"Innovation in the European Service Economy – scenarios and implications for skills and knowledge"

C150083.X82

Deliverable 12

FINAL REPORT

Framework Service Contract
150083-2005-02-BE

December 2008

Version 1

The authors of this report:

Ian Miles (University of Manchester)
Barbara Jones (University of Manchester)
Theo Dunnewijk (UNU-MERIT)
Huub Meijers (UNU-MERIT)
Adriaan van Zon (UNU-MERIT)
Bas Kotterink (TNO)

The ETEPS AISBL – European techno-economic policy support network has been set up on the initiative of the Institute for Prospective Technological Studies (IPTS) of the European Commission. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making.

The ETEPS network is organised as a legal entity – the ETEPS AISBL, founded in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations.

The main activities of ETEPS are:

Undertaking scientific research on the interdependencies between science, technology, economy and society, with a focus on foresight and evaluation;
Developing and using scientific models, data and other related tools to improve the scientific understanding of European Science & Technology related policies; and
Taking appropriate actions to disseminate the knowledge thus gained

The network for European Techno-Economic Policy Support
ETEPS AISBL
Represented by its Secretary-General GOPA-Cartermill SA
Responsable: Gabriele Jauernig
Rue de Trèves 45
B – 1050 Brussels
gjauernig@gopa-cartermill.com

Executive Summary

This report outlines the outcomes of a short study concerning the future of Knowledge-Intensive Service Activities (KISA), in particular their skills requirements in the light of technological innovation and other trends. The main objective of the study was to map out where research is needed to better understand future skills requirements in KISA.

The concept of Knowledge Intensive Service Activities (KISA) is relatively new, having been introduced in part because of perceived limitations in the widely-used construct, Knowledge-Intensive Business Services (KIBS). KIBS are firms and associations that specialise in producing services to support the business processes of private firms and public organisations – technical services (T-KIBS) include computer support, R&D, engineering, industrial product and process design, etc., professional services (P-KIBS) – including accountancy, legal services, market research, and business-related creative services (C-KIBS) covering advertising in particular, but also elements of architecture and design.

The limitation of the KIBS construct is that it deals only with services provided by specialist firms and sold to other organisations. Similar services, however, are provided in-house by employees within organisations across the economy – and these are also included in the KISA concept: most if not all professional jobs could be thought of as KISA – together with a host of specific professions. The International Standard Classification of Occupations (ISCO) provides three occupational categories that together capture managers, professionals and associate professionals in an agreed way, and thus give access to statistics of change and forecast of change in the volume and deployment of these jobs across European economies. For more detailed analysis, though, it is necessary to examine particular classes of KISA and for the purposes of this study, we focus on KISA that correspond to the standard definition of KIBS in terms of firms occupying the "business services" category of the main industrial classification scheme. This includes the KISA groups mentioned above, T-KISA and P-KISA, but it omits some C- KISA such as telecommunications, financial, photographic and graphic design. The view of experts consulted in the course of the study was that main issues concerning these KISA would be shared with those focused on here, though further research is required on this topic - and many others!

Several studies have documented that KISA can play major roles in improving the competitiveness and performance of firms, regions and countries. For this reason, the issue of KISA skill requirements is important to study, and it is surprising just how little systematic research there has been on this theme. It is extremely likely that these requirements will change – as demand for KISA inputs of different sorts evolves, as technology is applied to KISA processes and as we see how socioeconomic development takes different paths around the world.

The study presented here addresses the questions of future KISA skill requirements in Europe by means of several approaches. The main approaches, and some highlights from their conclusions are:

a) **Preliminary literature review,** which informed the approach to defining and assessing **KISA**. It noted the extensive growth of KISA in economic activity – some of which is a matter of increased specialisation and division of labour, but which is more substantially a matter of growing demands for the application of (a

wider range of) knowledge in economic affairs. There are some difficulties in identifying comparable KISA jobs across sectors, but the indications are that most KISA work is actually carried out in user industries, not in the KIBS sectors that specialise in these activities. The conclusions we can draw about KISA thus have implications for activities across the economy.

b) **Second literature review,** which informed the approach to defining and assessing the skills (and the competences used to characterise those skills) needed for KISA. This showed us that skills for KISA are more complicated than appear at first, in that employers do not require, nor do employees possess, single isolated skills. Rather, combinations of skills are possessed, and it is (more or less specific) combinations of skills that are sought and defined as appropriate for specific professions. These combinations are liable to vary across firms and industries, and to change over time. The literature advances several approaches to understanding skill profiles, but commonly these differentiate between specialist technical skills, and more generic skills (including basic skills, social skills, managerial skills, and the like). KISA occupations typically require combinations of specific technical skills – associated with the KISA in question – and more generic skills. Research indicates that the trend has been towards a broadening of jobs and the emergence of new occupations, requiring more skills, often recombined or converted in professional and associate professional roles.

c) **A further literature review of forecasting skill demands**. Basic modelling of trends in demand for specific professions, or for professional occupations more broadly, is possible, and there have been both detailed assessments quantitative trends in demand for a few professions (mainly ICT-related) and for professional occupations in general. In both cases the main approaches are simply to extrapolate trends or to estimate demand for these employees as a consequence of general trends in economic growth and industrial structure. These "independent variables" are very conditional on broad patterns of economic development, and recent financial shocks indicate that it is unwise to assume that steady long-term growth is the most probable future. Other lines of research could examine changing skill requirements associated with established jobs (e.g. studies of future management skills) or economic sectors (e.g. professions in financial services); few studies explore new and emerging KISA activities. In the latter line, we note especially the USA's system for monitoring for new occupations, and an intriguing Finnish study that sought to assess the scope for new professions to emerge in connection with major technological trends. Most studies are less adventurous, and extrapolate well-known trends to reach unsurprising conclusions. There have been a few scenario-based studies that set out in new directions, and these are discussed below.

d) **An Online Survey about Future KISA Skill requirements**. For this project, an online survey was employed in which we enquired both as to which KISA activities would be liable to experience most future growth, and what sorts of skills would be required in these. A long list of drivers of KISA development was also generated. The survey suggested that the KISA seen to have greatest job generation prospects in the EU are consultancy-related: Business and management consultancy, and Software consultancy. Most of the high-growth KISA were seen as liable to grow most rapidly in the KIBS sectors, than in the in-house KISA associated with these. The specific skills requirements that were likely to grow, in those professions that were seen as most likely to increase substantially, varied quite a lot – for example technical skills were stressed in software, social skills in management consultancy. Complex problem solving

skills were seen as important across most of the high-growth KISA, as were resource management and systems skills. The survey respondents were relatively few in number (about 100), perhaps reflecting the complexity of the questions being asked, but this sort of approach would seem to be well worth further exploration.

e) **Case Studies: KISA Innovation:**

f) **A Review of KISA Scenario Studies**. A number of studies have appeared in recent years which use scenario techniques to outline possible future paths of development of KIBS and KISA. (Several of the studies concerned KIBS, and one concerned professional occupations.) These studies point to a number of drivers that are liable to shape the development of these areas in the future, and outline some key uncertainties about their future development. Broadly, the key drivers the discuss can be classified into those dealing with

(1) The technologies in use for KISA, and the technologies where KISA support is required by clients;
(2) The organisation of the KIBS sector, in terms of the roles of firms (specialisation/integration), firm size, and their own use of offshoring to accomplish functions;
(3) Demand for KISA on the part of clients, and client strategies (and management philosophies) in relation to internalisation of KISA versus externalisation to KIBS, to offshoring internal KISA and/or using overseas KIBS, and in terms of possibly moving into commercial supply of KISAs to other firms;
(4) Factors affecting demand such as technological change, regulations, turbulence in markets and levels of economic growth, client firm internationalisation, etc.;
(5) The availability and quality of training in KISA skills, modes of provision of training (on-the job and in formal institutions, life-long learning, etc.), and possibly by professionalization in KISA work itself and the strategies of KISA users in terms of management control of professional work.

g) First Scenario Workshop: Two workshops were conducted. The first workshop explored and then elaborated the implications of, a set of scenarios on KISA development.. Four scenarios were initially developed, but it was later concluded that a trajectory of rapid application of new ICTs to KISA was actually a pervasive feature of all scenarios, and not really a scenario in its own right. The three scenarios that remained can be seen as representing different ways in which this trajectory might be realised – on a bottom-up basis through professional communities' self-organisation; as a result of initiatives by large firms and cartel-like industrial groupings establishing long-term strategic relationships with KISA suppliers; and as a result of local and regional governments and other actors seeking to establish particular localities as prime sites for KISA production.

h) Second Stakeholder Workshop: The second workshop elaborated the scenarios created in the first workshop, and explored the implications for skills and the KISA skill research agenda. We attempted to discuss a series of "skill profiles" – 'specialist', 'generalist', 'T-shaped', and so on. While job broadening and increased requirement for managerial and other generic skills was seen as likely in all scenarios, there were differences between them. The "cartel" scenario might see greater divisions of labour and more specialists, as large firms pursue efficiency and reconfigure KISA work with support teams for professionals; the "professional

community" future requires more capability in self-management and entrepreneurial skill, and so on.

i) Modelling KISA impacts: The main message of this part of the study is that the structure of the economy, knowledge intensive services, labour market flexibility and resource competition all matter for growth. Different sectors of economic activity require different occupations and different skill levels. It is the interaction of the common factors of production and new ideas that drive economic growth, requiring new jobs and new occupations. Especially knowledge intensive services carry the embryonic forms of new products and new services. With the use of these KISA's supplied by R&D firms and complementary in-house KISA activity, new products and services are being created again and again. To grasp the essentials of this world, a first generation model was constructed named KISAMOD. This model integrates the production and subsequent use of external and internal KISA's in a multi-sectoral input-output framework. Growth of aggregate productivity is – in this model-generated by the use of KISA's by the different sectors of production and reallocations of factors of production. Growth generated by R&D is directly in line with insights from endogenous growth theory. We have also added an extensive job-structure to the model's production structure including two job-categories that are KISA intensive. KISAMOD has four main dimensions: (1) A sectoral structure of the economy, (2) each sector has its own possibilities to enhance productivity, (3) sectors compete with each other for workers that have certain professions and skills and (4) growth sectors drive out stagnant sectors in situations that are path dependent to some extent.
Using KISAMOD two scenarios were compiled: the 'cartelisation' and the 'local concentration' scenario, are summarised below.

The KISA cartels scenario: The cartelisation scenario is based on the view that knowledge based firms are predominantly organised in cartels which are collections of suppliers along the value chain and which are dominated by the ability of the cartel leader to sell the products which bear its brand. In the world of 'cartelisation' the highly focussed knowledge intensive firms exhibit high labour productivity and therefore employment will gradual decline in the direct KISA jobs. More focussed and more effective services will on the other hand lead to a more competitive position in intensive KISA using sectors. Moreover, KISA firms in this world are bigger and have deeper pockets, reducing for them the negative productivity growth effects of indivisibilities in research. Consequently, they themselves are more productive, and the users of their products/services are as well.

The KISA local concentration scenario: The local concentration scenario is based on the notion of external economies of scale. The main idea is that such local concentrations reduce information costs, and enable the pooling of scarce labour resources, resulting in a more efficient use of these labour resources, and correspondingly higher labour mobility between firms within sectors as well as sectors that are relatively close together.The local concentration scenario highlights the consequences of removing labour market rigidities. These rigidities enter the model because workers have sector specific experience and are only perfect substitutes for other workers in as far as these are faced with the same technologies and have the same kind of experience as a result. Workers may also be reluctant to switch to another sector of industry, because of private adjustment costs. Removal of such labour market rigidities results in extra growth and lower unemployment on average.

The main implications of the model and findings from running the scenarios are listed below.

Regarding the sectoral structure of the economy: Different sectors require different labour inputs, and so the distribution of aggregate activity over sectors determines the scarcity of different labour resources, and the other way around;

Regarding sector specific growth potentials: Each sector has its own possibilities to enhance production. There are differences in the extent to which sectors may experience productivity growth. In some sectors this is difficult (for example labour intensive services like hairdressing and music making are well known examples), whereas for other sectors this is much easier. Consequently, growth generating activities may become biased in the direction of particular sectors;

Regarding resource competition: Sectors of economic activity compete for labour resources on the same markets. Reallocation of resources among sectors takes time, so reducing labour market rigidities may boost economic growth. An important insight arising from this research is that growth is promoted not only by greater mobility of R&D resources, but also by greater mobility of production labour resources. This is because the benefits of R&D increase with the size of actual production.

Regarding differential growth performance: Growing sectors crowd out other sectors. Growth sectors require more intermediate goods/ services. This claims production elsewhere in the economy. Thus growth generates additional competition for scarce primary resources in the form of derived demand for those resources in the sectors that are part of the backward linkages of the growing sector. Resource competition affecting the realisation of growth potentials is routinely ignored in partial equilibrium TFP-growth measurement exercises.

Regarding KISA jobs and growth:. KISA-jobs are important for economic growth. We have observed relatively large differences in the contribution of KISA-intensive jobs to output growth among sectors. Consequently, differential growth rates between sectors have important effects on KISA-job demand. Conversely, the availability of labour qualified to fill these KISA-intensive jobs becomes a *condition sine qua non* for generating growth potentials and the subsequent realisation of these potentials.

Regarding labour mobility and growth. Higher labour market mobility in combination with myopic foresight, as we have implemented it in the model, may lead to cyclical fluctuations regarding the allocation of both R&D resources and (complementary) other (primary) resources.

j) **Future Research Considerations**: A long list of topics for future research, and suggestions concerning the appropriate organisation of such research, was generated; both of the workshops and the more general analysis and review activity contributed suggestions. A small selection of the key points include:

Extensive scope for secondary analysis of existing data – for example on trends in KIBS employment and KISA professions across all sectors, and on the experience of working life in particular professions and sectors.

The sort of modelling exercise presented in this project could be usefully extended to more countries and different conceptualisations of KIBS and KISA.

There is also much need for more case study work and indeed conceptual work on skills and skill profiles to inform improved statistics and larger-scale studies of changing occupations, employment and skill requirements, and how these may evolve in the future.

Comparative studies across countries, and interdisciplinary approaches to analysis, are widely recommended.

There are still many unanswered questions concerning the dynamics of change in KISA and KIBS, the interactions between KISA providers and users, the construction of KISA professions, and the ways in which skill profiles are identified and combined within specific organisations.

There is also scope for management studies of how KISA succeed, especially in providing new solutions for emerging problems, and for policy studies (on training programmes and KISA-related innovation policies, for example).

Table of Contents

1. Introduction

The service sector was long thought of as an unproductive and non-innovative residual. But it is now recognised that services have vital and dynamic roles to play. The rapid development of the service sector in recent years is indicated by its increasing share in the economy, which has already reached two thirds of GDP and employment in Europe, and is well above these figures in several countries.

Though services innovation is now recognised to be common, there are concerns about relative low rates of innovation and performance in terms of productivity growth in many service sectors, in many European countries. At the Lisbon European Council in March 2000, the European Commission stressed the need to "define a strategy to promote innovative services in the EU" (Commission of the European Communities 2005). The Commission was invited to produce an overall assessment on innovation in services (Council of the European Union, 2006), and this was published in the Expert Group report "Fostering Innovation in Services" (March 2007). This report sought to define a strategy for promoting innovative services in the EU, arguing that effective, holistic and integrated policies are required to make innovation in services more effective in terms of enhancing European growth and competitiveness. This corresponds with points made in a growing literature on the specific aspects of service related growth and innovation, as well as related skills requirements (EMCC, 2005).

In addition, across economic analysis and Foresight studies there is a widely shared expectation that the importance of services will continue to grow further. It is also often stressed that services – seen as activities and products – are not just restricted to the tertiary sector. Firms of all types produce services for their internal consumption, and often for their customers and collaborators (from after-sales service to research support services). Services are remarkable diverse in terms of their occupational profiles. Some are mainly low-wage activities, while others have the highest share of graduate employees of any sectors. It is widely expected that a future "service economy" will require different skills and competencies across a wide range of professions (EMCC, 2005).

These trends are widely anticipated, but their underlying drivers, and their implications in terms of societal change and values, ecological challenges, and global economics and politics remain much less clear. How the emergence of a more innovative service economy will affect the demand for skills and knowledge remain to be explicated, beyond the rather banal point that higher levels of innovation will require more innovation-related skills.

This study aims to contribute to filling in at least some of this knowledge gap, by focusing directly on the knowledge and skills needs for the service economy.

2. KISA, KIBS and beyond

This project concerns the skills required for Knowledge-Intensive Service Activities (KISAs). This means that we need to ask just what KISAs are. Let us begin with the last part of the phrase: Service Activities.

Service Activities are defined as activities that produce services (which we will thus need to define, in turn). These activities are undertaken throughout the economy – in manufacturing and primary sector organisations as well as in the tertiary sector which is normally identified with services. They are also carried out in household and other social activities that do not enter the national accounts (people produce their own leisure services, domestic services, and so on, without these having a financial value attached to them). We talk about service **activities** here, rather than service firms.

The point is that activities may be carried out in-house by an organisation in any sector, or contracted out to a specialised service firm – one which makes its living by producing that particular set of services. Good cases of knowledge-intensive service activity – KISA - that are often conducted in-house by some organisations and externalised by others, are the production and maintenance of computer software, the development of marketing campaigns for new products, and the preparation of company accounts and tax returns. Less knowledge-intensive activities that may be internalised or externalised include, for example, the transport of goods or personnel, the cleaning of premises, and catering services.

What then are **services**? The word "service" is a metonym, referring both to the service product, and to the service activity that has created it. It can be used to describe the work that one party undertakes for another (or for oneself, in the case of self-service), or the outcome of this work (the customer being transported, entertained, presented with a requested, repaired, stored or otherwise transformed artefact). The term "services" is even more ambiguous, being applied to firms and industries, as well as products and commodities, and activities and occupations. The focus here is on service sectors and firms. We shall examine what is included under the label of "services" here, but first we note the alternative applications of the term. In the sense of products or commodities services - such as after-sales, marketing, maintenance, etc. - may be generated and sold (or delivered free of charge) by firms in any sector, manufacturing included. In the sense of occupations services - such as white-collar and other "non-production" jobs like security, catering, cleaning - may also be found in all sectors. Some of the important dynamics behind the evolution of service firms and sectors concern the relocation of such activities and occupations within specialised producers.

There have been considerable efforts to statistically define **service sectors**, and this can be a useful starting point. After the primary sectors and manufacturing, the NACE codes feature (**E)** electricity, gas and water supply, and (**F)** Construction. It is now common to exclude these from "services sectors", though the utilities were often included as part of the tertiary sector in the early days of national accounting some fifty years ago and indeed these do have many features in common with some services. The utilities resemble network services like telecommunications (distributing things that are not solid artefacts through complex infrastructures); and transport (spatially extensive infrastructures). Construction resembles some services, too, in that a lot of its activity involves creation of products that are complex and very much tailored to the circumstances of particular clients and locales – though it does result in a very tangible material artefact or set of arte-facts. The main service sectors are:

G - wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods;
H - hotels and restaurants;
I - transport, storage and communication;
J - financial intermediation;
K - real estate, renting and business activities;
L - public administration and defence; compulsory social security;
M - education;
N - health and social work; and
O - other community, social and personal service activities.

Finally the NACE classifications feature two other sectors that have service characteristic, but enter into industrial analyses less often: (P) - Private households with employed persons – e.g. domestic servants, and (Q) - extra-territorial organizations and bodies.

Traditionally service sectors were typically defined in negative terms – what they were NOT. Services were not in the business of manufacturing goods, erecting buildings, extracting coal from mines or growing vegetables. They were the residual sector, once one had classified sectors that create materials or material artefacts. But the work of such pioneering analysts as T P Hill and D. Riddle suggests a more positively inclusive approach, and Miles (1996) suggested that distinct classes of transformative activity can be identified with the "grand" economic sectors:

The primary sector is mainly concerned with extracting raw materials from the environment.

The secondary sector predominantly involves transforming these raw materials into material goods and other artefacts.

The tertiary sector can then be seen as:

effecting changes in the state of the environment (other than those concerned with extracting raw materials) - waste management, pollution clean-up, park-keeping;

effecting changes in the state of the artefacts produced by the secondary sector - repair and maintenance, goods transport, building services, wholesale and retail trade;

effecting changes in the state of people - health and education services, hospitality and consumer services such as hairdressing, public transport;

effecting changes in the state of symbols (that is, information) - knowledge services (which bring intelligence to bear on any of the operations already mentioned); entertainment services; communication services such as broadcasting and telecommunications.

Thus services may be concerned with effecting changes in the state of organisms, material artefacts, and symbolic material of all kinds. At a rather abstract level, these changes in state can span, for instance, movement and storage, maintenance and revitalisation, elaboration and intensification. Production is usually an activity of primary and secondary sectors, though services may produce information and symbolic material

As this study is concerned with skills and occupations, the service activities we are concerned with will be **Business Services** – sold to or undertaken within firms and other organisations in the formal economy (which feature business processes) – and not Consumer Services. For the purposes of the current study, too, we are not focusing on Public Services, some of which are supplied to businesses (though most are provided to individuals).

