definition also includes education and health. The Work Foundation has extended this definition in the recent *Ideopolis* report to capture a higher share of employment in the cultural and creative industries.

Industry based definitions and measures have the important virtue of allowing international comparisons (although the OECD based definitions are quite broad) and can be used below national level in the UK. However, trying to define the knowledge based economy in terms of knowledge intensive and less intensive industries also has disadvantages. The fundamental point is that the knowledge economy phenomenon applies across all sectors. So while we can say that the knowledge intensive industries are an important part of the knowledge economy, the knowledge economy is not limited to knowledge intensive industrial sectors.

Standard definitions of the knowledge economy based on knowledge intensive industries will not include the retail sector. However, retail is a big user of ICT and a significant part of the improvement in US productivity over the past decade has come from ICT-driven improvements in the US retail sectors. And a recent OECD case study of large global retail firms concluded that the key reasons for their success was the combination of high performance workplace practice and the intelligent use of ICT[2]. Other high investment and high value added sectors such as energy supply could also make a good case to be included within the knowledge intensive industries.

Such definitions may not fully capture the emergence of significant new sources of

[2] *Case Studies of Successful Companies in the Services Sector and Lessons for Public Policy*, STI Working Paper 2005/7, OECD.

output and job growth such as the cultural and creative industries as defined by the DCMS. For example, software design, computer gaming and electronic publishing has increased from 1.8 per cent of Gross Value Added (GVA) in 1997 to 2.8 per cent in 2003, an annual growth rate of 11 per cent, with employment growing by around 8 per cent per annum in the period 1997 to 2004 to reach over 590,000[3]. These activities alone account for almost all the relative expansion in the creative industries in this period.

Innovative firms in sectors regarded as relatively low tech are just as much part of the knowledge economy as the more R&D intensive sectors, according to a paper prepared for the European Commission. Such firms are *"intensive creators and users of practical knowledge and high grade design skills. They use engineering and scientific knowledge and are closely integrated with the science and technology infrastructure. The mere fact that they do not do much internal R&D says nothing about knowledge intensity or their contribution to the knowledge economy."*[4]

Examples of "low tech" industries include furniture, a sector where employment has held up well across Europe despite competition from low wage economies. But it could also embrace those parts of the textiles industry in higher quality niche markets associated with fast changing fashion or at the high-tech end with, for example, the development of industrial textiles for the car industry.

If we apply the extended OECD/WF definition to the UK economy today, we find that about 40 per cent of GDP is accounted for by knowledge-based industries using UK national data.

The OECD wide definition of knowledge based industries (high to medium tech manufacturing, finance, business services, telecommunications, education, health) indicates that Ireland was the most knowledge based economy in the OECD, with these industries accounting for 48 per cent of GDP followed by the US, Germany, and Sweden with around 43 per cent. The knowledge based industries accounted for around 40 per cent of GDP in the UK and France. Estimates for Japan are only available on the more restricted market based industry definition, excluding health and education. However, on this basis Japan has a less knowledge based industrial structure than Germany, the US, the UK or France.

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[3] Creative Industries Economic Estimates Statistical Bulletin, DCMS October 2005
[4] *Low Tech Industries and the Knowledge Economy,* Hirsch-Kriensen et al, EU PILOT project August 2003.

Knowledge based industries as share of gross value added 2002

	Market based		All sectors
Ireland	37.7%	Ireland	47.8%
Germany	32.1%	United States	43.1%
United States	30.5%	Germany	42.8%
Korea	31.2%	Sweden	42.1%
UK	28.7%	Belgium	41.6%
Belgium	28.1%	UK	40.7%
France	28.0%	France	39.8%
Netherlands	26.2%	Korea	39.5%
Sweden	26.1%	Netherlands	38.9%
Hungary	26.0%	Denmark	37.4%
Japan	25.6%	Finland	37.3%
Australia	25.4%	Australia	36.7%
Italy	24.8%	Hungary	36.3%
Austria	24.3%	Canada	34.7%
Finland	24.3%	Italy	34.6%
Canada	23.8%	Austria	34.3%
Denmark	21.6%	Portugal	32.0%
New Zealand	20.8%	New Zealand	30.2%
Spain	19.9%	Spain	30.1%
Mexico	19.0%	Norway	29.3%
Portugal	18.7%	Mexico	29.1%
Norway	15.6%	Greece	23.8%
Greece	13.5%		

Note: market based are high to medium tech manufacturing; finance; telecommunications; business services. All knowledge based includes education and health. Estimates for Japan only available for market based knowledge industries.
Source: OECD science and technology scoreboard 2005.