Knowledge-Intensity is a problematic concept, since all human activity depends on knowledge. We will return to this in more depth shortly. For now, let us say that one approach (useful, even if limited) is to focus on those features of knowledge-intensity that are reasonably well-captured by the existence of educational qualifications. For example, some sectors are particularly heavily characterised by having high proportions of University graduates in their work force – and apart from the public services of health and education, the outstanding cases here are the **Knowledge-Intensive Business Services (KIBS)**. These services sectors are further elaborated and related to NACE classifications in Box 2.1 below. It is common for researchers to differentiate between P-KIBS (traditional professional services such as accountancy and law), and T-KIBS (technology-related services such as computer services and engineering services). We suggest that a third category be added – that of C-KIBS, "creative" business services, drawing on the body of recent literature on creative industries (much of which focuses on their producing "creative content". The outstanding example in NACE72-74 is advertising. Elements of other KIBS – such as industrial design, architecture, perhaps marketing – also involve substantial production of creative content. A broader definition of **Knowledge-Intensive Service Sectors** has been propounded by Eurostat and various other commentators, but this includes many services that are much less graduate-intensive than are the KIBS. Eurostat, recognising the need to differentiate among service sectors, has introduced the concept of "Knowledge-Intensive Services". This is a very broad classification, and is set out in Box 2.2.

BOX 2.1 KIBS in NACE-1

The services in NACE-1 70 and 71 concern real estate and equipment renting, which are not usually considered to be KIBS. The main KIBS sectors are usually seen as **NACE 72-74:.**

72,1 Hardware consultancy

72,21 Publishing of software

72,22 Other software consultancy and supply

72,3 Data processing

72,4 Database activities

72,5 Maintenance and repair of office, accounting and computing machinery

72,6 Other computer related activities

73,1 Research and experimental development on natural sciences and engineering

73,2 Research and experimental development on social sciences and humanities

74,11 Legal activities

74,12 Accounting, book-keeping and auditing activities; tax consultancy

74,13 Market research and public opinion polling

74,14 Business and management consultancy activities

74,15 Management activities of holding companies

74,2 Architectural and engineering activities and related technical consultancy

74,3 Technical testing and analysis

74,4 Advertising

There are other services in the 74's that should be excluded, in all probability, as not being KIBS, or containing a low proportion of KIBS firms:

74,5 Labour recruitment and provision of personnel;

74,6 Investigation and security activities;

74,7 Industrial cleaning;

74,81 Photographic activities;

74,82 Packaging activities;

74,85 Secretarial and translation activities (some of these may be KIBS)*;*

74,86 Call centre activities;

74,87 Other business activities n.e.c. (some of these may be KIBS)..

Box 2.2 "Knowledge-Intensive Services : a broad definition

NACE codes follow in parentheses

Knowledge-intensive high-technology services

Post and telecommunications [64]
Computer and related activities [72]
Research and development [73]

(the latter two of these categories are TKIBS as understood above.)

Knowledge-intensive market services (excl. financial intermediation and high-tech services)

Water transport [61]
Air transport [62]
Real estate activities [70]
Renting of machinery and equipment without operator and of personal and household goods [71]
Other business activities [74]

(the final item here is largely comprised of PKIBS.)

Knowledge-intensive financial services

Financial intermediation (except insurance and pension funding [65,]
Insurance and pension funding, except compulsory social security [66]
Activities auxiliary to financial intermediation [67]

(These activities are mictures of business and consumer services.)

Other knowledge-intensive services

Education [80]
Health and social work [85]
Recreational, cultural and sporting activities [92]

(These are in large part public and community services, though many have a high private sector contribution – they are generally oriented to the general public, but KISA associated with many of them are supplied to, and within, firms in many sectors.)

(This leaves as **Less-knowledge-intensive market services:** trade, repair hotel and restaurant services, land transport, travel agencies, etc. and **Other less-knowledge-intensive services:** comprising Public administration and defence; compulsory social security, Sewage and refuse disposal, sanitation and similar activities, etc.)

(Sources: Eurostat)

Data on employment in KIS **sectors** is available from Eurostat.[1] One problem with this Eurostat classification is that some of the KIS sectors are extraordinarily knowledge-intensive, as indexed by the share of graduates in their employment, while others are much less so (e.g. post and telecommunications). Although the presence of graduates may be related to issues of skill inflation commented on below. The classification does not differentiate between business and other services, and in particular "Other Business Activities" involves professional services (some of which are technology-intensive) but these are classified in a market services set which includes many sectors that are not dominated by professional occupations.

The OECD has helped popularise the notion of KISA in a set of TIP project studies.[2] Here, KISA were defined as:

> *"the production and integration of service activities undertaken by firms or public sector actors in the context of manufacturing or services, in combination with manufactured outputs or as stand-alone services. Typical examples of KISA include research and development (R&D), management consulting, information and communications services, human resource management and employment services, legal services (including those related to intellectual property rights) accounting, financing, and marketing-related service activities. Most businesses and public sector organisations make use of such KISA in*

[1] See, for example, http://epp.eurostat.ec.europa.eu/tgm/ table.do?tab=table&init=1&plugin=0&language=en&pcode=eca26896

[2] http://www.oecd.org/document/43/0,3343,en_2649_34273_15709675_1_1_1_1,00.html

their daily operations, whether they provide them internally or source them from external suppliers in the private or public sectors."[3]

The overall TIP report (OECD, 2006) focused on the role of KISA in innovation. It suggested distinguishing between (p8):

Renewal services - Directly related to innovation, for instance R&D and strategic management consulting;

Routine services - Contribute to improvement of maintenance and management of various subsystems within organisations, e.g. accounting;

Compliance services - Help organisations to work within the legal framework and regulatory regimes, e.g. auditing and some legal services;

Network services - Facilitate communication, knowledge exchange and flexible resource allocation, e.g. informal personal networks and production related networks.

The main conclusions of the study are summarized as:

KISA affects innovation processes in different ways (see the classification above).
Use of KISA varies across industries and across time
Innovation is a collective process that requires access to multiple skill sets
Users and customers are important drivers of innovation
Emergence of supplies of KISA is contingent on demand
Integrating internal and external capabilities is increasingly important

For the present study, focus will be on KISAs as defined by the activities corresponding to the specialised KIBS sectors in Box 1 above. This means that some rather similar activities are neglected – these will hopefully be taken up in future studies. There are some KIBS-type activities that are not in the Business Services sector, for instance those in NACE-1 92, such as:

92.11	Motion picture and video;
92.20/1	Radio activities;
92.20/2	Television activities;
92.31/9	Other artistic and literary creation and interpretation (includes: activities of individual artists such as authors, lecturers or speakers, sculptors, painters, cartoonists, engravers, etchers, etc.; activities of composers, song writers, lyricists, etc.; restoring works of art such as paintings);
92.4	News agency activities;
92.5	Library, archives, museums and other cultural activities.

The above classifications contain many consumer services, but also producer services, sold to firms and public organisations. These are largely what we have referred to as C-KIBS (creative industry KIBS). Telecommunications and financial services similarly contain T-KIBS and P-KIBS – though many of the sub-sectors in these industries do not appear to be highly knowledge-intensive (with many staff providing more routine services at counters, working on telephone lines, etc.). It is likely that educational and health services are sometimes specialised for business users (and some firms in any sector may have health and training staff in place) and there are also services associated with industrial sectors, construction, etc. that are often located within these earlier NACE sectors.

The approach adopted here means that the KISAs being studied are those activities featured in the KIBS of Box 2.1, such as making decisions about IT equipment and

[3] Source: taken from: http://aegis.uws.edu.au/KISA/main.html, citing OECD (2002) *Progress Report on the TIP Case Study in Innovation in Knowledge Intensive Service Activities (KISA)*, 10-11 December 2002, Paris: OECD.

software, software writing and maintenance, and so on, through to testing and analysis and advertising services. These KISA are undertaken across the whole economy. But while KIBS sectors are tracked in national accounts statistics – so that one can even investigate the pattern of purchase of KIBS by other sectors, using Input-Output tables – this does not apply to KISAs and associated skills undertaken within firms. R&D data are one of the few topics where there is routine monitoring of the amount spent in-house and externally. A rare example of a broader study of internal-external service use is provided in a recent study (Alajkääskö,2006) which examined European businesses' sourcing of services including: Architectural, engineering & related technical consultancy; Research and development; Royalties and license fees; Human resources; Professional and business; Financial and insurance; ICT; Renting and operational leasing; Marketing and sales related and Transport, logistics and postal services. These are listed in ascending order of reported expenditure, so that the most extensively purchased service was transport, logistics and postal services (25.3 % of all purchases). Renting and operational leasing, marketing and sales, and ICT also accounted for double-digit shares. The majority of respondents said that their main service provider was external, as opposed to internal provision from within the same enterprise/enterprise group. Furthermore, the main external service providers are usually from the same region (less so for high-tech inputs). Manufacturing industries tend to favour external service providers more than other sectors do.

The most obvious approach to locating and measurement of the incidence of KISAs more generally would be to look for occupations associated with these activities in different sectors). This is based on the assumption that many KISAs will be represented by specialised occupations, as well as by specialised KIBS sectors, and that these occupations will be found across the economy. A first list of possible candidate occupations, drawing on the sectoral categories of Box 2.1, is featured in Box 2.3. There are some problems inherent in this approach. First, not all KIBS employees are professionals (for instance, they may be data entry or clerical staff). In general, we would wish to examine the professional occupations across the economy, not to compare professional occupations in nonKIBS with ISA professionals in other sectors. Second, it is likely that the content of job roles varies across sectors. In particular, "management" poses a problem, because:

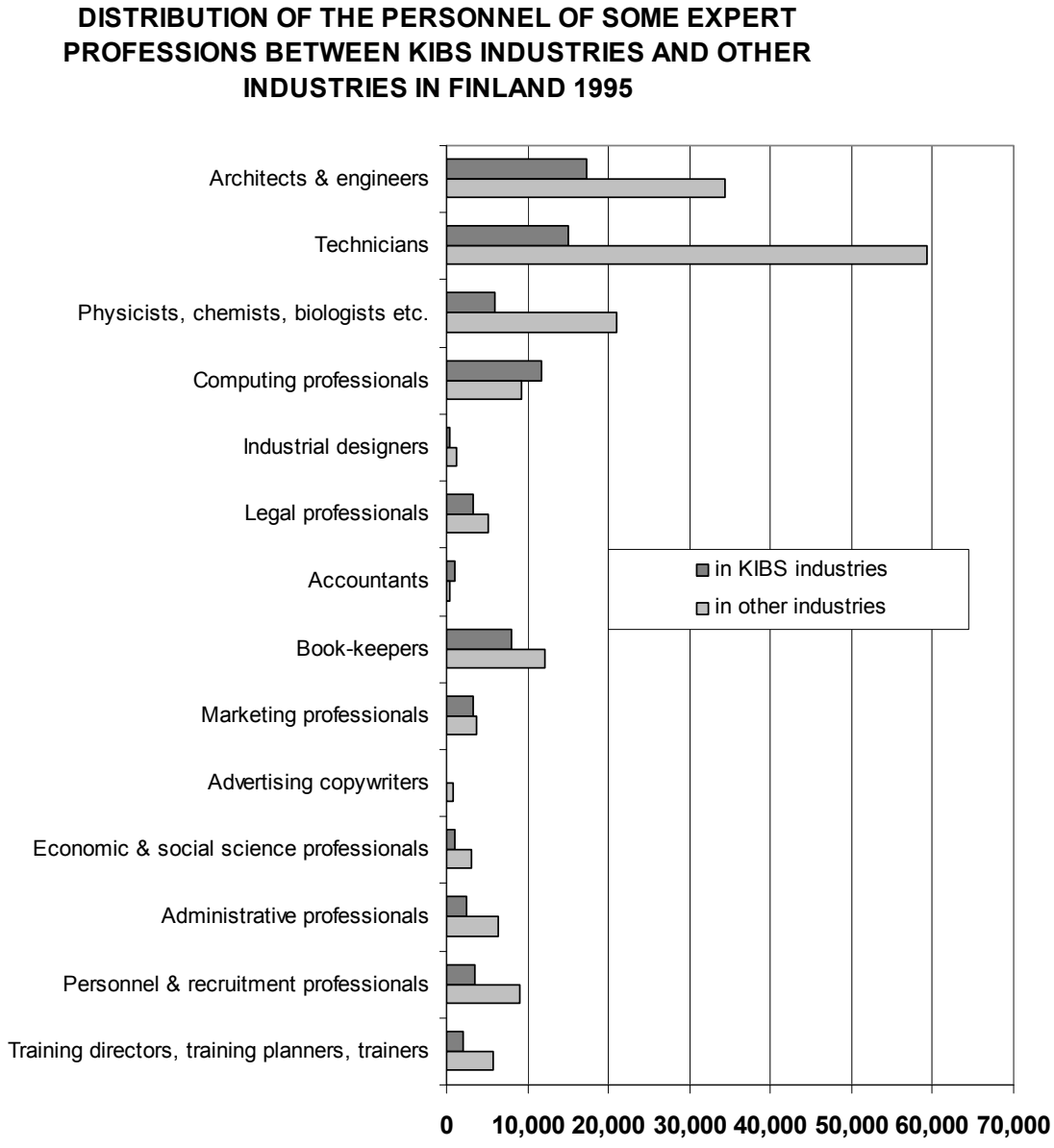
(a) all sorts of jobs have been relabelled "management" in recent years and
(b) the services provided by management consultants are not strictly comparable to services of general managers.

Nevertheless, this would seem to be the best approach available, since there is no obvious source of detailed information on "activities" themselves. As we shall see later, some data sources do give us a little insight into a few broad classes of activity, and how frequently these are encountered at work. If we do relate together KIBS and KISA in this way, it may make sense to follow the classification of KIBS into TKIBS, PKIBS` and CKIBS. We will then be able to differentiate between T-KISA, P-KISA and C-KISA. (In our scenario analysis we went some way in this direction with a distinction between T-KISA and P-KISA – the scope for further specifying CKIBS and C-KISA had not been fully recognised at that point.)

BOX 2.3 KIBS and related KISA Occupations	
KIBS Sector (c/f Box 2.1)	**KIS Professional Occupation**
Hardware consultancy	IT hardware professionals
Maintenance and repair of office, accounting and computing machinery	IT maintenance and repair staff
Publishing of software	IT software professionals
Other software consultancy and supply	IT software professionals
Data processing	Data processing and Database managers
Database activities	
Other computer related activities	All above categories
R&D (natural sciences and engineering)	R&D personnel
R&D (social sciences and humanities)	
Legal activities	Lawyers and other skilled legal workers
Accounting, book-keeping and auditing activities; tax consultancy	Accountants, auditors and related professionals
Market research and public opinion polling	Market research, marketing, and advertising professionals
Advertising	
Business and management consultancy activities	Management (senior management only?)
Management activities of holding companies	
Architectural and engineering activities and related technical consultancy	Architects Engineering and engineering design professionals
Technical testing and analysis	Technical testing and analysis professionals

Figure 2.1 takes up the approach of identifying KISA with occupations, and examines the distribution of these occupations in the Finnish economy. What is striking is that in all cases except one – computer professionals - only a minority of the profession is employed in the relevant KIBS industry. This underlines the pervasiveness of KISA. We do not have similar results as yet for other countries in such a systematic form, but the general trend does seem established in the data we have inspected.

Figure 2.1 KIBS and KISA Employment Compared



source: Statistics Finland, elaborated by Marja Toivonen, unpublished paper 2003

One UK study (Higgs et al 2008) does undertake a rather similar analysis – intriguingly focusing on two of the KISA which we are not paying central attention to

in the present study: professions associated with financial and creative services.[4] For financial KISA (the term KISA is not actually used by Higgs et al, who talk of "specialists"[5]), it was found that two thirds of the (something over a million) specialists worked outside the core Financial Services industry in 2001. 39% of all of the UK financial services workforce was estimated to be employed in non-financial services industries. Some 35% per cent of the total creative workforce (where this total includes support staff in creative industries) were similarly found to be employed in non-creative sectors. This "embedded creative employment" was most prominent in, especially, financial services, and also in manufacturing, real estate, business services, and wholesale and retail trade. NACE Division K (real estate and business activities) had the highest employment of creative specialists (306,328 people), and the second highest level of embedded creative employment (150,485). But this Division includes three of the creative industries (Computer software consultancy, Architectural services and Advertising services) defined in this study, along with twelve other sub-sectors. These account for many of the specialists. Nevertheless, examining these latter 12 "non-creative industries" there are still many specialists recorded in Division K: thus it is pointed out that in the "Legal, accounting, business consultancy" services there were over 40,000 embedded creatives – 37% in advertising and marketing functions, 33% in software development and 13% in architecture, design and visual arts roles. Table 2.1 reproduces some of the results presented in the Higgs et al study. Finally, it is interesting to note that Higgs et al also report that the sectors that made most use of financial expertise were also more likely to be employing creative specialists. It would be interesting to explore the relations with P-KISA and T-KISA, and extend this to firm-level studies. The methodology of the Higgs et al study provides something of a model for future work, even if we might quibble with some of the identification of C-KISA. Applying this sort of approach to KISA more generally, and for other countries, would be most worthwhile.

Table 2.1 "Creative" employment in UK NACE Section K, 2001 (to be added)

Figure 2.2 examines European data, but at a much higher level of aggregation. It presents data for three occupational classes as demarcated in the ISCO classification:[6]

1: Legislators, senior officials and managers (11 Legislators and senior officials; 12 Corporate managers; 13 Managers of small enterprises)

2: Professionals (21 Physical, mathematical and engineering science professionals; 22 Life science and health professionals; 23 Teaching professionals; 24 Other professionals)

---

4 "Creative software activities" are included in the creative professions here, it should be noted.

5 More precisely, the study defines the 'creative workforce' as comprised of three types of employment. (1) 'Specialist' artists, professionals or creative individuals – these are creative professionals working in creative industries. (2) 'Support' staff in creative industries providing management, secretarial, administrative or accountancy back-up – these include "non-creative professionals" and clerical and other staff in the creative sectors. (3) Creative individuals 'embedded' in other industries not defined as 'creative' – these are professional posts, since it is these that are identified as creative, and thus should match the specialists as identified in the creative industries in group (1).

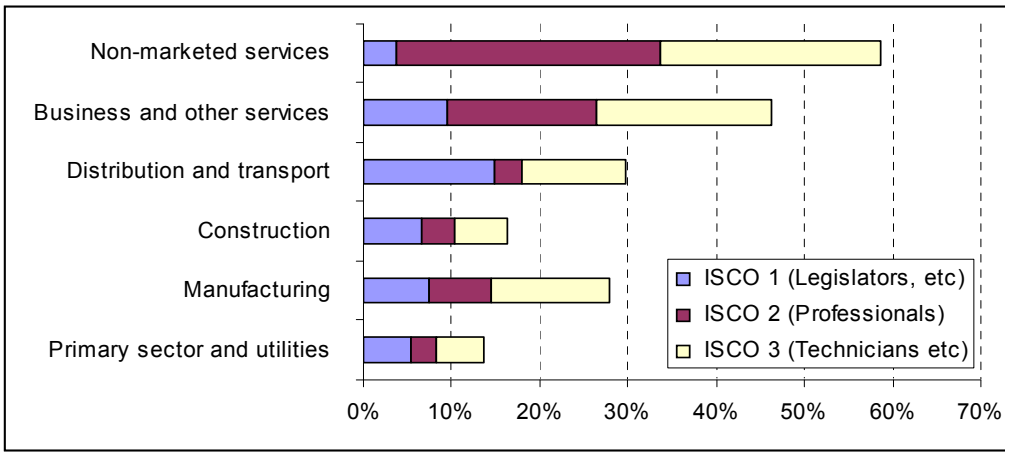
6 The remaining ISCO groups are: **Major group 4**: clerks (41 Office clerks; 42 Customer services clerks). **Major group 5**: service workers and shop and market sales workers (51 Personal and protective services workers; 52 Models, salespersons and demonstrators). **Major group 6**: Skilled agricultural and fishery workers (61 Skilled agricultural and fishery workers). **Major group 7**: craft and related trades workers (71 Extraction and building trades workers; 72 Metal, machinery and related trades workers; 73 Precision, handicraft, craft printing and related trades workers; 74 Other craft and related trades workers). **Major group 8**: plant and machine operators and assemblers (81 Stationary plant and related operators; 82 Machine operators and assemblers; 83 Drivers and mobile plant operators). **Major group 9**: elementary occupations (91 Sales and services elementary occupations; 92 Agricultural, fishery and related labourers; 93 Labourers in mining, construction, manufacturing and transport). **Major group 0**: armed forces.

3: Technicians and associate professionals (31 Physical and engineering science associate professionals; 32 Life science and health associate professionals; 33 Teaching associate professionals; 34 Other associate professionals).

Again, the data is indicative of the distribution of profession occupations across sectors – though one notable feature is the high share of KISA professions in KISA sectors. Another interesting feature concerns the ratio of "technicians" to the ISCO groups of professionals and senior managers.

What can be deduced about the composition of work from such data? As Table 2.2 demonstrates, there are typically fewer technicians than the sum of senior professionals and professionals. There are relatively high proportions of technicians in manufacturing, but quite possibly they – and a proportion of their peers in services – are tending for equipment more than supporting professionals. (Indeed, it is only in the Business and Non marketed services that there are more professionals than seniors.) This would tend to suggest that these KISAs are not typically marked by a high division of labour between those coded as professionals and technicians (as captured in these classifications).[7] There may also be some delegation of routine tasks to clerical workers.

Figure 2.2 Distribution of various Occupational categories across Sectors



Source: data from CEDEFOP (2008), Future Skills Needs in Europe

Table 2.2 Three KISA Occupational Groups

	ISCO groups - percentage of labour force			
	ISCO1 Legislators, senior officials and managers	ISCO2 Professionals	ISCO3 Technicians and associate professionals	**Ratio ISCO3 to ISCO1+ISCO2**
Primary sector and utilities	5.3%	3.0%	5.4%	65.6%

[7] If this were the case, we would tend to expect thereto be several technicians per professional. However, this is speculative, and it is quite possible that there is a substantial division of labour within the "professional" groups, such that many members of this group are actually working in support capacities for other members of the group. (If half of those in ISCO 2 are seen as supporting the other half, together with technicians, the ratio of professionals to supporters moves to 1:0.75 to 1:1.5, approximately.)

Manufacturing	7.4%	7.1%	13.5%	93.2%
Construction	6.7%	3.7%	6.0%	57.7%
Distribution and transport	14.8%	3.2%	11.8%	65.6%
Business and other services	9.6%	16.8%	19.8%	75.2%
Non-marketed services	3.7%	29.9%	25.1%	74.9%
All industries	8.7%	13.0%	16.1%	74.2%

Source: data from CEDEFOP (2008), Future Skills Needs in Europe

Knowledge-intensity might be assessed in various ways, of which the most frequently used is data on the educational attainments of the workforce – the share of employees who have completed education at primary, secondary and tertiary levels – which is translated into low, medium or high skills. Figure 2.2 present data on the composition of the labour force of major services sub sectors in these terms.

From Figure 2.2 we see that two mainly public services (education and health) and two private services (business services especially, and also financial services) have particularly large proportions for high skilled workers. Public administration is notable for its large share of medium skill jobs (presumably much of this is back- and front-office work). Such a classification, based on formal credentials, may of course fail to capture the knowledge acquired on the job or through informal channels. However, the sectoral differences that emerge from this approach do correspond fairly well with information on problem-solving, complexity of work, etc. as derived from working conditions surveys.

Figure 2.3 uses data from the Community Innovation Survey (CIS4 – the fourth implementation of this survey) to explore the nature of graduate employment in a little more detail. The CIS differentiates between employment of Science and Engineering graduates, and of "other graduates". As the figure indicates, some business services are dominated by the former – these are TKIBS. Those dominated by the latter are PKIBS (and some CKIBS, but we are not able to differentiate among these categories). We also see that telecommunications is technology graduate-intensive, financial services other graduate-intensive.

Figure 2.4 provides an alternative to a credential-based classification of jobs and sectors. This evidence, related to the types of work accomplished and working condition experienced, is drawn from the European Working Conditions Survey. This asks employees about their experiences at work. Figure 2.4a shows data in terms of the sectors within which the people work; Figure 2.b examines the experiences of people in different occupations. The indicators are crude and imperfect, but clearly show:

Service sectors involve more contact with people such as customers;

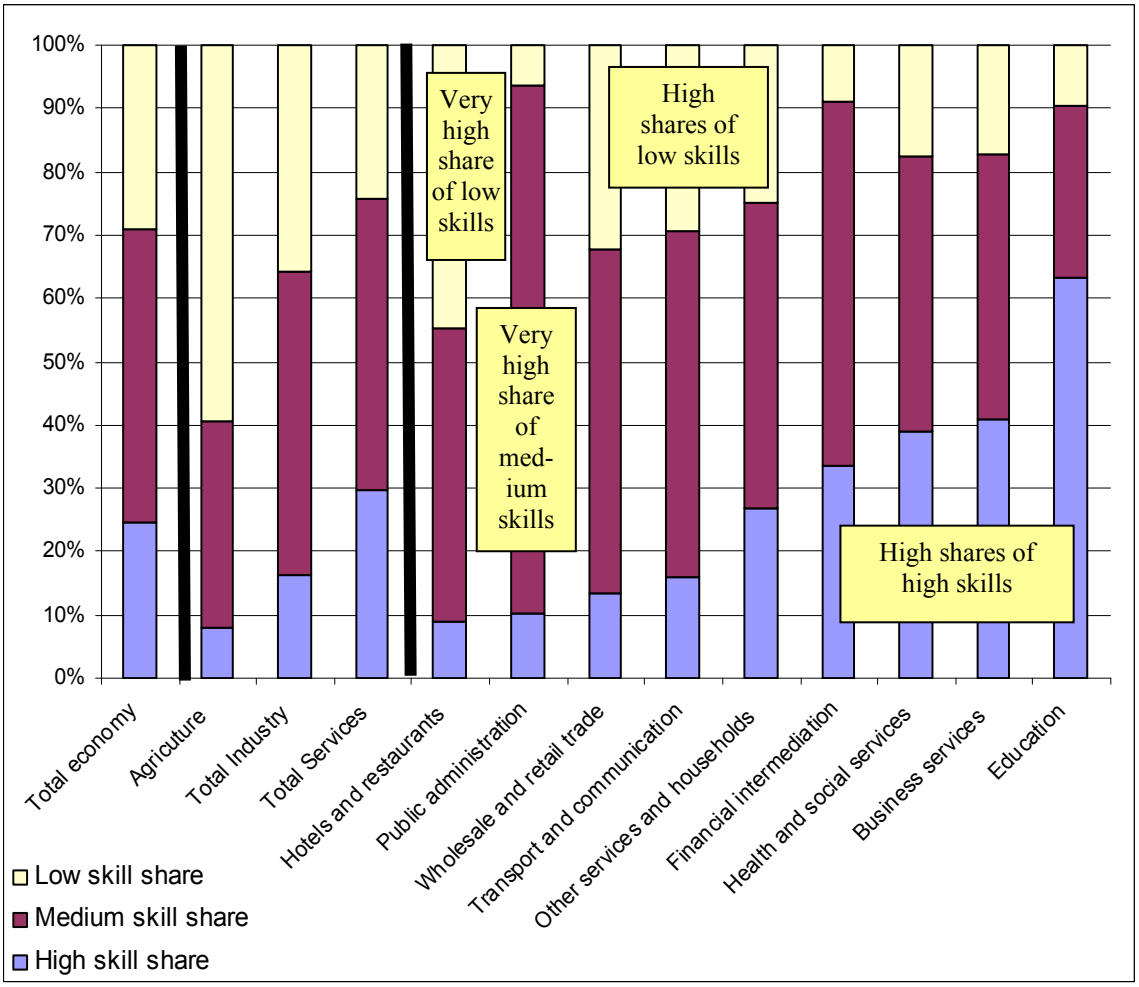
Finance, real estate and business services, public services like education feature relatively large shares of jobs where the employees report complex tasks, problem-solving, learning new things on the job, computer and internet use, and so on, and relatively low shares of people reporting monotonous work (these are the sectors with high levels of high-skill employment as measured by credentials);

The reverse ends to be the case for transport and trade services, and HORECA (hotels, restaurants and catering) - these are the sectors with low levels of high-skill employment as measured by credentials;

The three ISCO KISA categories, we identified earlier feature work that is more complex, demanding, and knowledge-intensive – like the picture for business services.

We see that some types of industry, and some types of occupation, feature less routine work and more complex, challenging, and problem-solving work. This is particularly marked for KIBS (within business services) and KISA (as managerial, professional and technical occupations). It would be interesting to further disaggregate these data, exploring the experience of occupations within specific industries, examining specific KIBS in more detail, and so on. But these indicators do tend to validate the use of credentials as a way of identifying knowledge-intensity, since this very different approach yields similar results.

Figure 2.2 Skill Composition of Economic Sectors in the EU-15, 2000

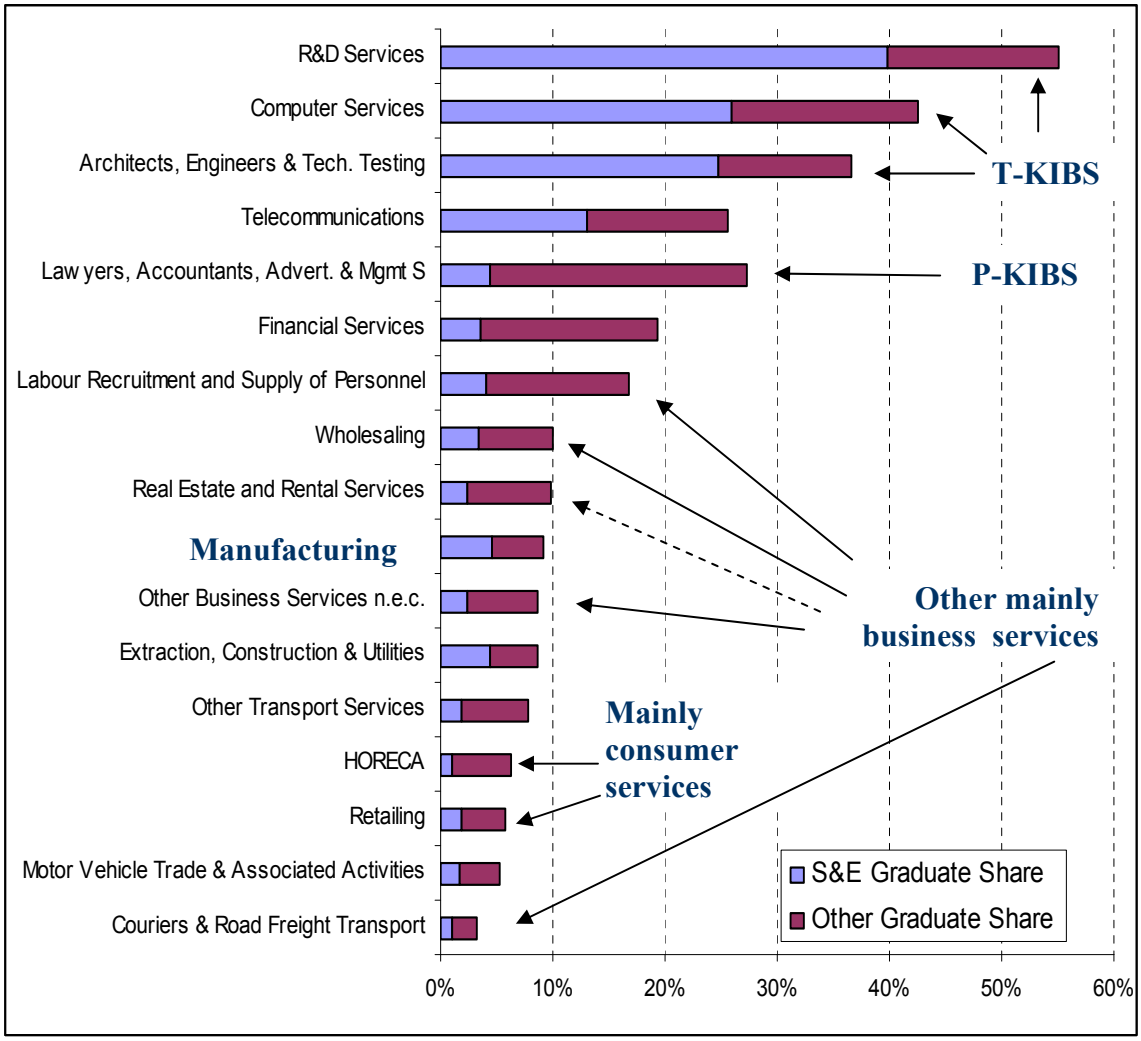


Note: low skill is defined in terms of attainment of less than upper secondary education (below level 3 in the International Standard Classification of Education (ISCED) classification); medium skill involves attainment of upper secondary education (ISCED level 3). High skill is an attainment of higher education (ISCED levels 5, 6, and 7).

Source: developed from data and skill classifications presented in annexes to EC (2005)

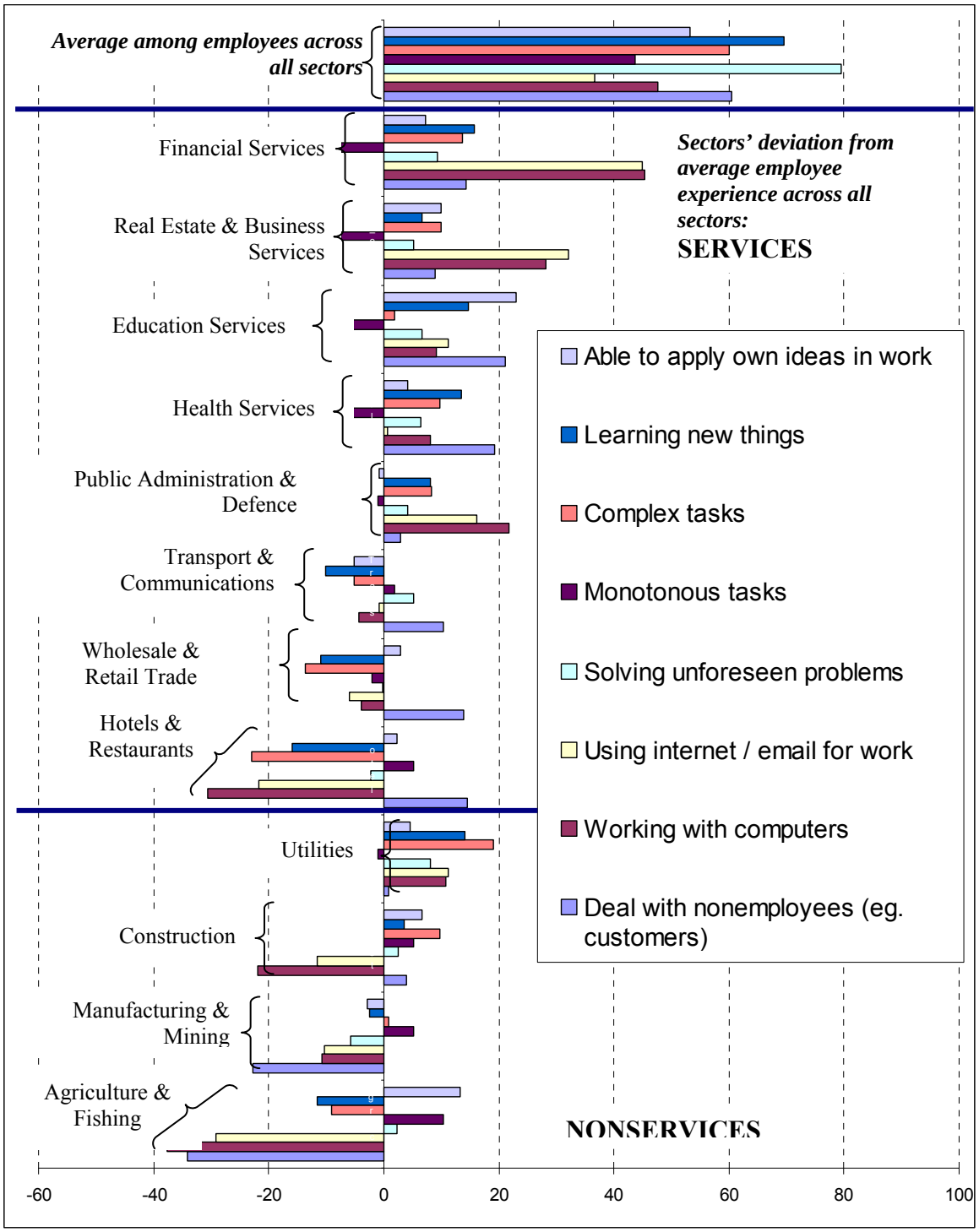
Figure 2.3 Employment of Graduates in Major Sectors, UK 2004

Mean share of graduates in firms' total employment (unweighted)



source: derived from UK CIS4 data, using approach presented in Tether and Swann (2003) for CIS3 data.

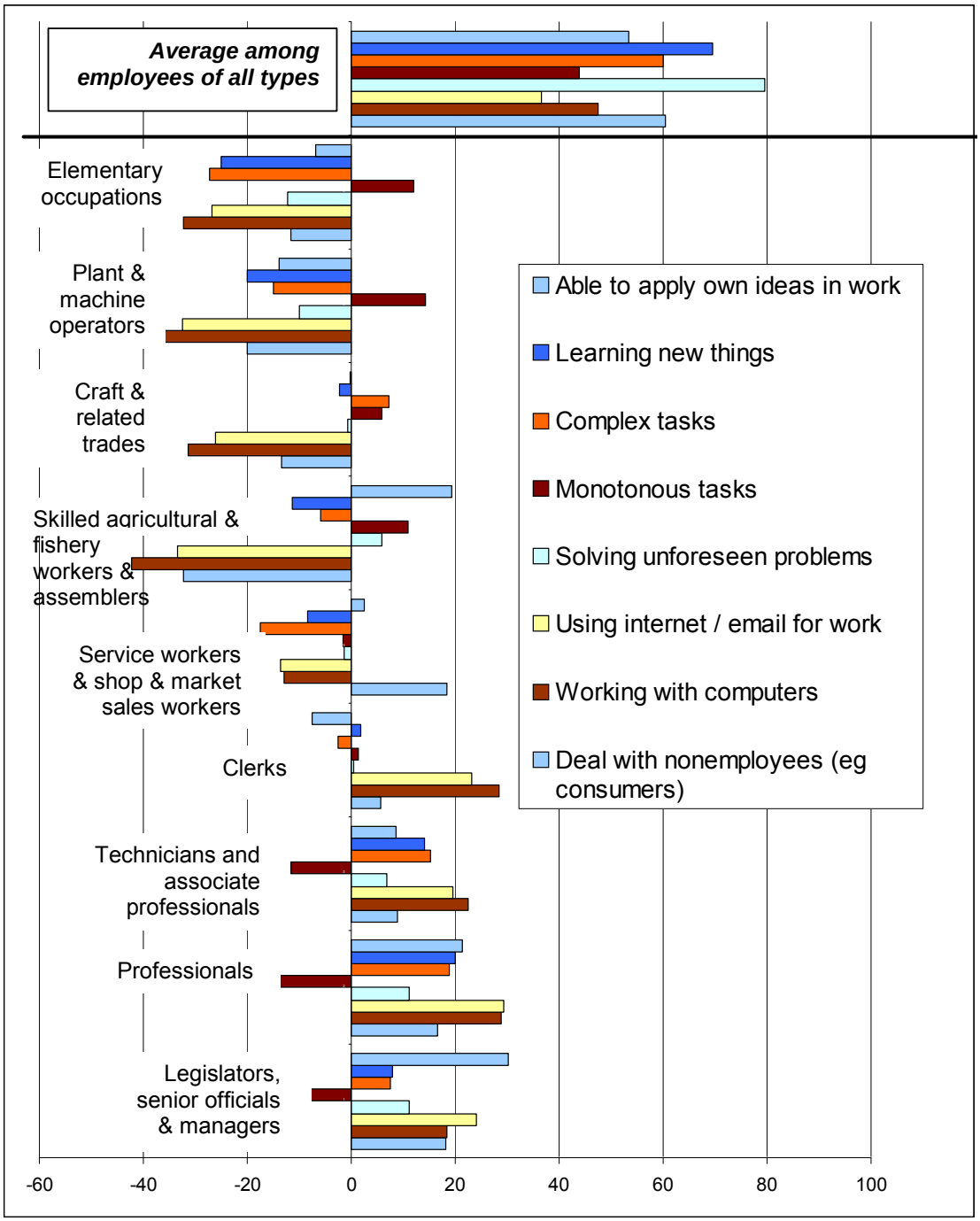
Figure 2.4a Features of Work in Sectors of European Economy (EU-27+), 2005



Source: based on data in Parent-Thirion, A., Fernández Macías, E., Hurley, J., and Vermeylen, G., (2007) Fourth European Working Conditions Survey, European Foundation for the Improvement of Living and Working Conditions, Dublin available at: http://www.eurofound.europa.eu/pubdocs/2006/98/en/2/ef0698en.pdf

Notes: countries covered are EU27 plus Croatia, Norway, Switzerland, Turkey. The comparison with the average for employees will not take into account the experience of self-employed people.

Figure 2.4b features of Jobs in Occupational Groups of European Economy (EU-27+), 2005



Source and Notes: as in Figure 2.3a.

3. Skills in KISA

3.1 What are skills?

At their most general level "skills" are usually viewed as the abilities of people (including management, leadership abilities, technical, scientific and production abilities and soft/interpersonal abilities) for which there is a demand within the formal economy. People typically acquire skills that enable them to implement existing technologies (whether using the plough or the PC) and fit in with current ways of doing things. They also acquire skills that assist them in developing novel products and services or in organising work and production processes in new ways. However knowing and measuring what skills people have and therefore determining population based movements in the levels of skills over time is difficult. Qualifications levels are used as a proxy for skills is used as it is easier to do this than attempting to develop a fuller measure of an individual's skill base. This approach has limitations as it ignores, among other things, the skills base gained tacitly or informally through on *the on the job training* etc.