Knowledge jobs and knowledge workers

The Kok Report suggested that in the future up to 30 per cent of the EU's workforce would be directly employed in the production and diffusion of knowledge in the manufacturing, service, financial and creative industries, and a much larger share of the workforce would need to be knowledge based in the new emerging economic structures.

Defining the knowledge economy in terms of knowledge workers has the advantage of being cross-sectoral, so avoids the shortcomings of industrial definitions. It has the disadvantage that there is no agreed or straightforward definition of who is a knowledge worker.

There are (at least) three ways we can work towards a definition of knowledge workers:

- All those who work in the top three standard occupational classifications (managers, professionals, associate professionals)
- All those with high levels skills, indicated by degree or equivalent qualifications (NVQ level 4)
- All those who perform tasks that require expert thinking and complex

communication skills with the assistance of computers.

These are not exclusive, so for example, we might define knowledge workers as all those with a degree working in the top three occupational categories. Similarly, a more task-based definition – discussed in more detail below - rests on occupational classifications.

The straight –forward approach is simply to take the top three occupational groups, and this approach was used in the Robert Huggins Competitiveness Index and adopted by the Work Foundation report on Ideopolis. The underlying rational is pragmatic – these occupational groups include the sort of jobs we most readily associate with the knowledge intensive industries, particularly those that require professional or technical qualifications and include large numbers of well-educated graduates.

One drawback is that some categories include large numbers of people who would not typically be regarded as knowledge workers, for example, managers of small stores and corner shops. They also exclude significant numbers of people with degree or equivalent qualifications working in occupations not usually thought of as part of the knowledge economy, such as secretarial and administrative and personal services.

We could limit the definition to those with a high level skill, evidenced by qualifications levels, for example by degree or equivalent (NVQ4). This fits the conventional OECD view that one of the key indicators for investing in knowledge is the share of GDP devoted to higher education. However, while we might expect most knowledge workers to be well educated, but it does not follow that all well-educated workers will be knowledge workers. Moreover, defining knowledge workers just by qualification level looks even more arbitrary than an occupational classification.

The top three occupations have a much higher proportion of graduates than across the economy as a whole, but graduates are in the minority for managerial jobs, and are only just a majority for the associate professional and technical group. Only amongst professionals are graduates the overwhelming majority. In the first quarter of 2006 just under 43 per cent of managers and senior officials in the UK had a degree or equivalent qualification compared with 52 per cent of those in the associate professional and technical occupational

group and over 81 per cent among those working in professional occupations. This compares with a whole economy average of 17 per cent.

Knowledge workers account for about 42 per cent of all employment in the UK in the first quarter of 2006, using the occupational definition of the top three occupational groups. This compares with 31 per cent of total employment in 1984, according to the latest projections prepared for the Sector Skills Development Agency (SSDA). The SSDA is projecting the share will grow to just over 45 per cent by 2014.

The share of knowledge workers has increased both because of strong growth in the total numbers employed in these occupations and falls in low skill elementary jobs, in skilled and semi-skilled manual job, and non-manual administrative jobs.

The underlying story is one of fairly stable constant structural change in the labour market decade on decade. The share of knowledge economy jobs has increased by between 4 and 5 percentage points in each decade, while the share of unskilled jobs has fallen by about 2 and 3 percentage points in each decade. Non-manual jobs in personal services and sales related occupations have also increased by about 2 to 3 percentage points per decade, but from 1994 onwards have been offset by a falling share of administrative and clerical jobs.

However, the fall in the share of skilled and semi-skilled manual jobs *decelerates* from the mid 1990s onwards. This is not what might have been expected, given the vulnerability of such jobs to computerisation and intensification of global competition and the shift of assembly manufacturing to China.

Some studies have seen the changes in the overall occupational structure as creating an "hour-glass economy" with lots of good relatively well paid "knowledge economy" jobs at the top and bad poorly paid jobs at the bottom, with the disappearance of middle income jobs associated with the collapse of manufacturing employment. This may have been part of the story in the 1980s, but looks less convincing during the past decade. We will be looking at this key question as part of the knowledge economy programme.

International comparisons are difficult because of differences in occupational classifications and how these are interpreted in national surveys. The best comparable data we have found to date suggests that in 2004 or latest year available

between 40 and 45 per cent workers in the smaller North European economies, North America, and Australia are knowledge workers. The UK lies alongside Germany and Canada, but behind the Nordic economies, Switzerland and the Netherlands.