For classification purposes (e.g., the International Standard Classification of Occupations ISCO) the concept of skill is intertwined with the concept of the kind of work performed – a job – to define an occupation. A 'job' is defined as a set of tasks or duties to be carried out by one person, the notion of a job represents a basic element in the employment relationship (Elias 1999). Jobs are usually structured by employers (or by the worker in the case of self-employment) and others, including professional bodies, employer and/or worker organisations and governments, may regulate their definition. Skill is defined as the ability to carry out the tasks and duties of a job in a competent, thorough and efficient manner. Skill levels are defined in terms of complexity of the tasks and duties to be performed and skill specialisation are defined as the field of knowledge required for competent, thorough and efficient conduct of the tasks.

Within ISCO, for example, **four skill levels** are broadly defined and given that skill is related to the complexity of the tasks and duties to be performed, skill levels are linked to the length of time deemed necessary for a person to become fully competent in the performance of the tasks associated with a job.
The **first skill level** equates with the competence associated with a general education, usually acquired by the time a person completes his/her compulsory education and is signalled via a satisfactory set of school-leaving examination grades. Competent performance of jobs classified at this level will also involve knowledge of appropriate health and safety regulations and may require short periods of work-related training.
The **second skill level** covers a large group of occupations, all of which require the knowledge provided via an extensive general education as for occupations at the first skill level, but which typically have a longer period of work-related training or work experience. Occupations classified at this level including machine operation, driving, caring occupations, retailing, and clerical and secretarial occupations.
The **third skill level** applies to occupations that normally require a body of knowledge associated with a period of post-compulsory education but not to tertiary degree level. A number of technical occupations fall into this category, as well as a range of trades occupations and proprietors of small businesses. In the latter case, educational qualifications at sub-degree level or a lengthy period of vocational training may not be a necessary requirement for competent performance of tasks, but a significant period of work experience is typical.

The **fourth skill level** relates to what are termed 'professional' occupations and managerial positions in corporate enterprises or national/local government. Occupations at this level normally require a degree or equivalent period of relevant work experience.

Classification systems like ISCO express skill in terms of type of work, qualification levels (educational attainment) and existing occupational structures. Changes in the nature of skills demanded by employers and skills supplied by employees are not readily apparent from existing classification systems, based on legacy data compilations and not rapid data capture, where a new paradigm exists of required constant adaptation to changing market situations.

This has been recognised for a long time. Merton (1947) for example, foresaw problems arising from the wholesale reorganisation of work and associated loss of transparency of occupational names: "splintering of work tasks involves loss of public identity of the job". Areas in which transformed or new occupations, and consequently new or converged skill sets, have emerged or are emerging include, computing and related occupations, managerial occupations, conservation and environmental occupations, customer service occupations and distributed remote service provision.

Managerial occupations form an area where there is widespread lack of consensus in definition (across the EU) and an inflation in skill definition through the use of the title "manager" in jobs not previously regarded as managerial. A "personal assistant" has become an "executive assistant". But there may be changes in job content as well as in job title. The "executive assistant" post is no longer essentially a clerical job; it is now one whose holder should display initiative, make efficient use of information technology and maybe able to move to a more traditional managerial position at some future stage. In health care, some nursing occupations are now defined in terms of a requisite university level education: changes which could not have taken place in the absence of a supply of suitably qualified persons and may well have been consequential upon such availability.

Becker (1964), in his classic work on the distinction between general and specific training, defined skills bases being constituted by general, generic and transferable skills. However the boundaries in different economic sectors (and sub sectors) can be inherently varied depending on the degree to which work processes and hence types of skills required can be varied. Processes which involve the wholesale replacement of a technology and its associated infrastructure and skill structure destroy whole fields of competences and radically alter the boundaries between general and specific skills and this introduces uncertainties into the calculation of benefit for both employers and employees of new skill acquisition and recognition, anyway, of what those new skills could or should be. Software and associated skills are especially subject to rapid obsolescence or to sudden expansions and contractions in their areas of applicability for example.

Generic skills are often regarded as the basic social and mechanical skills which are perceived as being acquirable through the educational and training systems and which are necessary for individuals to have to ease integration into the labour market. This is an area of some difficulty as it is not clear whether deficiencies in education and training systems have failed to socialise individuals for successful labour market entry or whether the minimum levels of general skills necessary for labour force participation are being raised by technological advances and increasing social complexity. Transferable skills, which are not always easily distinguishable

from generic skills, have been defined as those skills which (whilst not completely generic) are easily adaptable to new contexts and environments. However, as noted above, these notions of skills have followed different paths in different countries and have led to discrepancies in terminology from one cultural tradition to another.

Becker's market-oriented dichotomy, between generic and transferable skills, in terms of their value in encouraging investment in new skills in the face of waves of skills obsolescence, is perhaps uncertain - since the true scope of applicability of such skills is itself uncertain. The reason for this may lie in current models of employment where workers are priced on the basis of fitting into a definite slot in a given task procedure(s) and firms have not historically been equipped to plan for skill changes which new technologies will require in the future (Snower 1996 p.106). For SMES and micro businesses, opportunities for any kind of long term projections of skill needs may be lacking, simply because of market instability and because of being fully occupied on day to day decisions. Market unpredictability and lack of rapid data capture concerning skills uptake might also affect the effectiveness of the networks of advisers and consultants who service such entities.

3.2 Skills Frameworks

Classifying skills and exploring the combinations of skills in specific occupations is related to estimating different types of labour quality currently and potentially available. As we noted above the number of labour skill types is traditionally based on educational attainment or qualifications but skills classifications differ across countries as does the content of educational attainment and qualifications.

A large study (2003, O'Mahoney & van Ark) illuminated this problem finding that the number of labour skill types varied across European countries and this presented difficulties when calculating growth trends across EU industry sectors. The table showed variations in four countries which they compared to US types.

France	**Netherlands**
1. Bachelor degree and above 2. Baccalaureate plus 2 years 3. Baccalaureate 4. Vocational (CAP, BEP ou autre de ce niveau) 5. General Educational (BEPC) 6. No formal qualifications	1. Master degree and above 2. HBO 3. HAVO/VWO 4. MAVO 5. MBO 6. LBO/VBO 7. Primary educational level
US	**UK**
1. Bachelor degree and above 2. Associate degrees 3. Some college, no degree 4. High school graduate 5. Did not complete high school	1. First degree and above 2. Other NVQ4 3. NVQ3 4. NVQ2 & NVQ1 5. No formal qualification
Germany	
1. Higher education (16-17 years education plus) 2. Vocational degree 3. No degree	

In the US division at the post-secondary level depends on the number of years of college attendance and/or whether a degree was awarded. First degrees and above in the US are awarded after 3-4 years of study and tend to be dominated by academic subjects. Associate degrees are shorter, 2–3 years, and are dominated by vocational subjects areas. The final two categories distinguish those who have

graduated from high school from others and so is more an attendance than an attainment measure. The categories used in the UK were different at the intermediate/lower end, although degrees and higher level below degree (other NVQ4) are roughly equivalent to the US first degree and above and associate categories, respectively. The category NVQ3 includes school leavers who have achieved at least one pass at A-level and equivalent vocational qualifications. NVQ12 includes school leavers with passes in the main examinations taken at age 16 (GCSE) plus lower level vocational qualifications. For France, the categories Bachelor degrees and Baccalaureate plus two years are broadly equivalent to the US university degrees and associate degrees. Baccalaureate is similar to the UK A levels whereas the vocational qualifications can be achieved at a number of different levels. BEPC is similar to the UK GCSE. In the Netherlands, there are seven levels of educational attainment. The higher level categories are less comparable to other countries in that most students in academic subject areas complete a masters degree or above. The next level down (HBO) is tertiary education, but more of a vocational type. MAVO/HAVO/VWO is general education which normally leads to entry into a higher level, taking up 4 to 6 years of study after primary school. LBO/VBO and MBO are vocational schooling, taking up a maximum of 4 to 6 years after primary school. Primary schooling (the lowest category) ends at age 12. People in the final category have the lowest educational attainment which is completed primary schooling or below. The German skill categories only show a three way division into higher education, vocational and other. A finer classification is available for employment, dividing in particular the two lowest groups.

What educational attainment does not tell us is the nature, character or content of skill acquisition. Roos and Treiman (1980) made an important contribution to defining skills and skills sets based on the US Dictionary of Occupational Titles (Miller at el 1980) where jobs are viewed in terms of the complexity of the work they involve, with respect to **data**, **people**, and **things**. These sets are understood as:

> **Data** – **manipulating data, dealing with information, ideas and content** - the extent to which the job requires cognitive skills so that data can be compared, compiled, interpreted, etc. *(In Miller et al the least complex tasks involve comparing and copying, the most complex ones co-ordinating and synthesising)*
> **People** - the extent to which the job requires social and interpersonal skills so that other people can be attended to, understood, motivated, etc. *(In Miller et al the least complex tasks involve taking instructions and serving people, the most complex ones negotiating and mentoring)*
> **Things - Technical/equipment skills** - the extent to which the job requires skills in using equipment: these may be motor skills (involving physical dexterity) or more based on ability to work with complex machines or systems. *(In Miller et al the least complex tasks involve precision working and setting up systems)*

This approach underpins the basis of the US O*Net data capture system (see below) in elaborating important skill sets (which is wider than offered by ISCO for example).[8] The lists in Box 3.1 provide further explication.

Box 3.1 Six Sets of Skills

Basic Skills - Developed capacities that facilitate learning or the more rapid acquisition of knowledge

- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Active Listening — Giving full attention to what other people are saying, taking time to understand

[8] The six skills sets which form the basis of the KISA survey are derived from this source.

the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Learning Strategies — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.
- Mathematics — Using mathematics to solve problems.
- Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
- Science — Using scientific rules and methods to solve problems.
- Speaking — Talking to others to convey information effectively.
- Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Complex Problem Solving Skills - Developed capacities used to solve novel, ill-defined problems in complex, real-world settings

- Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Resource Management Skills - Developed capacities used to allocate resources efficiently

- Management of Financial Resources — Determining how money will be spent to get the work done, and accounting for these expenditures.
- Management of Material Resources — Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.
- Management of Personnel Resources — Motivating, developing, and directing people as they work, identifying the best people for the job.
- Time Management — Managing one's own time and the time of others.

Social Skills - Developed capacities used to work with people to achieve goals

- Coordination — Adjusting actions in relation to others' actions.
- Instructing — Teaching others how to do something.
- Negotiation — Bringing others together and trying to reconcile differences.
- Persuasion — Persuading others to change their minds or behavior.
- Service Orientation — Actively looking for ways to help people.
- Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Systems Skills - Developed capacities used to understand, monitor, and improve socio-technical systems

- Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
- Systems Analysis — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
- Systems Evaluation — Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

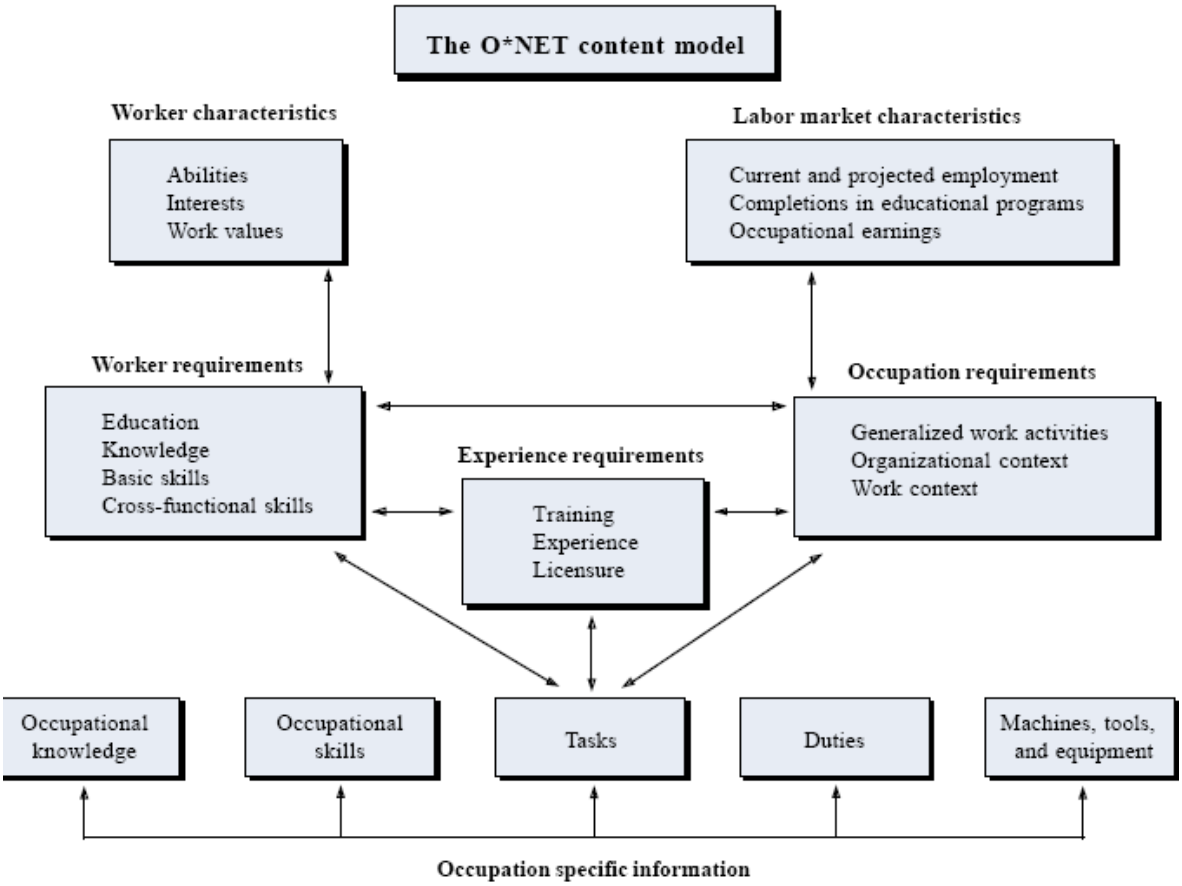
Technical Skills - Developed capacities used to design, set-up, operate, and correct malfunctions involving application of machines or technological systems

- Equipment Maintenance — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
- Equipment Selection — Determining the kind of tools and equipment needed to do a job.
- Installation — Installing equipment, machines, wiring, or programs to meet specifications.
- Operation and Control — Controlling operations of equipment or systems.
- Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.
- Operations Analysis — Analyzing needs and product requirements to create a design.
- Programming — Writing computer programs for various purposes.
- Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
- Repairing — Repairing machines or systems using the needed tools.
- Technology Design — Generating or adapting equipment and technology to serve user needs.
- Troubleshooting — Determining causes of operating errors and deciding what to do about it.

Source: http://online.onetcenter.org/skills/

This approach has been developed as the basis of the US' O*Net,[9] a public domain on line comprehensive data capture system designed to describe occupations (currently 1,100 are covered). It uses multiple descriptors to provide "multiple windows" on the world of work, utilizes cross-job descriptors to provide a common language to describe different jobs, and uses an hierarchical taxonomic approach to occupational descriptors. The Content Model of O*Net contains descriptor domains which are detailed below. The Content Model is the conceptual foundation of O*NET and provides a framework that identifies the most important types of information about work and integrates them into a theoretically and empirically sound system. Figure 3.1 displays the parts of the Content Model and how they are related.

Figure 3.1 The O*Net Content Model



The Content Model was developed using research on job and organizational analysis. It embodies a view that reflects the character of occupations (via job-oriented descriptors) and people (via worker-oriented descriptors). The Content Model also allows occupational information to be applied across jobs, sectors, or industries (cross-occupational descriptors) and within occupations (occupational-specific descriptors). Table 3.1 shows how the parts of the O*NET Content Model are classified.

[9] http://www.doleta.gov/programs/onet

Table 3.1 Cross Classification Table of O*NET Occupational Information

Type of Occupational Information		
Specificity of Application	*Job-Oriented Descriptors*	*Worker-Oriented Descriptors*
Cross Occupation Descriptors	Generalized Work Activities Work Context Organizational Context Labor Market Information Occupational Outlook Wages	Skills Knowledges Education Abilities Interests Work Styles Training Experience Licensing
Occupation Specific Descriptors	Tasks Machines, Tools, and Equipment Labor Market Information Occupational Outlook Wages	Occupational Skills Occupational Knowledges Training Experience Licensing

The Content Model is organized into six major domains. These are: Worker Characteristics, Worker Requirements, Experience Requirements, Occupation Requirements, Occupational Characteristics, and Occupation-Specific Information. The structure enables the user to focus on areas of information that specify the key attributes and characteristics of workers and occupations. The following accounts briefly describe the information included within each domain.

Worker Characteristics — enduring characteristics that might influence both performance and the capacities to acquire knowledge and skills required for effective work performance. Worker characteristics comprise enduring qualities of individuals that may influence how they approach tasks and how they acquire work-relevant knowledges and skills. Traditionally, abilities have been the most common technique for comparing jobs in terms of these characteristics. However, recent research supports the inclusion of other types of worker characteristics. In particular, interests, values, and work styles have received support in the organizational literature. Interests and values reflect preferences for work environments and outcomes. Work style variables represent typical procedural/process differences in the way work is performed.

Worker Requirements — category of descriptors referring to work-related attributes acquired and/or developed through experience and education. Worker requirements represent developed or acquired attributes of an individual that may be related to performance. Knowledge represents the acquisition of facts and principles about a domain of information. Experience lays the foundation for establishing procedures to work with given knowledges. This set of procedures is more commonly known as skills. Skills may be further divided into basic skills (skills, such as reading, that facilitate the acquisition of new knowledge) and cross-functional skills (skills, such as problem solving, that extend across several domains of activities).

Experience Requirements — requirements related to previous activities; explicitly linked to certain types of work activities. This domain includes information about the typical experiential backgrounds of workers in an occupation or group of occupations. Certification, licensure, and training data also are available. For example, information about the professional or organizational certifications required for entry and advancement, preferred education or training, and required apprenticeships all will be documented by this part of the model.

Occupational Characteristics — variables that define and describe the general characteristics of occupations that may influence occupational requirements. Organizations do not exist in isolation. They must operate within a broader social and economic structure. To be useful, an occupational classification system must incorporate these global contextual characteristics. O*NET provides this information by linking descriptive occupational information to statistical labor market information. This includes compensation and wage data, employment outlook, and industry size information. Much of this information is collected outside of O*NET's immediate scope. Collaborative efforts with organizations such as the Bureau of Labor Statistics, the Department of Commerce, The Department of Defense, America's Job Bank, The U. S. Bureau of the Census, and The Employment and Training Administration facilitates these labor market information linkages.

Occupational Requirements — a comprehensive set of variables or detailed elements that describe what various occupations require. This domain includes information about typical activities required across occupations. Task information is often too specific to describe an occupation or occupational group. The O*NET approach is to identify generalized work activities (GWAs) or dimensions that summarize the kinds of tasks that may be performed within multiple occupations. Using this framework it is possible to use a single set of descriptors to describe many occupations. Contextual variables (e.g., the physical, social, or structural context of work) that may impose specific demands on the worker or activities are also included in this section.

Occupation-Specific Information — reflects variables or other Content Model elements in terms of selected or specific occupations. Occupation-specific information details a comprehensive set of elements that apply to a single occupation or a narrowly defined job family. This domain parallels other Content Model domains in that it includes requirements such as knowledges, skills, tasks, and machines, tools, and equipment. Similarly, labor market information defined by industry or occupation is also provided here. This domain is particularly important when developing specific applications of O*NET information. For example, to specify training, develop position descriptions, or redesign jobs, it is necessary to refer to occupation-specific descriptive information.

Labour Market Characteristics: - employment projections and earnings data fall within this domain and include national occupational employment projections from the US Bureau of Labour Statistics, wage data from US Occupational Employment Survey and the Current Population Survey and there are also now cross walking links to regional and local data.

The O*Net capacity has now been further enlarged to encompass what are termed New and Evolving Occupations (N&E) (O* Net Methodology Report, 2006) New occupations are described as those where skill sets (knowledge, skills, abilities and work activities) are so new they are not captured by present occupational classifications. Evolving occupations are described as established occupations that have seen a rapid change in their skill sets in recent years and as a result required updated information. Identifying these occupations requires data collection on whether the occupation involves significantly different work than that performed by

job incumbents of other occupations, information about the history of the development of the occupation (due to changes in technology, society, law or business practices), employment growth, education, licensure and certification requirements, related professional associations and related journal and professional publications. The current US high growth sectors include biotechnology, energy, financial services, geospatial technology, health care, hospitality, IT, retail trade and transportation.

Mahoney and van Ark (2003) have explored developing a general skills taxonomy (including ICT) for all industries combining the Eurostat skills database (EULFS based on 15 countries and which gives data on diversity of skills structure) and data from UK and US skill taxonomies (which allow more detailed analysis at the intermediate skill level). Skill intensity is measured by the number of people classified by NACE industry sector and ISCED categories. Their approach has resulted in a 4 level taxonomy comprised of high skill (HS), high intermediate skills (HIS), low intermediate skills (LIS) and low skilled (LS) which they have combined with an ICT taxonomy and innovation taxonomy for all industries. The services innovation taxonomy is based on the work of van Ark, Broersma and den Hartog (2003) who describe 5 patterns of innovation in services dependent on the relationship between inputs (the supplier relationship), the client firm or final consumer (client relationship) and the nature of the innovation provided within the firm itself. The five patterns are:
1. Supplier dominated innovation:
2. Innovation within services:
3. Client led innovation:
4. Innovation through services:
5. Paradigmatic innovations

This approach has not been fully explored within this study but it is an approach which offers a productive framework for understanding the relationship between skill structure and innovation patterns. The table below indicates how the combined taxonomy is described for sectors of interest to this study:

Table 3.1a

Industry	ICT Taxonomy	Skills Taxonomy	Occupational Taxonomy	Innovation Taxonomy
Computer & related activities	**ICTPS**	**HS**	**IOPS**	**SSS**
Research & Development	**ICTUS**	**HS**	**IOU**	**SSS**
Legal, technical, advertising	**ICTUS**	**HS**	**IOU**	**SSS**
Other Business Services	**NICTS**	**HS**	**IOU**	**CLS**

ICPTS=ICT Producing Services
ICTUS=ICT Using Services
NICTS=Non ICT Services
IOPS=IT Producer Service
IOU=Dynamic IT User
SSS = Specialised service suppliers
CLS=Client led services
HS = High skill

Source :Mahoney & van Ark (2003)

3.3 Skills and KISAs

Until recently, there was little exploration of the skills required for KISAs, but several recent studies have addressed this topic – notably some of the research reports

developed for Skillsnet UK around the turn of the century: alhough a few years old, these studies still offer a great deal of relevant information.

Penn & Holt (2000) explored skills in a number of what we have termed PKIBS – KIBS that are largely based on professional rather than technological knowledge. The sectors considered were Management consultancy, Advertising, Market research, Legal services, and Accounting. While there were many differences across these sectors, they also found a number of common features – and indeed, found some blurring of functions (for example, accountants offering management consultancy services; and Information Technology Service firms moving into these professional service areas – and professional service firms offering IT-related KISAs). Though "multi-skilling" has long been a feature of all sectors, this blurring is increasing pressure for this – as are other changes, and all the sectors were found to be undergoing considerable structural change.

One common trajectory, very much related to the continuing diffusion and further development of IT systems for supporting KISA, has been growing requirements for IT associate professionals. One important consequence of this is blurring at the occupational level - between professional and support staff (previously rather sharply distinguished).[10] But the development here is complicated. On the one hand, IT specialists are often moving into the professional category, acquiring relevant skills. Meanwhile, established professionals are often acquiring new IT skills. All sectors – perhaps especially the "creative" activities of consultancy, advertising, etc. – are being reshaped by Internet use. The study also reported that on-the-job training is an important way of acquiring relevant skills. The way this is accomplished varies across KIBS sectors. It is typically highly company- specific in management consultancy, but less so for advertising and market research.

Another study in this series examined a number of KISA occupations: Rodgers & Waters (2001), took a number of what they labelled **Business And Public Service Associate Professionals** (BPSAP) which appear to be mainly ISCO group 3 professions - five such occupations were selected for case study work: insurance underwriters, legal associate professionals (legal executives and barristers clerks), personnel officers (including recruitment consultants), market researchers and estate agents. Some of these are arguably ISCO2 roles.[11] As this selection indicates, KISA, ISCO2, and the BPSAP categories are extremely heterogeneous, even if they are at the lower skill levels of KISA professional work. The "minor groups" they are

[10] The authors note that much earlier literature depicts a 'dual model' of employment in these sectors. In this model, firms are clearly divided between professionals and non-professional support staff. But the growing importance of IT has meant that IT specialists have been necessary. Such specialists are hard to fit into the traditional professional frameworks – their skills, capabilities, qualifications are too different.

[11] Rodgers & Waters note some uncertainty about definitions, and point to the definition of associate professionals given by the ONS (2000) in its revised Standard Occupational Classification 20004. This states that: "*The major group Associate Professional and Technical Occupations] covers occupations whose main tasks require experience and knowledge of principles and practices necessary to assume operational responsibility and to give technical support to Professionals in the natural sciences, humanities and related fields and to Managers and Senior Officials. The main tasks involve the operation and maintenance of complex equipment; legal, financial and design services; the provision of information technology services; providing skilled support to health and social care professionals; and serving in protective service occupations. Culture, media and sports occupations are also included in this major group. Most occupations in this major group will have an associated high-level vocational qualification, often involving a substantial period of full-time training or further study. Some additional task-related training is usually provided through a formal period of induction."* Associate professionals usually have higher educational attainment than the rest of the intermediate skills category with which they are grouped, in which they tend to have atypical qualifications. In general intermediate level occupations are characterised as: *Needing a considerable amount of job-related training, or an equivalent time spent gaining experience of the work involved; Requiring some formal qualifications at entry (typically below the level of a higher education award).* However, the authors also note that By 2009 it is anticipated that around 27 per cent of associate professionals will be graduates (Skills Task Force, 2000b).

composed of have different skill needs, entry routes and skill development strategies, but the study was able to identify cross-cutting features of, and trends that apply widely to KISA professions. Note that the study is again mainly concerned by non-technology KISA, though they have their own requirement for technical skills.

Employment growth was seen as reflecting both an absolute growth in demand for employees to perform these job roles, and a reclassification of job roles such that some BPSAP job roles have come to incorporate tasks that were earlier associated with other occupational titles. In terms of skills, the jobs were seen to require various combinations of:

technical skills
generic skills and
personal attributes.[12]

The KISA employees require a complex mix of these three skills to provide and effectively deliver the KISA in question. This is mainly achieved through a combination of technical knowledge and effective customer handling skills; these are underpinned by relevant personal attributes.

Three categories of skills combinations were identified;

1 'Traditional' Associate Professionals. These employees require a high level of technical skills with above average generic skills and well-developed personal attributes. The ability of individuals to perform their job is largely determined by the technical knowledge and skills that they possess. The majority of BPSAP occupations are positioned in this category….

2 'Transitional' Associate Professionals. This group of employees requires an average level of technical skills. High-level generic skills and well-developed personal attributes are the key skills defining the job role. Job roles in this group are most likely to be undergoing some form of reclassification, with additional job tasks being incorporated into the job role

3 'Generic' Associate Professionals. These employees require high-level generic skills and personal attributes but relatively low levels of technical skills. The skills required for these associate professional roles are largely transferable and, as such, this range of job roles typically has lower entry requirements and higher levels of employee turnover…." (p2, our emboldening)

(Of the case study KISA occupations, Sales Underwriters (one of two sets of underwriters differentiated in the course of research) were seen to belong more to the 'general associate professional' group than to the traditional associate professional occupational group.)

.

More detailed descriptions of the skill requirements associated with the three groups, with examples form the case studies, are provided in Box 3.2.

Box 3.2 Characteristics of Three KISA skill groupings

Skills Mix A - 'Traditional' Associate Professionals

- The associate professional occupations located in this grouping require a high level of technical skills, above average generic skills and well-developed personal attributes such as interpersonal skills. The ability of individuals to perform their job role is largely determined by the technical knowledge and skills that they possess with generic and personal attributes, although important, typically being secondary in importance.
- The majority of associate professional occupations are positioned in this category. Indeed, the range and magnitude of skills

[12] These categories are initially defined very sparsely, as follows: "Technical skills are … specific to the particular job role and require a certain degree of theoretical knowledge and competence. Generic skills … can be transferred between occupations and sectors. Personal attributes (e.g. confidence, tenacity) are considered innate."

found in this group are those that have traditionally been found in archetypal associate professional occupations. Examples of BPSAP occupations located in this group include legal executives, market researchers and technical insurance underwriters.
- Legal executives require in-depth technical knowledge about the area of law in which they specialise, plus a detailed understanding of legal protocol. Meanwhile market researchers need to possess research skills as well as have the ability to analyse and report upon the findings of the research undertaken. Finally, technical underwriters need to be able to assess a risk and decide upon the level of risk the particular policy poses to the firm before underwriting that risk. Technical skills and knowledge are therefore key to performing the job role. However, all three case study occupations also require employees to hold high level interpersonal and customer handling techniques in order to provide an appropriate level of customer service.

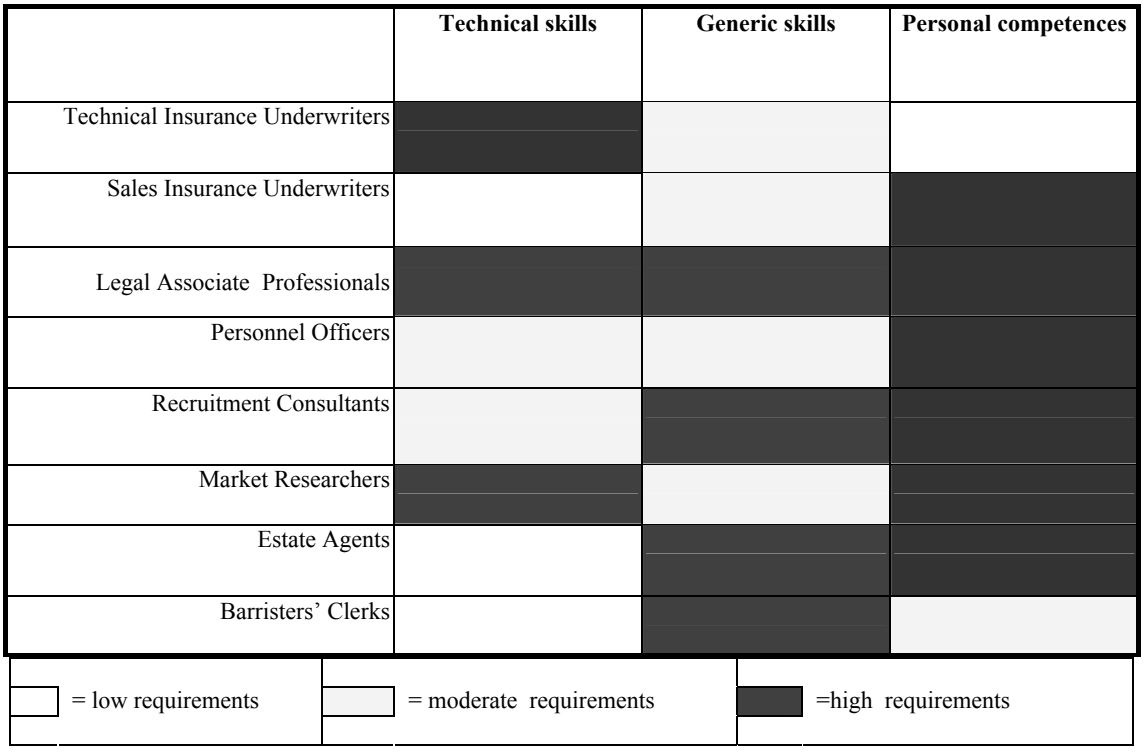
Skills Mix B - 'Transitional' Associate Professionals
- The BPSAP occupations that are situated in this category are characterised as having high-level generic skills, well-developed personal attributes and average level technical skills.
- Generic and personal attributes are the key pertinent skills shaping these occupations and determining a person's ability to perform a job role. Technical skills are typically secondary in importance to generic and interpersonal skills. However employees do require an intermediate level of technical knowledge in order to be able to carry out their job tasks.
- Examples of associate professional occupations falling into this group include personnel and development officers and recruitment consultants.
- The occupational groups located in this category are most likely to have undergone, or be undergoing, some form of reclassification of the skills needed to undertake the job role.
- For instance, personnel officers no longer merely perform a welfare and administrative role for which few technical skills are required. Personnel officers are increasingly likely to perform a strategic function which requires the ability to undertake strategic decision making within the wider business process. In addition, the introduction of additional employment regulation means that personnel officers now need to possess and maintain higher levels of technical knowledge e.g. employment law.
- The technical knowledge needed by recruitment consultants has also increased. The continuing shift in the recruitment consultant industry away from generalist towards specialist recruitment consultancy means that employees now need high levels of germane technical industry knowledge in order to carry out the job role more effectively.

Skills Mix C -'Generic Associate Professionals'
- People employed in these positions typically require a relatively low level of technical skill and knowledge in order to perform their job roles. High levels of generic and personal attributes are the key skills required to undertake these job roles.
- This group of associate professional occupations includes, estate agents, barristers' clerks and 'sales' underwriters.
- In the main, estate agents and sales underwriters perform a sales role and as such require the skills associated with working in a sales environment e.g. high level interpersonal and customer handling skills as well as confidence and tenacity in order to secure and close a sale. As such, technical skills, although considered useful are not essential and not fundamental to the job role.

Source: Rodgers & Waters (2001) pp26-27

Figure 3.2 is a graphic depiction based on two charts in this study, indicating how far low, medium, or high requirements are posed for each of the three classes of skill/personal attributes.

Figure 3.2 Skill Requirements of Selected KISA Occupations



Source: based on Rodgers & Waters (2001) Figures 1 and 2

To give an idea of the sorts of things here referred to as technical and generic skills, and personal capabilities, we can extract some key elements from the Rodgers and Waters study. They list key technical skills required by the associate professional KISA occupations studied, and these are reproduced in Box 3.3 Meanwhile, Figure 3.3 outlines where generic skills and personal capabilities were particularly required in the occupations. These illustrate (a) the wide range of skills required; (b) the presence of some very common requirements, and also the distinctive skill profiles of specific occupations.

Box 3.3 Key Technical Skills Required by the Associate Professional KISA Occupations

Insurance Underwriters
- Risk analysis and decision making
- Ability to identify and source technical information to inform risk analysis
- Bespoke underwriting statistical techniques
- Insurance policy writing
- Bespoke IT system skills
- Insurance specific selling skills
- High level insurance product knowledge

Legal Associate Professionals
- Technical knowledge of the Law
- Law library and research techniques
- Legal report writing
- Fee and plea negotiation skills
- In-depth knowledge of court protocol
- Clerking specific administrative skills

Personnel Officers
- Theoretical knowledge of employment law etc.
- Bespoke IT system skills e.g. payroll systems
- Interviewing skills
- Industry/firm specific knowledge

Recruitment Consultants
- Industry sector Knowledge
- Recruitment Writing skills
- Recruitment specific selling skills

Market Researchers
- Research design
- A range of qualitative and quantitative research techniques
- Presentation skills
- Data manipulation using specific IT packages

Estate Agents
- Property related selling skills
- Familiarity with house sale process
- Valuation skills

Source: derived from Rodgers & Waters (2001) Table 6

Table 3.3 Key generic skills and personal attributes required by selected business and public service associate professionals

	Insurance Underwriters	Legal Associate Professionals	Personnel Officers	Recruitment Consultants	Market Researchers	Estate Agents
Generic Skills						
Accuracy						
Analytical skills						
Creative thinking						
Customer handling						
Flexibility in approach						
IT skills / computer literacy						
Mediation						
Negotiation skills (basic)						
Numeracy						
Organisational skills						
Problem-solving						
General report writing						
Sales skills (basic)						
Team working						
Written skills / literacy						
Personal Attributes						
Inter-personal skills						
Confidence						
Determination/Tenacity						

Source: Rodgers & Waters (2001) Table 7

Reflecting on change in the skills profiles of the KISA professions, the authors concluded that overall, across these occupations, there has been an increase in the required level of **technical knowledge**, with the extent of this increasedepending upon the extent of change in the job roles more generally. **Interpersonal and "customer handling" skills** have also grown in importance across all KISA occupations considered, which is seen as being a result of consumers (including clients in the same organisation) demanding higher levels of "service".

All had experienced some degree of change in the level and range of technical, generic and interpersonal skills required. By and large, the number of skills associated with the BPSAP occupations has risen - a "**job broadening**" that takes several forms:

Reclassification of the tasks associated with the occupation, so that it incorporates tasks previously mainly covered by professions from both higher and lower levels of the occupational classification.

When new tasks have "migrated" down from a higher occupational group, this was often accompanied by an increase in the number of technical skills required. (This trend was most evident, among the cases studied by Rodgers & Waters, in the legal executive occupation.)

In contrast, where roles had in effect migrated down the occupational classification, it was generic and interpersonal skills whose importance grew. (This trend was most evident, among the cases studied by Rodgers & Waters, in the development of sales insurance underwriters.)

The extent of change in the period studied here should not be overestimated, however. Most of the KISA occupations studied, it was concluded, had not experienced major change in the skills required to perform the job role. The key changes in skill needs in the three groups of profession were summarised as:

Traditional associate professional occupations (high technical and generic skills and well-developed personal attributes). Here, the important skill shifts were not so much to do with required levels of technical skills and technical knowledge (these tended to remain constant or rise slightly in significance). The major change is more increases in the importance of generic and interpersonal skills. Greater "customer handling" skills are required for better service – for organisations to differentiate their product/service offer in the eyes of their consumers.

Transitional associate professional occupational group (high level of generic skills and personal attributes, and average level technical skills). These KISA professions increasing importance, range and level of required technical skills - technical knowledge is increasingly critical for these occupations. Rodgers & Waters (2001) note as an example that "a higher level of technical, industry specific knowledge has become increasingly important for recruitment consultants. As the market has shifted towards specialist recruitment agencies, consultants are increasingly expected to possess industry specific skills in order to service this market. A similar trend is evident within the personnel and development officer occupation. As the role of a personnel officer has moved away from welfare to a more strategic role the level of business acumen required has risen. In addition, the introduction of new areas of employment law means that the range of technical knowledge required has risen. These trends suggest that as technical skills become more prevalent the skill mix of transitional associate professionals is migrating towards that of the 'traditional associate professional group'."

Generic associate professional occupational group. These occupations show a more subtle pattern, or set of patterns, of change in skill requirements and job role, with little change in the fundamental skills and roles. The main development has been the introduction of additional generic skills, especially those associated with the introduction of basic IT.

Further up the KISA professional occupation scale, general management skills have attracted attention from many researchers; and featured in the Skillsnet set of studies in the report by Johnson, & Winterton (1999). They note how official definitions of

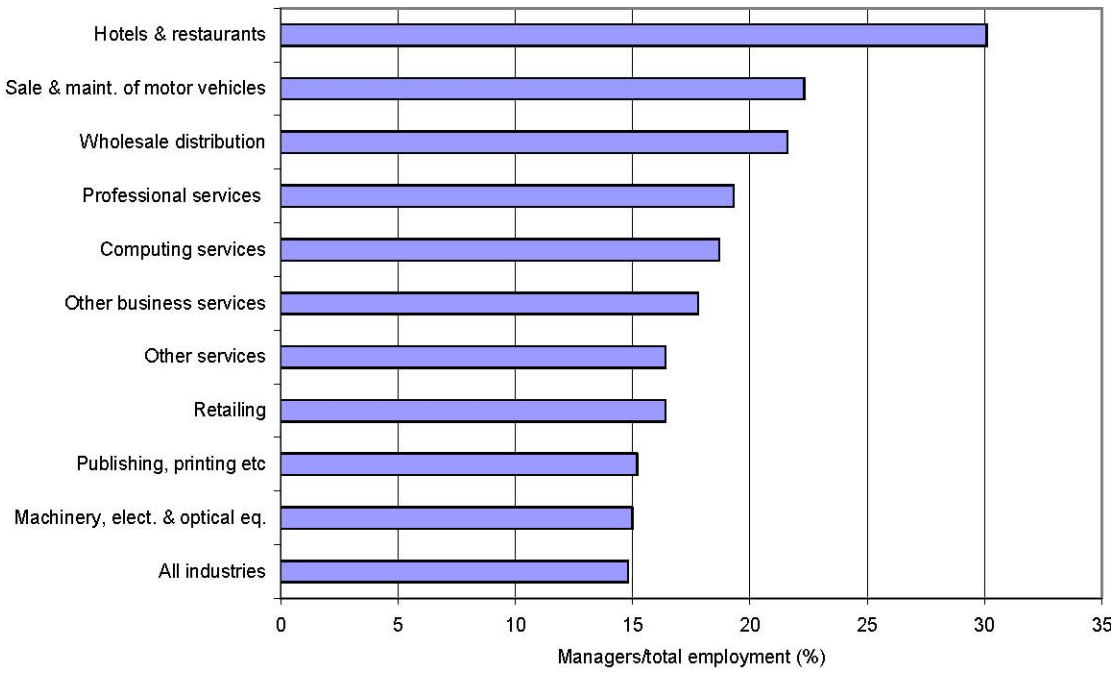
management skills have evolved, with an influential definition of occupational competence - adopted by the Investors in People program (1995) - being 'the ability to perform activities in the jobs within an occupation, to the standards expected in employment'; which also included 'mastery of skills and understanding' and 'aspects of personal effectiveness'. The approach was taken up in relation to management skills through a "Management Charter Initiative", which developed standards for management including capabilities to:

manage activities
manage resources
manage people
manage information
manage energy
manage quality
manage projects.