Knowledge workers in the UK economy 1984-2014

Occupations	1984	1994	2004	2014
Knowledge workers	31%	36%	41%	45%
Personal services; sales; admin/clerical	25%	28%	28%	28%
Skilled/semi-skilled; manual	28%	23%	19%	18%
Unskilled jobs	16%	14%	11%	9%

Note:2014 projected. Knowledge economy jobs are managerial, professional, associate professional standard occupational classifications. Personal services include care, recreational, and some hospitality jobs. Employees and self-employed.
Source: Working Futures 2004-2014, table 4.1

One of the biggest drawbacks is that there are no comparable figures for the United States or Japan. The US occupational surveys suggest that jobs that might be categorised as knowledge economy account for around 27 per cent of total employment. If true, this might suggest the US has fewer knowledge workers than many European economies. However, we have no way of knowing at this stage if the knowledge economy workforce is really smaller, whether the knowledge economy is less employment intensive in the US, or whether it is simply a survey definition difference.

The Netherlands has the highest share of knowledge workers in the workforce at 48 per cent compared with 41 per cent in Germany and around 40 per cent in the UK and Canada. The share is significantly lower in the Southern European economies where between 25 and 30 per cent of total employment is accounted for by knowledge workers. The big anomaly is France, where only 21 per cent of the workforce is classified as knowledge workers. This may be a survey definition problem.

Over the past decade, the share of knowledge workers has grown in almost every OECD economy for which comparable figures are available. The fastest growing are the Nordics, Ireland, Belgium and Italy, followed by the UK. We might say there has been an almost universal trend towards better jobs associated with the knowledge economy in most industrialised economies but a very different experience in terms of wage inequality. This is encouraging, in that

it suggests the expansion of the knowledge economy and greater social inequality are not inevitable.

One striking feature of this and other similar comparisons is the wide differences in the share of managers, especially between the UK and most other economies. Only Ireland had a higher share of managers than the UK. About 15 per cent of the UK workforce were classified as managers and senior officials compared with between 1 and 7 per cent in France, Germany and Italy. The Nordics had between 5 and 10 per cent and the Netherlands 12 per cent.

It is impossible to know how much of this is due to differences in interpretation of what a manager is within the surveys or to "real" differences such as industrial structure, size of the public sector, corporate governance, or the skills of the workforce. For example, it has been argued that the relatively high deployment of managers in the UK and the US reflects weak vocational skills in the rest of the workforce.

Knowledge workers across the OECD 1995-2004

% of total employment	1995	2004	Change % points
Netherlands	44%	48%*	+ 4
Switzerland	38%	44%	+ 6
Sweden	40%	44%*	+ 4
Denmark	36%	43%	+ 7
Belgium	39%	43%	+ 4
Australia	44%*	—	—
Norway	36%*	42%	+ 6
Finland	—	43%	—
Germany	36%	41%	+ 5
Ireland	30%	41%	+ 11
UK	39%	40%	+ 1
Canada	39%	39%	nc
Czech Republic	34%	38%	+ 4
New Zealand	37%	38%	+ 1
Slovakia	33%	35%	+ 2
Hungry	29%	35%	+ 6
Austria	29%	33%*	+ 4
Italy	26%	31%	+ 5
Poland	27%	32%	+ 4
Spain	26%	31%	+ 5
Greece	27%	29%*	+ 2
Portugal	26%	23%*	– 3
France	—	21%	—
Korea	16%	21%	+ 5
Mexico	15%	17%	+ 2

Note: *Australia and Sweden are 1997; Norway 1996; Austria, Greece, Netherlands 2002; Portugal 2003.
Source: ILO

Human skill definitions

An interesting alternative approach to using broad occupational categories is set out in a recent paper by Autor, Levy and Murname[5] that divides human skills into five categories:

- *Expert thinking*: solving problems for which rule based solutions do not exist. Computers cannot substitute for human beings but can assist by making information more readily available
- *Complex communication*: interacting with other people to acquire or convey information and persuading others of the implications – examples might include some managers, teachers, sales people
- *Routine cognitive*: mental tasks closely described by rules such as routine processing application forms and claims – these jobs are often vulnerable to computerisation
- *Routine manual*: physical tasks closely described by rules, such as assembly line work and packaging. These repetitive tasks can in some circumstances also be undertaken by programmed machines
- *Non-routine manual tasks*: physical tasks hard to define by rules because they require optical and fine muscle control, including truck-driving and cleaning. Such jobs are unlikely to be assisted or replaced by computers.