More recently, Bosworth and Wilson (2005) examined management skill issues across different sectors of the (UK) economy. They found major sectoral differences in the structure of management, which suggests that generalisation about KISA professions may be dangerous. For example, the gender composition of the management workforce varied from 11% female for example, sales and maintenance of motor vehicles and 10% for construction, through to all industries average of around 35 per cent, to over 70% within education and health and social work. In terms of age (which will be related to experience) the all industries average featured just under 40 per cent of managers are aged 45 and over – ranging from just over 20% for computer and financial services (KIS!) to just under 60% for mining and quarrying. The share of managers in employment varies across sectors (Figure 3.3), as do the proportion of managers that are corporate as opposed to self-employed.

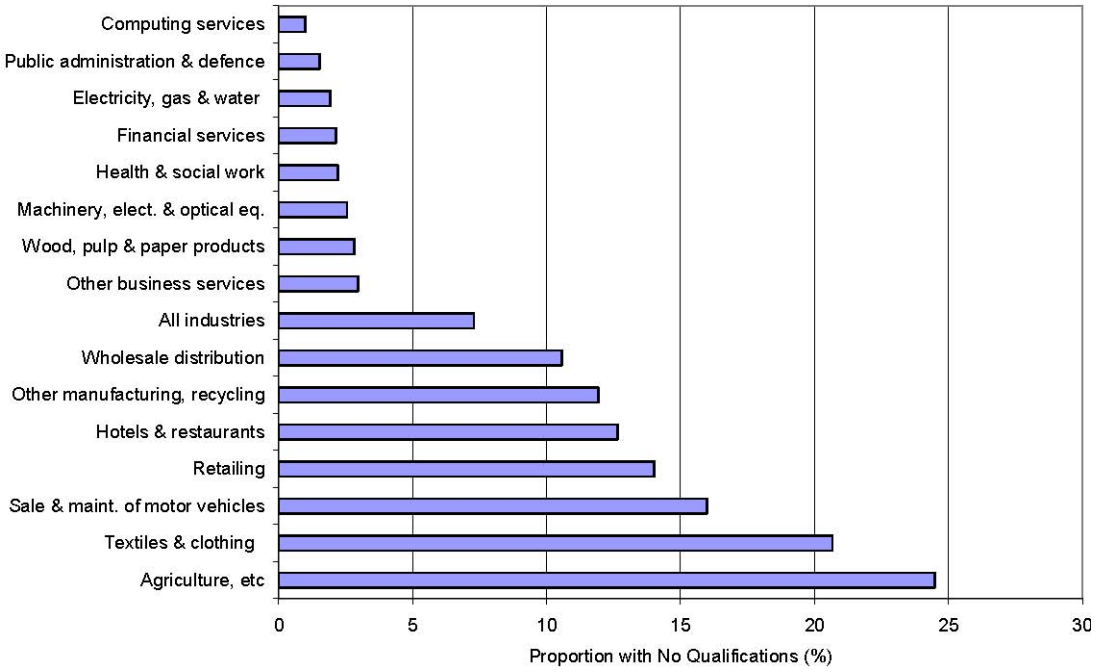
Figure 3.3 Managers as a Percentage of Total Employment: UK sectors

Source: Bosworth and Wilson (2005), Figure 3.3.



There are also strong sectoral variations in the qualifications of managers. (This reflects both managerial status – self-employed, corporate manager, etc. – and overall qualification levels of the sector - when overall workforce qualifications are low, those of managers are also low.[13]) One simple indicator is the share of managers without qualifications. The sectors with fewest managers without qualifications are computing services (even though this is a "low-training industry"), public administration, and utilities (electricity, gas & water) - under 2%. In contrast, agriculture, textiles & clothing, and sales & maintenance of motor vehicles all feature over 15%. (See Figure 3.4). The evidence suggests that KIBS typically have high levels of qualified managers.

Figure 3.4 Managerial Qualifications (Absence of) across Sectors in the UK



Source: Bosworth and Wilson (2005), Figure

When comparing qualification levels across occupational groups, the basic picture is that managers and administrators have on average higher qualification levels than all employees, but this is lower than for professionals. In large part this is due to the large difference between the two management groups – manager-owners and administrators have substantial lower qualification levels than corporate managers, though even this latter group falls behind professionals.

What about those KISA that are more technology-based – T-KISA? One set of occupations where skill issues have received a huge amount of attention – usually in the context of supposed skill shortages – is "e-skills", or more specifically skills related to Information and Communication Technology (ICT) professions. Though we might think of many ICT skills as being to do with manufacturing production of material artefacts, in fact most of the professional specialisms here are actually KISA – involved in design, maintenance, troubleshooting, management, and the like. They

[13] The researchers concluded that while there is an association such that when overall workforce qualifications are low, those of managers are also low, the differential in qualifications between managers and other employees is higher in these sectors than in those where the qualification levels of all employees, and those of managers, is higher.

are distributed across the ICT production sectors, computer services, and all sorts of ICT user sectors. It is not possible to review all of the studies and debates concerning these skills here, but a number of landmark studies do highlight some important messages for this project.

First, Figure 3.5 demonstrates the range of occupational roles and skill levels associated with ICT occupations. The ISCO occupational groupings remain one of the least controversial aspects of this topic. There has been a proliferation of different approaches to classifying ICT practitioner skills – one can even see a proliferation of studies that compare and contrast different systems, that provide meta-frameworks, and so on. The skill levels in this Figure are relatively widely agreed on, and so this provides a view of KISA professions – in terms of higher education qualifications, we are talking of skill level 3 upwards.

Figure 3.5 ICT practitioner groups within the International Classification of Occupations (ISCO-88)

ISCO-88 (COM)			
Level	**Major Groups**	**Minor Groups**	**Unit Groups**
Skill Level -	Legislators, senior officials and managers (ISCO 1)	Other specialist managers (ISCO 123) Production and operations managers (ISCO 122)	Sales and marketing managers (ISCO 1233) Computing services managers (ISCO 1236) Production and operations managers in ... communications (ISCO 1226)
Skill Level 4	Professionals (ISCO 2)	**Computing professionals (ISCO 213)** Architects, engineers and related professionals (ISCO 214)	Computer systems designers, analysts and programmers (ISCO 2131) Computing professionals not elsewhere classified (ISCO 2139) Electronics and telecommunications engineers (ISCO 2144)
Skill Level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science technicians (ISCO 311) **Computer associate professionals (ISCO 312)** Optical and electronic equipment operators (ISCO 313)	Electronics and telecommunications engineering technicians (ISCO 3114) Computer assistants (ISCO 3121) Computer equipment operators (ISCO 3122) Broadcasting and telecommunications equipment operators (ISCO 3132)
Skill Level 2	Craft and related trades workers (ISCO 7)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242) Telegraph and telephone installers and servicers (ISCO 7244)

Source: Petersen et al (2004) Figure 7

The Petersen et al (2004) study is one of those comparing frameworks, and it synthesises these to discuss **six** types of ICT specialism (with associated technical skill requirements), together with a number of generic business skills that are required. First, their three categories of basic skills are:

A) Behavioural and personal skills:

Flexibility, Self Learning, Motivation and Commitment, Stress Resistance and Emotion, Responsibility, Managing Risks, Decision Making, Negotiation, Initiative and Attention, Persuasiveness, Professional Attitude (Business or Technical Orientation and Interests).

B) Cross section and basic work and technical skills:
Quality Awareness, Commercial and Market Awareness, Entrepreneurship, Customer Orientation and Relationship, Company and Business Organisation, Work and Project Organisation, Business and Work Process Knowledge, Work Safety and Health Protection, Labour Law and Data Privacy, Environmental and Resource Awareness;

C) Soft and method skills:
Communication & Moderation, Languages & Culture, Collaboration & Interaction, Teamwork and Mentoring, Conflict and Consensus, Creative and Innovation, Analytical and Reasoning, Problem Analysis and Solving, Strategy, Conception and Planning, Context and Causal Connection Thinking, Information Handling, Documentation and Presentation.(Source: Petersen et al (2004) p57)

The six specialisms, with associated technical skill needs are as listed in Box 3.4.

It should be noted that the various skills studies here have attempted to be more precise in identifying different levels of competence in these varied skills. This would mean too much detail for the current discussion, however. At this point we should note that several of the teams working on new skill requirements have noted the emergence of new profiles that effectively merge and span existing skill sets. The Career-Space Consortium, exploring skills for the ICT industry, noted that even without taking into account broader business skills, graduates increasingly need combined qualifications from that span the engineering and informatics "cultures" (see Figure 3.6) – but also places emphasis on the need for business and behavioural skills. In terms of qualifications, the consortium recommends that Universities build curricula with elements spanning electrical engineering, informatics, and these less technical skills.

Box 3.4 Six ICT Specialisms, and their Technical Skills

1) Technical skills in 'ICT marketing, consulting and sales'
- "a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. It applies to both the ICT industry and to companies of the ICT user industries (keyword: Profit Centre Organisation). Successful marketing and sales of ICT products and services requires fundamental analyses of external and internal market and customer needs. Following various consultations these requirements need to be translated into services and products that answer specific customer needs while providing benefits to the own company or department at the same time. These combinations of business and technical tasks ask for specific skills justifying the elaboration and delimitation of a generic ICT work area and corresponding skills at different levels."

2) Technical Skills in 'ICT Business and Project Management'
- "also combines business and ICT skills ensuring the work flow success of an ICT project and business process. Within a wide range of project activities and responsibilities business and project orientated ICT practitioners at different skill levels closely collaborate with internal and external ICT experts, providers and customers in order to ensure that customers' business needs are met when developing and deploying infrastructure and software ICT solutions and services. All together business orientated ICT practitioners constitute the crucial 'interface' between the customer and primary ICT specialists and technicians. Common goal of more business and technical orientated ICT practitioners is a clear description of the business requirements within the 'technical specification' of the ICT solution to be developed. In shared responsibility more business and technical orientated ICT practitioners organise and implement applied support, training and instructions to the customer."

3) Technical Skills in 'ICT Systems and Application Development'
- "covers far more than just mere individual programming or coding. In this work area ICT practitioners at different skill levels work in development teams that design, realise, update, test and document ICT systems and software applications. The work is carried out based on comprehensive analyses and descriptions of what ICT systems and applications are needed by the market, a specific sector or a specific (internal or external) customer. In practise contacts to the project manager and ICT business and technical practitioners within our without the company are important. In the daily work processes the transfer of the technical and business requirements into a consistent 'data processing specification' is crucial for the final success of the ICT systems and application development process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as

part of a team often runs under time constraints and must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions."

4) Technical Skills in 'ICT Integration and Administration'

"ICT systems and applications … need to be professionally integrated, deployed, administered, optimised, supported, etc. depending on the platform the applications run on. 'ICT Integration and Administration' teams configure, integrate, maintain and administer new developed or already running systems and software applications. The work is carried out based on comprehensive analyses and descriptions of needed or existing systems environments to be finally successful in the integration and deployment process. In daily work processes contacts to the project manager and ICT business and developers within our without the company are important. Eventually, the customer and its users often need applied (Help Desk) support, training and instructions. As part of the (continuing and often contracted) technical support, systems and applications are optimised and up-graded and troubleshooting need to be coordinated and problems resolved at different levels."

5) Technical Skills in 'ICT infrastructure and installation'

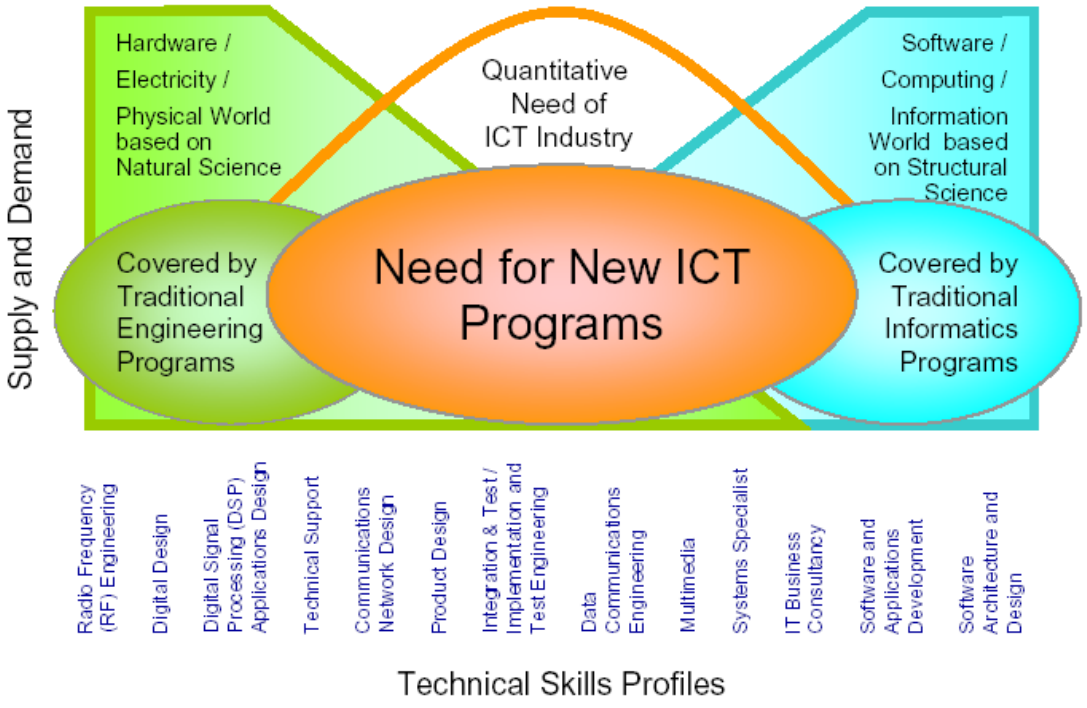
- "covers the planning, integration, modification and installation of the wide range of different ICT systems, devices, telecommunications, networks, etc., summarised as ICT infrastructure. The work is carried out based on problem orientated analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. In practise contacts to customers, project managers and ICT business and systems development practitioners within or without the company are important. For the realisation of the projects or project parts and depending on the skill and responsibility level ICT infrastructure practitioners need to consider aspects like cost effectiveness, expandability and upgradeability, reliability, security, etc. The integration of standard, specific and innovative solutions (e.g. software applications, wireless network and telecommunication solutions, web based infrastructure) is part of this work. The work, sometimes as part of a team, often runs under time constraints and must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions."

6) Technical Skills in 'ICT support and systems service'

'- "concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to well communicate with customers, users and colleagues. As part of the service and maintenance the ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems."

Source: Petersen et al (2004) pp55-57

Figure 3.6 ICT Industry needs for new Qualifications



Source: Career-Space Consortium (2001), New ICT Curricula for the 21st Century Designing Tomorrow's Education: Curriculum Development Guidelines http://www.career-space.com

It would be possible to review more studies, but several essential points are clear from those discussed above.

First, skills are multifaceted. Typically occupations demand a portfolio of skills, and there are liable to be changes in these requirements over time, with organisational and technological development. There are also liable to be variations across sectors and across specific occupational groupings (even within categories of KISA professional). It is possible to identify some broad directions of change, but when we look closely we will find much variety and specificity. This is even apparent when educational qualifications are taken as an indicator of skill, but is more acute when we explore the detailed requirements of specific KISA professions. We can anticipate cross-national and even regional differences, as well.

Second, it is hard to capture these multifaceted variations in skills in terms of a single dimension of more or less skill. At the very least we need to differentiate between technical, job-specific skills, and more generic skills that are required across a range of professional occupations. But among these more generic skills, there are also a range of different types of capability that are required – so, for example, as more managerial functions are taken on by professionals, so more fluency with the range of skills depicted as needed for management is likely to be experienced. One solution may be to think in terms of skill profiles, though we confront problems in easily capturing the diverse combinations of skills that may be involved. (For the approach used in our workshops, see Section 9.)

With these points in mind, we move on to consider the ways in which future professions and skill requirements have been addressed in the literature, before undertaking our own analyses of future skill requirements for KISA.

4. Forecasting KISA Professions and Skill Needs

4.1 CEDEFOP Forecasts

The bulk of Europe's economic activity, employment, and output is taking place in service sectors of the economy, reflecting the growth of marketed services as well as public services (CEC, 2002). There is clear growth in specific services like educational or health services, power and water supply or public services (Graz et al., 2007) and overall the economic importance of services has grown in the last years. According to national accounts, services accounted for EUR 6905 billion of value added in 2005. Their share in EU-25 GDP rose from 63.4% and 63.8% between 1995 and 2005 (Alajkääskö, 2006). Employment in services as a share of total employment grew from 63.4% to 68.6% in EU-27 between 1995 and 2006. These figures are even higher considering only the former 25 EU Member States where employment in services grew from 65.3% to 70.3% (CEC, 2007). This trend is expected to hold for the next years together with the increase of future demand for services. Services are therefore deemed a motor for growth in Europe now and in the future (Alajkääskö, 2006).

The CEDEFOP (2008) report on future skills needs in Europe provides extensive documentation of occupational skill needs in Europe, working from national accounts statistics and using legacy Labour Force Survey data depicting the structure of occupations across industrial sectors in the EU. For skills assessment, it used data on educational qualifications possessed by employees. The forecasts, for 2015, cover Europe as a whole (EU-25 plus Norway and Switzerland) and all individual Member States and here is some analysis of alternative scenarios of macroeconomic performance.

Overall results include the forecast that more than 13 million additional jobs are likely to be created in the EU-25+ between 2006 and 2015. Not all sectors share in this growth. Over 2 million jobs in the primary sector are anticipated to disappear, as are almost half a million in manufacturing. In contrast, "business and miscellaneous services" have the best prospects, with almost 9 million additional jobs being created over this period, representing roughly growth of 2% per annum. 3.5 million new jobs will be created in other market services such as distribution, transport, hotels and catering, and almost as many in non-marketed services.

Together with ongoing change in the organisation of work within sectors, these projected sectoral changes have significant implications for future occupational skills. The forecasts here include continuing growth in demand for many highly and medium-skilled workers as well as some lower skilled occupations. Almost higher level jobs such as management, professional work and technical support for those activities, which currently account for over 30% of employment, are projected to grow over the next decade. There should also be significant expansion in many service jobs, especially in retail and distribution, and also for some elementary occupations requiring little or no formal skills. Traditional agricultural skilled occupations, clerical occupations, and those employing several craft skills are forecast to decline in number.

The bar charts in Figure 4.1 represent the forecasts for the three types of "Higher Level Job". These correspond reasonably well to the activities regarded as KISA (though there may be some doubt about those involving the least qualified workers).

The CEDFOP (2008) study goes on to present information about forecast trends in various sectors of the economy. For this study, the most interesting data refer to the sectors described as "Other Business Services". (This includes most KIBS, but also some other business services in NACE groups 70-74: see the definitions below). Figure 4.2 displays key results presented in the CEDEFOP report. Figure 4.2a indicates general employment growth, with some services – especially "other Business Services" contributing substantially to this. Figure 4.2b depicts the shares of total employment coming from services sectors, again making apparent the major contribution and major growth associated with these services.

The category of "Other Business Services" is somewhat wider than that of KIBS, since it includes real estate, rental, and other services such as office cleaning, secretarial services, and security services. An issue of Statistics in Focus from 2006 presents some relevant data on KIBS, however, for the EU 25 in 2004 (Alajkääskö, 2007). Figure 4.3 presents information from this study concerning the composition of these activities, suggesting that the KIBS cover around half of the jobs recorded in "Other Business Services". (R&D services are omitted from the Statistics in Focus account – this is a relatively small sector in employment terms; but labour recruitment is included, and this is the second largest sector here.) Legal and accountancy services are the largest in terms of employment.

Finally, Figure 4.4 examines the relation between occupations and sectors in a little more depth. Using a wider category of "Business and other Services", we see that a huge part of the growth in the three more professional occupations comes from the demand from these sectors. More than half of the "new" top three jobs are created in these sectors, with the next nearest rivals being non marketed services and then distribution services.

Figure 4.1 Employment Projections from CEDEFOP 2008

Figure 4.1a Shares of Employment (across all industries combined) accounted for by Three Types of Higher Level Occupation in EU25+

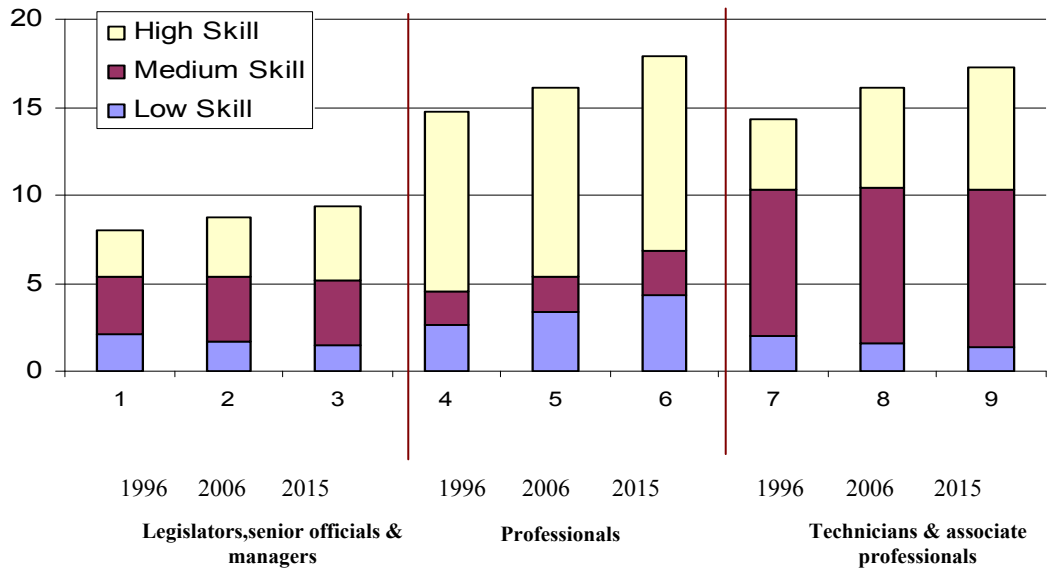
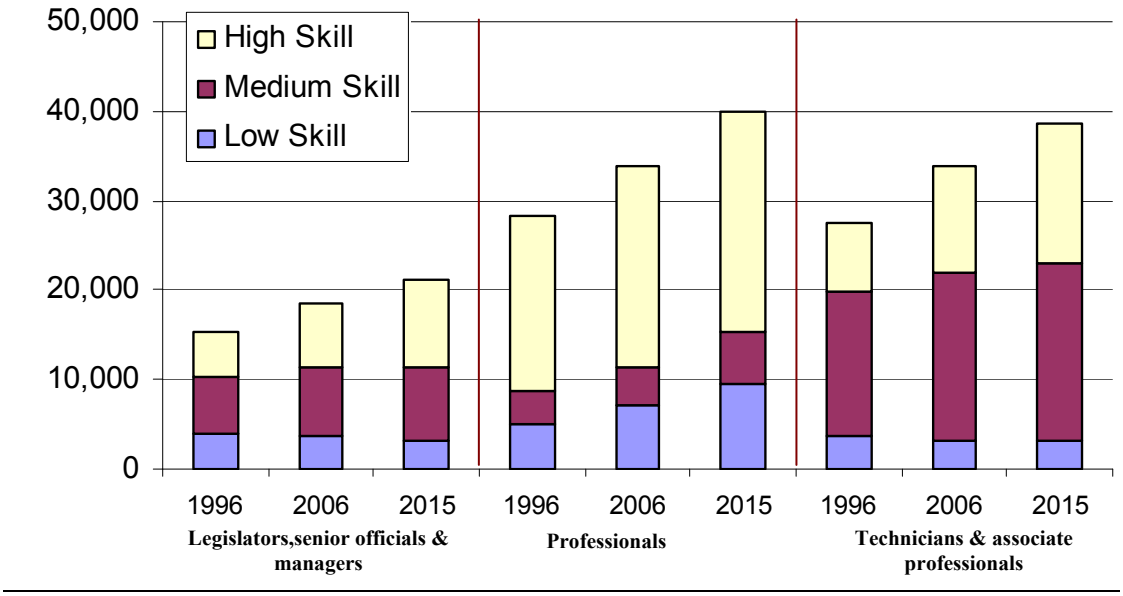


Figure 2b Numbers of Jobs (across all industries combined) accounted for by Three Types of Higher Level Occupation in EU25+



Notes to Figure 4.1

Note: "Skill" levels of occupations are understood in terms of qualifications required, as shown below: **Low Skill** At most lower secondary **qualification** (ISCED 0-2) **Medium Skill** Upper secondary **qualification** (ISCED 3-4) **High Skill** Tertiary **qualification** (ISCED 5-6)	
Occupations are classified as follows	
ISCO Major Group:	
1: Legislators, senior officials and managers	11 Legislators and senior officials 12 Corporate managers 13 Managers of small enterprises
2: Professionals	21 Physical, mathematical and engineering science professionals 22 Life science and health professionals 23 Teaching professionals 24 Other professionals
3: Technicians and associate professionals	31 Physical and engineering science associate professionals 32 Life science and health associate professionals 33 Teaching associate professionals 34 Other associate professionals

Note: this excludes the remaining groups, included in total employment figures:
Major group 3: clerks (41 Office clerks; 42 Customer services clerks).
Major group 4: service workers and shop and market sales workers (51 Personal and protective services workers; 52 Models, salespersons and demonstrators).
Major group 6: Skilled agricultural and fishery workers (61 Skilled agricultural and fishery workers).
Major group 7: craft and related trades workers (71 Extraction and building trades workers; 72 Metal, machinery and related trades workers; 73 Precision, handicraft, craft printing and related trades workers; 74 Other craft and related trades workers).
Major group 8: plant and machine operators and assemblers (81 Stationary plant and related operators; 82 Machine operators and assemblers; 83 Drivers and mobile plant operators).
Major group 9: elementary occupations (91 Sales and services elementary occupations; 92 Agricultural, fishery and related labourers; 93 Labourers in mining, construction, manufacturing and transport).
Major group 0: armed forces.

Figure 4.2 Sectoral Trends: the growth of "Other Business Services"

Figure 4.2a Trends and forecasts of sectoral employment in EU25+

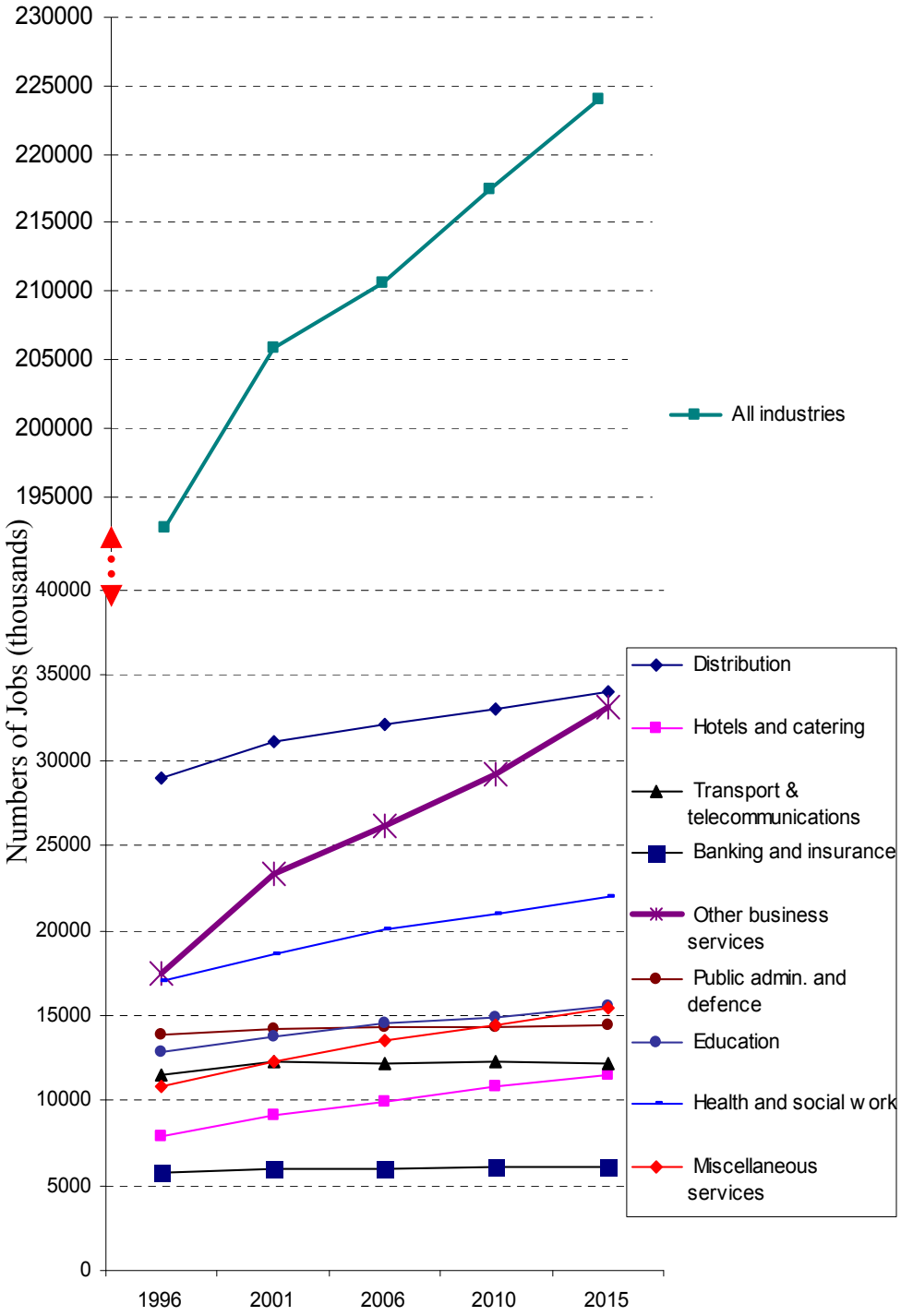
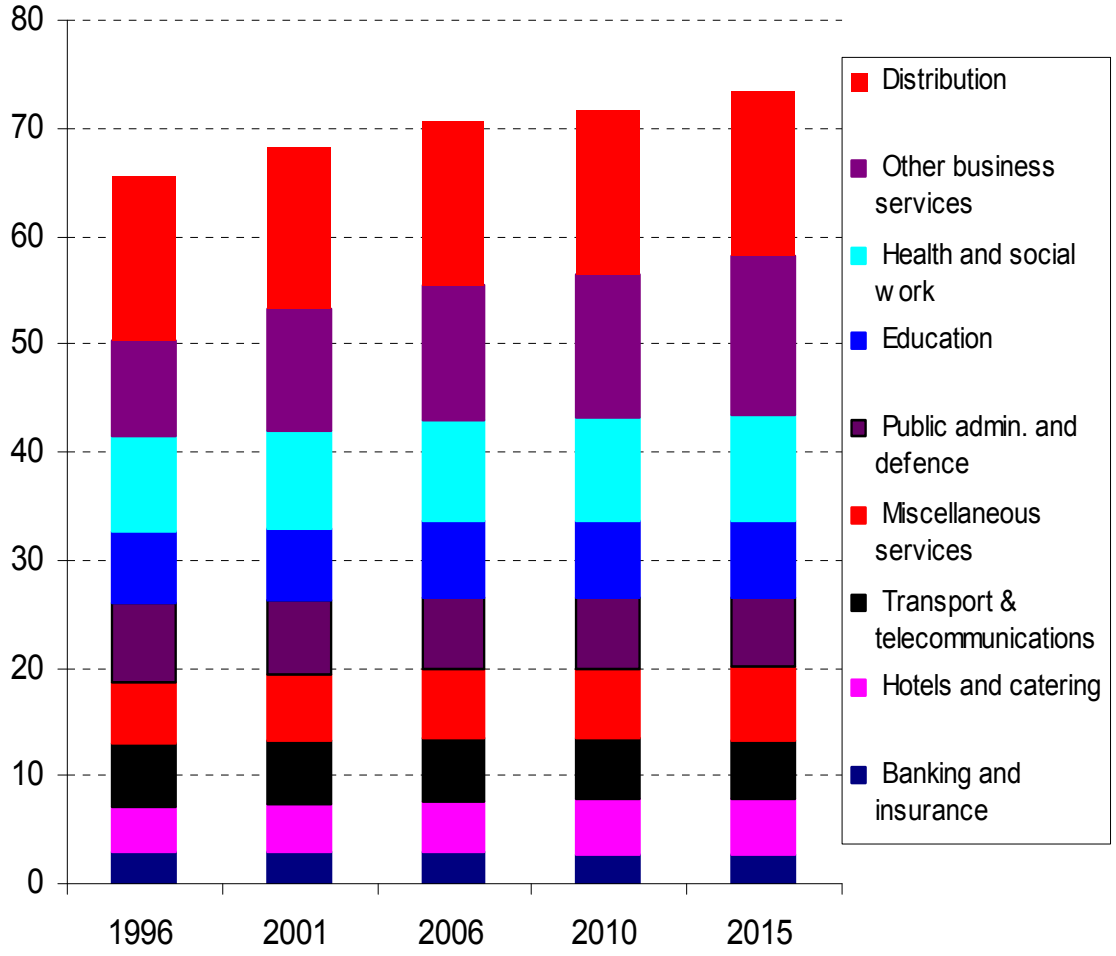
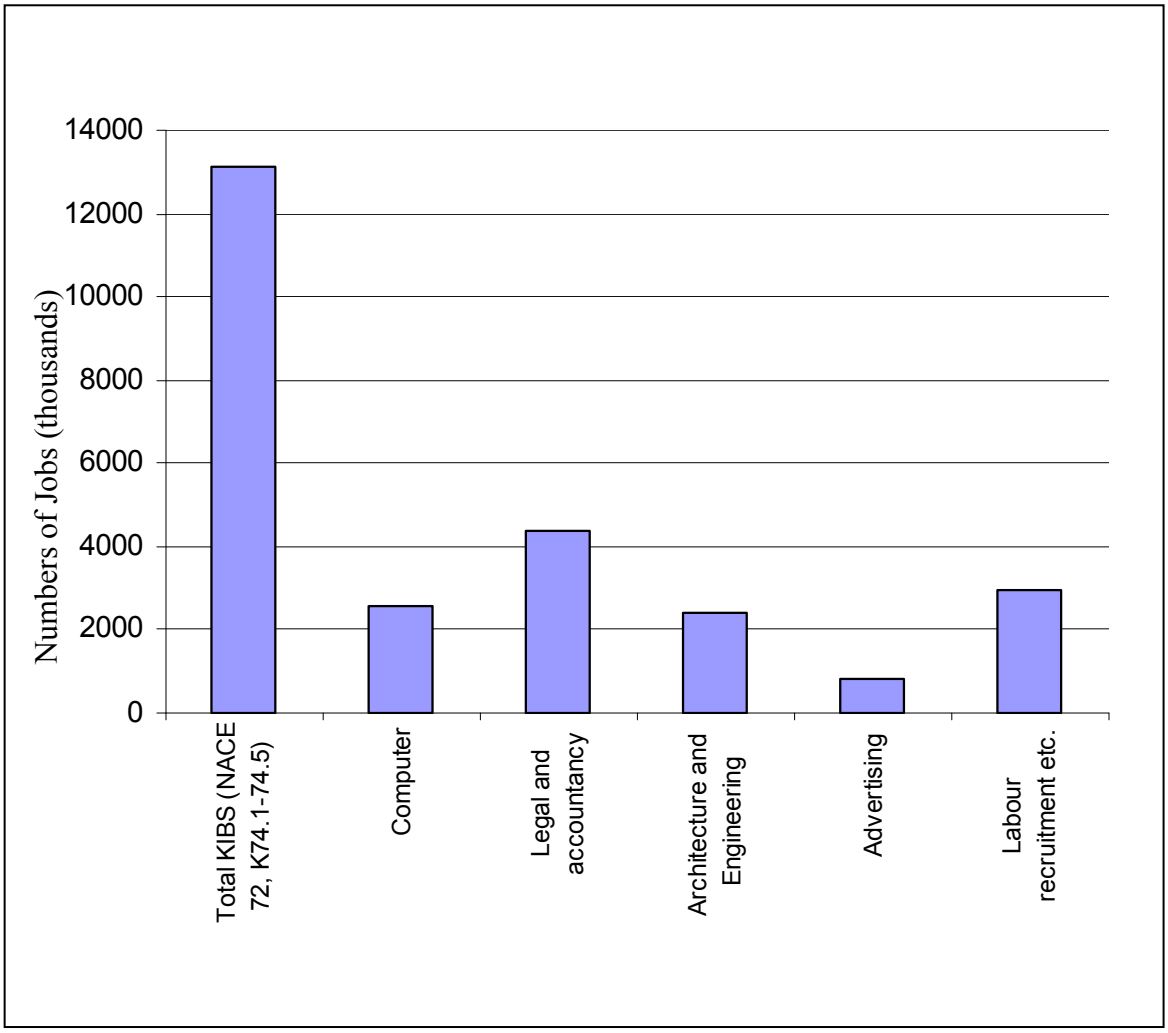


Figure 4.2b Shares of employment contributed by various service sectors in EU25+



Source: from data in CEDEFOP (20008)

Figure 4.3 Composition of Employment in Business Services, 2004



Source: Alajkääskö, P., 'EU-27 business services: thriving in the wake of outsourcing and liberalisation', Statistics in Focus - Industry, Trade and Services, 76/2007, Eurostat, Luxembourg, 2007

Figure 4.4 Sectoral Breakdown of Top Occupations (Professionals, Technicians, Managers))

Figure 4.4a Numbers of Top Jobs in Major Economic Sectors

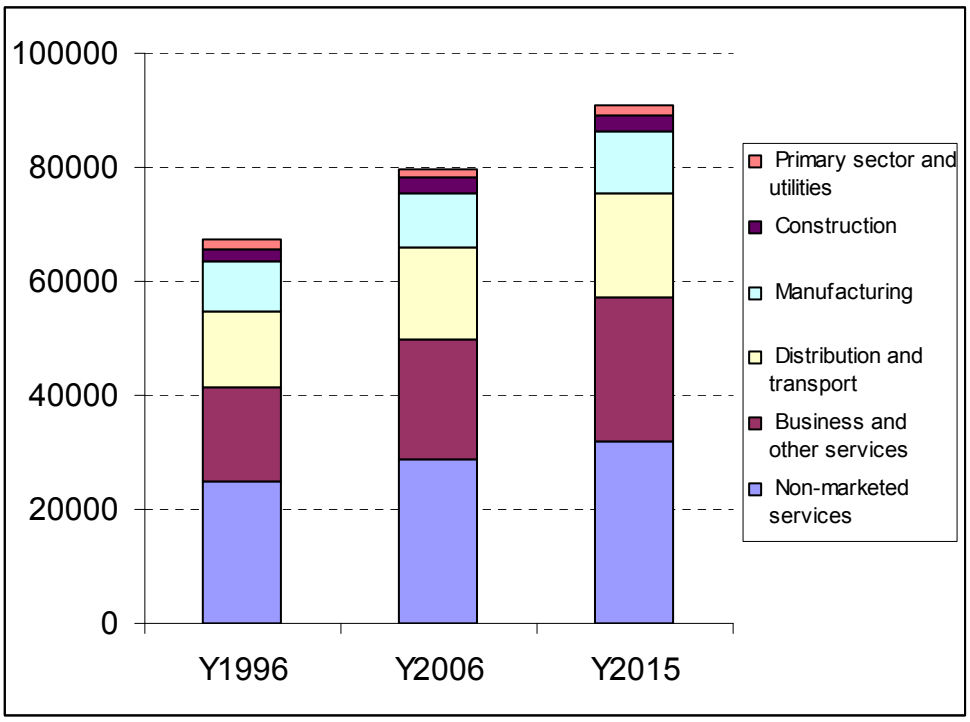
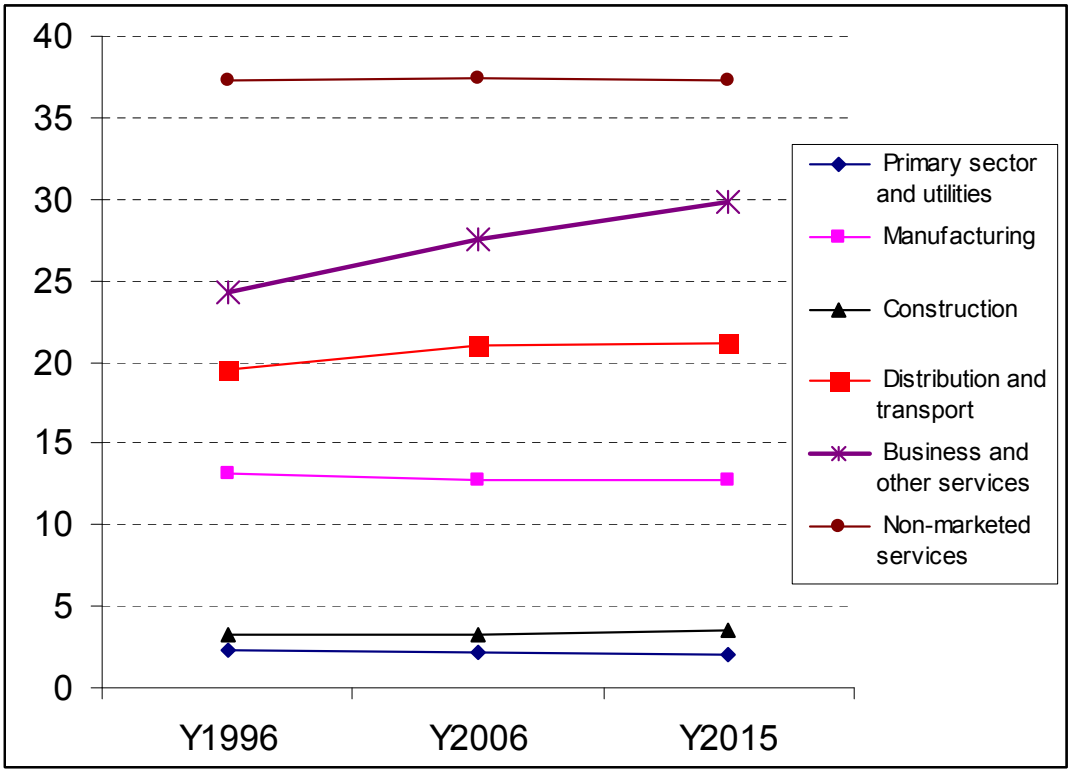


Figure 4.4b Share of the Top Jobs in Major Economic Sectors



Source: from data in CEDEFOP (20008)

/notes on continuing pages

Notes to Figures above

"Other business services" in these diagrams comprise NACE 70-74: -

Professional services – comprising: Real estate activities [70]; Renting of machinery and equipment without operator and of personal and household goods [70, 71]; Research and development [73]; Other business activities (professional services) [74.1-74.4]

Computing services [72]

Other business services: Other business activities as featured in NACE [74.5-74.8], including security and secretarial services

The wider category **"Business and other services"** as used in Figure 4 includes, as well as the above:

Banking and finance [65, 67]

Insurance [66]

Miscellaneous services [90-93,95,99]

The categories featured by Alajkääskö, (2007) and used in Figure 3 are:

Computer services [72.00]

Legal, accounting & management services [74.10]

Architecture & engineering, technical testing [74.20 & 74.30]

Advertising [74.40]

Labour recruitment & provision of personnel [74.50]

4.2 Skill deficiencies, shortages, and gaps

It is clear that finding ways of more clearly understanding what we mean by skill, and what future skill needs may be, is dependent on developing new tools and scenarios. These tools and scenarios need to go beyond the legacy data capture represented by current classification systems, and beyond merely extrapolating such data. There is also a need to be clear about the difference between and reasons in different sectors and sub sectors for frictional skills gaps (the inability of the workforce to keep up with change), skills gaps which are skills deficiencies in the workforce and skills shortages which are recruitment difficulties caused by a lack of skill in available labour markets.