The authors applied these categories to the US workforce between 1969 and 1998 and found that jobs requiring complex communication increased by nearly 14 per cent, and jobs requiring expert thinking increased by just over 8 per cent. All other jobs saw a declining share of employment over this period.

A recent large scale survey carried out by the Economist Intelligence Unit of top company executives and managers used a similar approach in identifying which skill sets would be most valuable in terms of competitive advantage in the year 2020. This adopted a five-category definition:

- Complex knowledge based roles that are primarily outward facing and require developed communication and judgement skills
- Complex knowledge based roles that are primarily inward-looking and require developed communication and judgement skills
- Simple knowledge based roles that are rules-based, outward facing and do not

[5] *How Computerised Work and Globalisation Shape Human Skill Demands,* Levy and Murane May, MIT, 2006.

require developed communication and judgement skills

- Simple knowledge based roles that are rules based, inward facing and do not require developed communication and judgement skills
- Production roles directly related to manufacturing or production processes.

Perhaps not surprisingly, 62 per cent of respondent's said outward facing complex knowledge based roles would be most important for the organisation's future competitive advantage, followed by 28 per cent saying inward facing knowledge based roles would be most important. The rest were cited by only 2 to 4 per cent of respondents as being important for future competitive advantage.

This approach undoubtedly gets closer to defining knowledge jobs in terms of both cognitive complexity and the relationship to computers – in other words, what people actually do - and might be regarded as superior to simply classifying jobs by occupational title or educational qualification of the job holder. The disadvantage is that it requires either an extensive re-working of the statistics or original survey work and may not easily lend itself to direct comparisons with previous work or international comparisons.

Process and innovation measures

Another way to define the knowledge economy is to look at the share of output or employment produced by firms who are introducing new innovations in either processes or products. Some of the more commonly used indicators, for example, investment in R&D are an input measure that tells us little about the efficiency of R&D. Innovation measures measure output and capture a much wider range of activities.

The OECD definition includes both technological new products or processes and significant improvements in products and processes brought to market or used within the production process. The innovating firm is *"one that has implemented technologically new or significant technologically improved products or processes"*.

The EU Community Innovation Survey provides definitions of innovation on this basis. The most recent available covers the period 1998-2000. By this measure, innovating firms in the UK represented about 62 per cent of turnover and 54 per cent of total employment. In most other European economies the shares were significantly higher. In Germany innovating firms accounted for 85 per cent of turnover and 86 per cent of employment.

Innovation activity across Europe in 2000

2000	Share turnover	2000	Share jobs
Germany	85%	Germany	86%
Sweden	79%	Austria	77%
Portugal	76%	Sweden	73%
Austria	74%	Belgium	72%
Belgium	73%	Finland	72%
France	73%	France	71%
Neth'lands	71%	Neth'lands	68%
Finland	68%	Portugal	68%
Spain	67%	Denmark	64%
Denmark	66%	Spain	54%
Uk	62%	UK	54%
Greece	40%	Greece	38%

Note: no information available for Ireland and Italy. Innovation includes product and process innovation new to the firm or introduced to the market in the period 1998-2000.
Source: Community Innovation Survey 2003

However, there are problems with the overall measure of this sort, come of which were highlighted in an OECD assessment published in 2003:

- Too broad a definition: with most enterprises reporting innovation, the overall definition may not be very useful (although more refined and precise measures of innovation can be derived from the CIS)

- Comparability: the ranking of some economies looks odd – for example, Portugal and Spain appear similar to or even higher than the UK, even though business R&D is much higher in the UK
- Standard innovation measures often do not capture equally important innovations around work organisation, design and marketing – this is discussed in more detail below.

In addition, many of the survey results are presented as a share of enterprises. This fails to take account of differences in employment structure. The figures above showing innovation by turnover and employment give a more accurate picture of the importance of innovating firms in economic activity.

The EU innovation scoreboard sets out a wide range of measures grouped under inputs and outputs, some derived from the CIS and others from Eurostat and OECD statistical measures. The scoreboard includes:

- Innovation drivers (input measures): science and engineering graduates per 1000 population; population with tertiary education; broadband penetration; participation in life-long learning; youth education attainment level
- Knowledge creation (input): R&D expenditure as % of GDP; share of high-medium tech R&D as % of manufacturing R&D; share of enterprises receiving public funding for innovation; share of university R&D financed by business sector
- Innovation and entrepreneurship (input): shares of SMEs innovating, co-operating with others, introducing non-tech change; innovation spending as % of business turnover; early stages venture capital as % of GDP; ICT spending as % of GDP
- Application (output): employment in high tech services as % of workforce; exports of high technology products as % of total exports; sales of new to firm products as % of turnover; employment in high to medium tech manufacturing as % of workforce
- Intellectual property: EPO and USPTO patents per million population; triadic patent families per million population; new EU trademarks and designs per million population.

These measures are brought together in a single innovation summary index. The

latest index shows a lead group of Germany, Denmark, Finland, Sweden and Switzerland, together with the US and Japan (although the latter have been assessed through a more limited range of indicators). Most of the rest of Northern Europe and (on the margin) Italy are regarded as around the average. The rest of Southern Europe and the new EU States are below average.

The UK does relatively well on innovation drivers, ahead of Germany and France but behind the US and Japan. However, on knowledge creation the UK ranks behind all these economies (although the gap against France is relatively narrow). Innovation and enterprise measures put the UK ahead of France, but behind Germany, the US and Japan. Application measures are only available for the EU States, where the UK ranks behind France and Germany.

The OECD has adopted a similar approach through three groups of indicators designed to capture three closely related innovation measures – the generation of new knowledge; industry-science linkages; and industrial innovation and technology diffusion:[6]

- *Generation of new knowledge:* R&D performed by the non-business sector as a share of GDP; non-business researchers per 10,000 labour force; basic research as a share of GDP; PhD graduation in science, engineering and health; scientific/technical articles per million population
- *Industry-science linkages*: business financed R&D performed by public sector as % of GDP; scientific papers cited in US-issued patents; publications in 19 most industry relevant scientific disciplines per million population
- *Industrial innovation:* business funded share of GDP; business researchers per 10,000 labour force; patents in "triadic" patent families per million population; share of firms with new or technologically improved products and processes.

The OECD found that generation of new knowledge correlated strongly with industrial innovation and moderately correlated with industry-science links. However, the link between industry-science links and industrial innovation, while positive, was much weaker. The OECD has heavily qualified these results – the science-industry linkage indicators in particular were felt to be much less satisfactory than the other indicator groups. Moreover, the correlations were based on giving equal

[6] *Freudenberg M. (2003) Composite Indicators of Country Performance: A Critical Assessment,* OECD STI Working Papers 2003/16..

weights to each group of indicators so that they have the same relative importance and at the individual country levels different weights might be more appropriate.

Organisational and presentational innovation

Standard definitions of innovation excludes two other forms of innovation, described by the Community Innovation Survey (CIS) as *"organisational innovation"* around changes in work practice and "presentational innovation" covering design and marketing.

The latest CIS asked a question covering both these forms of innovation and, not surprisingly, found a close link between the two forms of innovation. In other words, firms introducing new products and processes were also more likely to make innovations in work organisation.

Unfortunately, the data is presented by share of enterprise and is split between innovating and non-innovating firms. But taking the measure at face value, innovating firms in the UK appear to be much more likely to introduce these complementary innovations that their European counterparts with the exception of organisational innovation. Unfortunately, there are no UK results for "aesthetic" innovation, although UK performance in the cultural and creative industries also appears to be relatively strong. The results from the CIS comparing the UK against the European average are shown on the next page.

Organisational and presentational innovation compared

% of enterprises	Innovators	
Type of innovation	**UK**	**EU**
Strategic	62%	46%
Management	52%	39%
Organisation	53%	53%
Marketing	66%	38%
Aesthetic	—	42%

Source: Community and Innovation Strategy

These "softer" innovations may be a key distinctive feature of the knowledge economy, especially around the introduction of knowledge management practices. Not all of the competencies required for the knowledge economy are new – the soft-skills such as leadership, ability to work in teams, learning to learn, and communication and analytical skills have been a feature of the workforce for centuries. What is new - apart from specific IT skills - is the emergence of knowledge management skills based on making effective use of the ICT technologies to analyse, process and share information and knowledge among knowledge workers.

"Knowledge management" practices describe how organisations track, measure, share and make use of intangible assets such as an employee's ability to think and react quickly in a crisis. The OECD identifies the following as key knowledge management practices:

- Creating a knowledge sharing culture
- Incentives policy to retain employees
- Alliances for acquiring knowledge
- Written knowledge management policy.

The OECD study suggested that not only were such practices becoming widespread but also there was an association between such practices and innovation and productivity. However, these linkages are not well understood. *"Knowledge management practices seem to have a far from negligible effect on innovation and other aspects of corporate performance. But there is little systematic evidence of just how great an effect knowledge management has. Among the various categories of knowledge-related investments…knowledge management is one of the areas about which little is known in terms of quality, quantity, costs and economic returns" (The Significance of Knowledge Management in the Business Sector*, OECD Policy Brief, 2004).

The OECD suggests that as well as an R&D gap, there may also be a knowledge management gap that helps explain differences in productivity and economic

growth across the OECD economies. This view appears to be supported by the emerging evidence that management quality and the ability to exploit new technologies helps explain some of the productivity gap between the US and Europe.

The EIU survey referred to earlier confirms the importance of knowledge management to the knowledge economy and to productivity growth more widely. Most executives and managers thought the biggest source of future productivity growth would come from knowledge management – far more than, say, new product development or management of the supply chain or procurement. So 43 per cent of respondents said that knowledge management was the biggest area of potential productivity gain compared with 19 per cent who identified new product development and 17 per cent who identified supply chain management.

The same survey suggested that firms would devote a much bigger share of their future IT investment to support of knowledge management systems and knowledge workers. For example, 44 per cent of respondents said general IT infrastructure was among their top three priorities for investment now, compared with 22 per cent who identified knowledge management. But asked about the future, the results are reversed with 42 per cent saying knowledge management was a top priority for IT investment compared with 18 per cent citing general IT infrastructure. So even if overall ICT investment rates by business do not change dramatically, the

Corporate view of knowledge management and productivity gains

Areas of biggest potential productivity gains	% of respondents
Knowledge management	43%
Customer service/support	35%
Operational/production processes	29%
Strategy/business development	29%
Marketing and sales	28%
HR and training	23%
Corporate performance management	22%
Product development	19%
Financial management	17%
Supply-chain management	17%
Risk management	14%
Procurement	10%

Note: responses to question, *"Which of the following areas of activity offer the greatest potential for productivity gains over the next 15 years?"*
Source: EIU Foresight 2020 survey of 1,600 CEOs and managers, 2006

focus certainly will do and in ways that are quite distinct from previous across the board increases in computerisation.

Conclusions

Defining the knowledge economy is challenging precisely because the commodity it rests on – knowledge – is itself hard to pin down with any precision. Perhaps for this reason there are few definitions that go much beyond the general and hardly any that describe the knowledge economy in ways that might allow it to be measured and quantified.

Turning to more specific and measurable definitions, it is clear no single definition will capture all aspects of the knowledge economy. All indicators have advantages and disadvantages. An important concern is that of international comparability, given the shift to a knowledge-based economy is a global phenomenon taking place in virtually all OECD economies.

We will adopt the wide OECD/Work Foundation industry definition of the knowledge intensive industries (high to medium tech manufacturing, finance, telecommunications, business services, education and health). By this measure about 40 per cent of GDP in the UK is generated by knowledge intensive industries. However, we will need to make clear that the knowledge intensive industries are not the knowledge economy,

for example, through work focusing on industries either entirely or partly omitted from the OECD wide definition of knowledge based industries such as energy supply, retail and the cultural creative industries.

We will retain the occupational definition of the knowledge economy workforce as the top three occupational groups of managers, professionals, and associate professionals. By this definition, just over 40 per cent of the UK workforce is "knowledge workers". However, we will need to refine this definition. In particular the assumption that all managers are knowledge workers looks unsustainable, at least in the UK. We will also explore alternative approaches that get us closer to the essence of knowledge work, such as defining knowledge based workers as those in jobs requiring expert thinking and complex communication skills.

Definitions based on innovation by firms cover all industries in the market sector but lack precision. Innovation surveys suggest that over 60 per cent of UK business turnover and over 50 per cent of business employment is in firms that use new technology to introduce new products and processes. We will refine our innovation-based definitions, taking account of the latest findings form the Community Innovation Survey.

Innovation in "softer" areas such as work organisation, knowledge management, design and marketing are vital to understanding how the knowledge economy works within the firm but the link to competitiveness is poorly understood and often inadequately measured. We will explore these measures of knowledge-based innovation in more detail.

This note will not be the final word – as we take the programme forward we want to refine and develop our definitions and measures of the knowledge economy by stimulating debate and inviting others to set out their view on the future of the knowledge economy. One area we want to explore in the coming months, drawing on outside experience and expertise, is the option of developing more sophisticated composite indicator. We will be making contact with the relevant academics and officials at the EU and the OECD currently working on knowledge economy statistical definitions and indicators.

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