The UK Employers Skills Survey (2001), for example, found firms employing sales/customers services staff and staff in elementary occupations reported internal skill deficiencies (85) whereas firms employing professionals were least likely (4%) The most desired skill was communication followed by team working and other technical/practical skills. Basic computing and advanced IT or software came in at 7th and 8th place respectively – both being sought less than half as often as communication skills The survey found that between a fifth and two fifths of internal skills deficiencies required a mix of generic and vocational skills rather then only one or another. Occupations most affected by skill shortages were professionals, associate professionals and skilled trades. Occupations most affected by skill gaps were sales and customer services, personal services and elementary service occupations.

Of course, the availability of appropriate skills depends on both levels of qualified people available and in addition to volume the composition of those qualifications. Newer vocational subjects such as design studies and computer studies have grown rapidly whereas areas such as physics and maths have declined. There is no level playing field. The UK for example still lags behind its European neighbours in the proportion of its working population with formal qualification. Several other advanced European countries have either very low proportions of people with numeracy and

literacy skills below or at level 1 or have a lower proportion at that level in younger age groups. This is not the case in UK and USA which have the highest overall figures for poor attainment and additionally have the highest proportions of young people with numeracy or literacy skills below or at the most basic attainment level (Layard 2001).

4.3 Exploration of Future Professions

The US O*NET team (O*NET 2006) have developed systems for identifying, evaluating, and incorporating New and Emerging (N & E) occupations, those "which are not adequately covered in the O*NET-SOC classification system. The focus is on high growth industries and the new occupations these industries are creating" in a way that "is "responsive to current developments in technology, social organization, business practices and government regulations." The N & E occupations are defined by criteria such as:

- The occupation involves significantly different work than performed by job incumbents of other occupations…
- The occupation is not adequately reflected by the existing O*NET-SOC structure…
- The occupation has significant employment;
- The occupation has a positive projected growth rate;
- The occupation has developed due to changes in technology, society, law or business practices;
- The occupation has licensure or certification requirements;
- The occupation offers education or credentials to its employees;
- The occupation has related professional associations;
- The occupation has related journals or professional publications;

Figure 4.5 depicts the process used to identify N&E occupations. High growth and emerging sectors are located and interrogated in some detail. In a pilot study, five potential N & E occupations were identified – at least four of these being clear professional KISAs (and the same almost certainly applying to the fifth):

- Advanced Practice Nurses
- Bioinformatics Scientists
- Bioinformatics Technicians
- Geospatial Information Systems Scientists and Technologists
- Geospatial Information Systems Technicians

The O*NET website provides a much longer lists of 102 occupations on which data collection was initiated in 2007.[14]

A very different approach to thinking about future professions is taken by Ahlqvist (2003). This uses Foresight methods such as Delphi surveys, to elicit expert opinion about trends in work, and about possible new occupations. The research first identified key trajectories in Information Technology, Biotechnology, Nanotechnology/ Materials technology, arguing for the pervasive importance of these key technologies. Then a Delphi survey was conducted which focused on the impacts of key developments in each of these technologies, on demand for each of a set of occupations. Important technology developments included:

Targeted medicines

Sensors (to observe, for example, hazardous changes in the environment…)

Integrated technology (Homes, offices, and other built environments will merge through IT.)

Biomedical materials (Implants and human spare parts made … used in skin and organ transplantation)

[14] See http://www.onetcenter.org/dl_files/NewEmergingList.xls

Photonic materials (…will replace conductors made of copper in many devices)
3-G Technologies (..fast data transfer … increases variety of different public services)
Intelligent materials (…that monitor and repair their own condition…)
Diagnostics (…nanosized machines in people diagnose diseases, dose medicines, and monitor vital functions)
Virtual reality (…enables distance working, distance healthcare, and other distance services…)

These were the developments from a much larger set that were rated as being most likely to occur by 2015. These were then related to a set of occupations:

Architect / spatial expert
Biochemist / biologist
Business / economics expert
Computer hardware expert
Computer software expert
Mathematician, statistician
Medical doctor / pharmacologist
Social and cultural researcher / psychologist
Teacher, educational expert
Office worker
Service, sales, and nursing
Manufacturing etc. (blue collar worker)

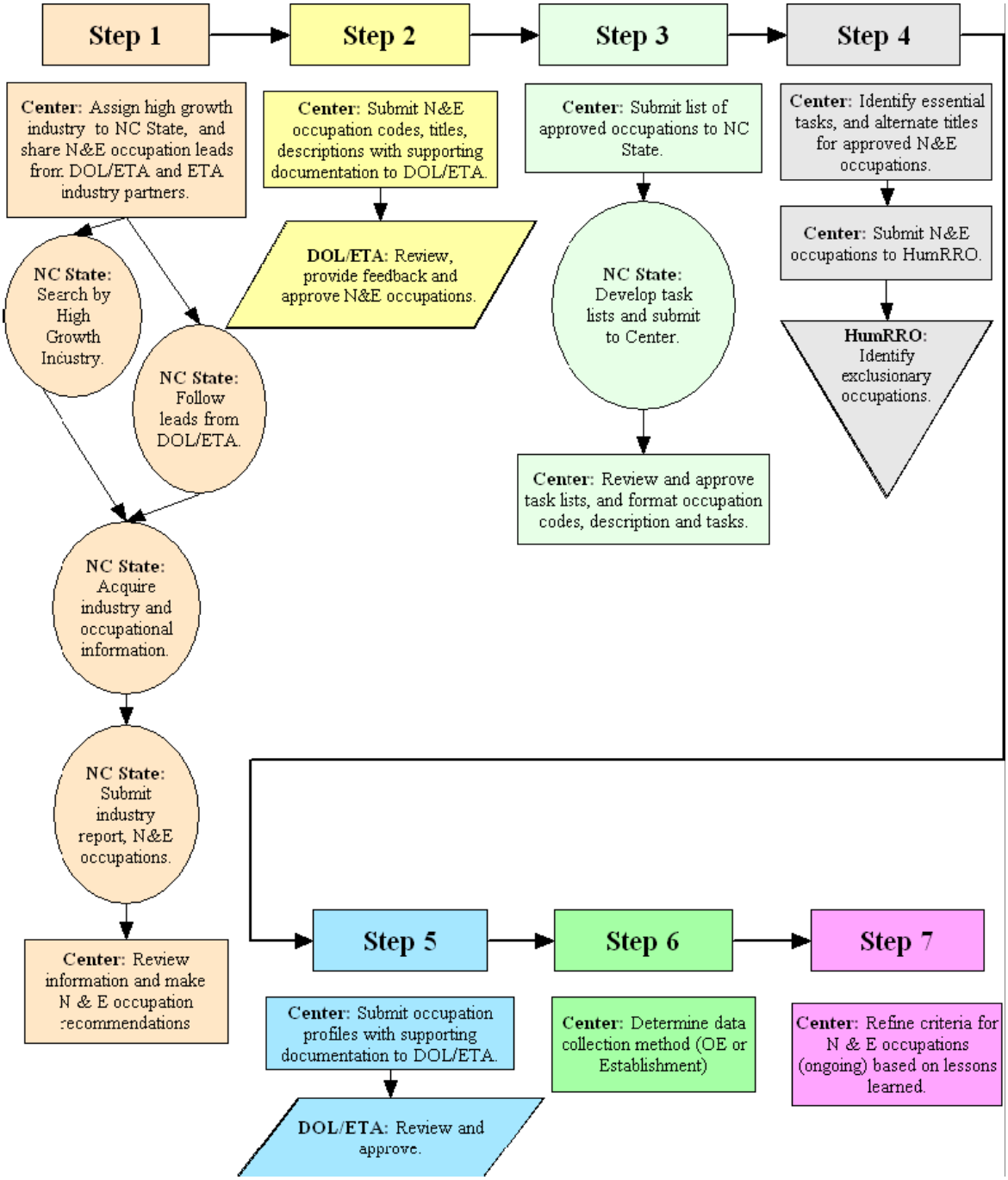
For each of these, the experts were asked to indicate whether the number of people involved increased or decreased, using a seven-point scale. Then, in another step in the study Ahlqvist asked for nominations of new professions, arriving at a list comprising:

Artificial organ designer
Artificial intelligence consultant
Bioelectronics designer
Bioinformationist (works with genetic information…)
Cool consultant (fashion and taste)
Cybrarian (monitors Internet)
Gene therapy consultant
Geoinformationist (digital applications of geographic information, e.g. positioning systems)
Nanotechnology consultant
Simplicity expert (streamlines organization or technology)
Smart home designer
Social network analyst (studies the flow of power through an organization or company)
Virtual doctor (practices [tele]medicine through VR)
Visualization specialist (visualization of data and visual interfaces)
Web gardener (maintains and nourishes web-sites)

Finally, each of these was rated by the experts in terms of its: plausibility of realisation, and the time at which it would become a clear profession, have matured. All of the professions were felt to be plausible in the next ten years, in particular Bioinformationist, Geoinformationist, Nanotechnology consultant, Smart home designer, Virtual doctor and Visualization specialist. Those with highest proportions of respondents thinking they would NOT happen in the time period were Cybrarian (15 %), artificial organ designer (12.5 %), cool consultant (12.5 %), gene therapy consultant (10 %), web gardener (10 %). The most rapid realization was anticipated for cool consultant, web gardener, virtual doctor, geoinformationist, social network analyst, cybrarian. The slowest realizations were: Artificial organ designer, gene

therapy consultant, nanotechnology consultant, Bioelectronics designer, and artificial intelligence consultant

Figure 4.5 O*NET approach to New and Emerging Occupations



Source: O*NET (2006)

The O*NET and Ahlqvist studies represent two very different ways of exploring future professions, one very much grounded in empirical analysis of current trends, one based more on expert visualisation of future possibilities.

A study by Winterton et al (DFEE 2000) reviewed future skill needs of managers in the light of changing socio-economic, political and technological trends in the UK, France and the USA. The study found that the future skill needs of managers would include knowledge-based technical specialisms in addition to generic management competences and for leadership styles which are more group-orientated based on trust and collaboration in the employment relationship. Traditional structures are giving way to horizontal structures of cross-functional core process teams in which employees are empowered, through initiatives to build involvement, participation, team working and autonomy. Five sets of required competences and competencies were distinguished:

> Knowledge or cognitive competence:- Managers will need a knowledge-based technical speciality in addition to more generic management competences. Globalisation will make demands for strategic leadership and will require managers to see and act beyond local boundaries (and UK managers will especially need to develop a European perspective). The rapid rate of organisational change will mean that essential management skills will be learning, innovation, managing change and flexibility.
>
> Functional competences: To exercise strategic control, managers need to acquire deep understanding of the competitive conditions and dynamics of the units for which they are responsible. Group-orientated views of leadership will increasingly be needed. To manage employee empowerment, managers will need to reject the transactional type of leadership which exchanges rewards for desired behaviour and develop instead a transforming leadership style that satisfies higher needs in people.
>
> Personal competencies:- Managers will increasingly need facilitation skills (for team working), greater cultural awareness (for trans national working), skills in developing and maintaining collaboration (in flatter organisations, relying on partnership), and a variety of personal qualities in order to function in a more fluid work environment - self-reliance, responsibility, ability to learn from experience.
>
> Ethical competencies:- New forms of employer-employee relationships mean that managers must establish trust and have the competencies to deal honestly with all stakeholders in the organisation. Managers will equally need to develop more convincing policies for sustainable development.
>
> Meta-competencies:- Managers will need to be comfortable with uncertainty, paradox and contradiction to develop flexible responses to the changing external environment. They will need to rely more on instinct and judgement and the competencies needed centre on learning, since sustainable competitive advantage derives from the ability of individuals and organisations to adapt and learn faster than the competition.

The report makes a number of recommendations, including encouraging significantly more time to be spent on management development, a greater focus on people management skills and on managing change and increasing enterprise, and promotion of the personal responsibility for managers to take charge of their own development needs.

5. Case Studies of Innovation and Change in KISA

The goal of the case study work was to describe how selected KISAs may contribute to the development of economic sectors – especially as innovation facilitators. The case studies aim to highlight alternative roles and contributions of KISAs for further elaboration and exploration in the subsequent scenario exercise. The case studies are also intended to capture different aspects of the service economy such as different types of service organisation, product variation, role of technology, knowledge management , etc. Based on the findings for the different sector/kisa combinations an attempt will be made to formulate more generic hypotheses on what the future of work will look like under alternative KISA regimes.

5.1 OECD case studies

The OECD studied KISAs as part of their ongoing research on national innovation systems. In a series of case studies (OECD,2006)[15] the value of KISAs in facilitating the growth of innovation capacity within recipient organisations was examined by "focusing not on service sector industries per se, but on the role of knowledge-intensive services *as carriers and sources of knowledge that influence the performance of individual organisations, value chains and clusters across industries.*" The objective of the OECD project was to generate a comparative *analysis of different kinds of service inputs to the management of innovation in firms*. As an exploratory effort, the study aimed to further analytical concepts and allow an understanding of the processes related to KISA. The OECD study identified three roles for KISAs related to how they influence the the flow of knowledge: the source of knowledge, the facilitator and the carrier of knowledge. The case studies produced some important observations and conclusions that we have grouped under three headings:

Research-based knowledge and a highly skilled labour force are basic requirements for many kinds of KISA. Since innovation tends to be increasingly complex, a wide set of skills is an ever more crucial element of success. Skills development policies can thus affect the use of KISA. The evolving division of labour and the volume of knowledge are strong drivers of KISA.. Innovation Policies can target KISA actors directly or indirectly through intermediary organisations, or through wider framework conditions including government regulation, education and skills development, and procurement practices.

Innovation policy frameworks need to respond to the nontechnological aspects of KISA and policy needs to focus more on the interactive people-centred activities, less on the individual firm and more on developing the collective strength of the sector or network. Close interaction with customers is seen as a strategic asset for securing the competitive position of the organisation. For production-driven firms this means that a wide range of new types of skills needs to be developed (with the assistance of internal and external KISA).

A central challenge in innovation is the integration of external capabilities, including those of users. All of these involve knowledge-intensive service activities. - Integrating internal and external KISA can be done in four ways: HR policy, organization, networks, buying/insourcing)

[15] OECD (2006), op.cit. p12.

The OECD study thus points to three important vectors (drivers) determining the role and type of KISAs in innovation systems: trends in knowledge management & corresponding skill requirements, emphasis on user-centred activities (and other non-technical innovation); and the need to integrating, balance internal and external expertise. These and other aspects of KISA are explored in the case studies discussed below.

5.2 Innovation in the network society

The evolution of the role of KISAs as vectors (sources, facilitators and carriers) of new knowledge is set against a backdrop of a rapidly expanding network society. On a wave of new residential and small business broadband connections massive numbers of mainstream users have joined the Internet since 2000. Armed with advanced multi-media tools and facilitated by intuitive web services they set-off an explosion of user generated content that continues to generate momentum[16]. This seemingly spontaneous outburst of new content is driving a new generation of business strategies and business models. The essence of these new business models is to source the collective wisdom (knowledge, intelligence) of the *crowd*, hence the term "crowdsourcing". This trend to mobilise the crowd is picked-up by major players across industries, from BMW[17] to Boeing[18], from game manufacturers to extractive industries, from marketing companies to IBM. The emphasis on people-interaction in KISA driven innovation as highlighted in the 2006 OECD report is a sign of this process unfolding. The empowerment of networked users (and micro-enterprises) will undoubtedly have a profound impact on the role and type of KISAs, in particular as vectors of knowledge in innovation systems.

The effect of user empowerment is already being felt widely in the creative industries where business models had to be realigned at the expense of some powerful incumbents such as record labels and the CD retail sector. However, as the examples above indicate, the scope of user-driven business models extends beyond the creative industries. Any value that lends itself to virtualization (digitalization) is a potential candidate for crowdsourcing. As intangibles are at the core of all high value added services even in the extractive and productive industries[19], the scope is comprehensive. The services sector is responsible for the bulk of growth in GDP in Europe since the 60s and is predicted to be a primary driver of growth in the coming decades. The services sector largely produces intangibles, prime candidates thus for distributed production in user driven networks.

---

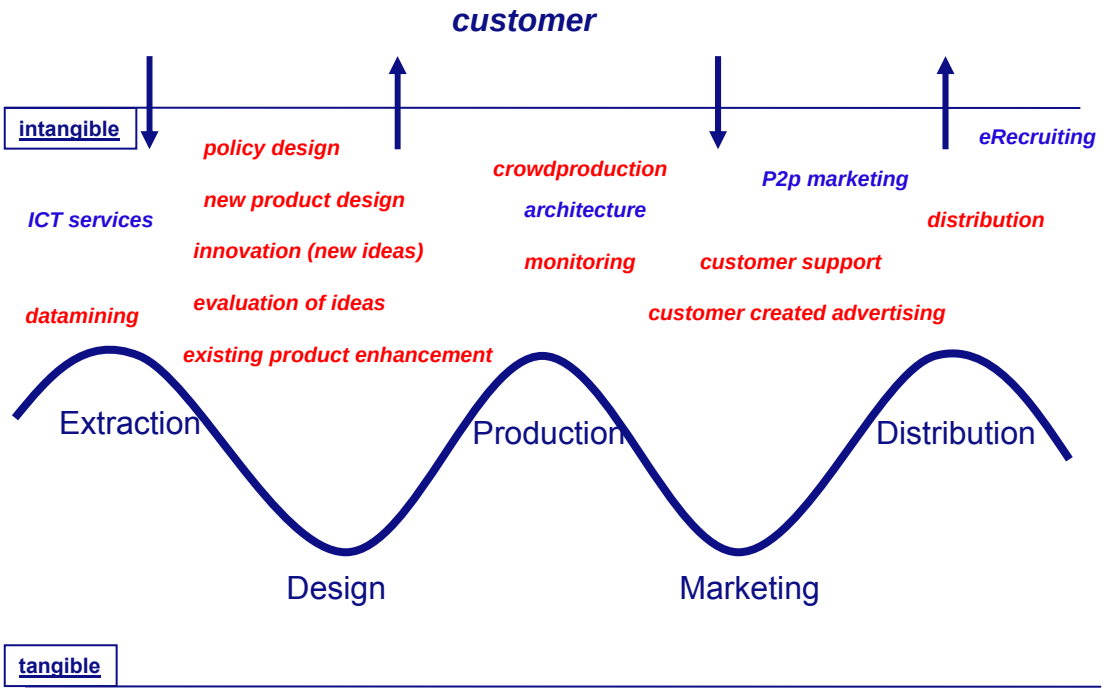
16 Cisco predicts 29 exabytes (18 zeros) of Internet content by 2011, an astonishing amount, largely driven by consumer generated content

17 Crowdsourcing of in-car telematica concepts. BMW portrays itself more an more as a lifestyle company.

18 Kartel-type, distributed production of the new Dreamscape aircraft. The community style manufacturing process produced many profound innovations such as a radically new wing.

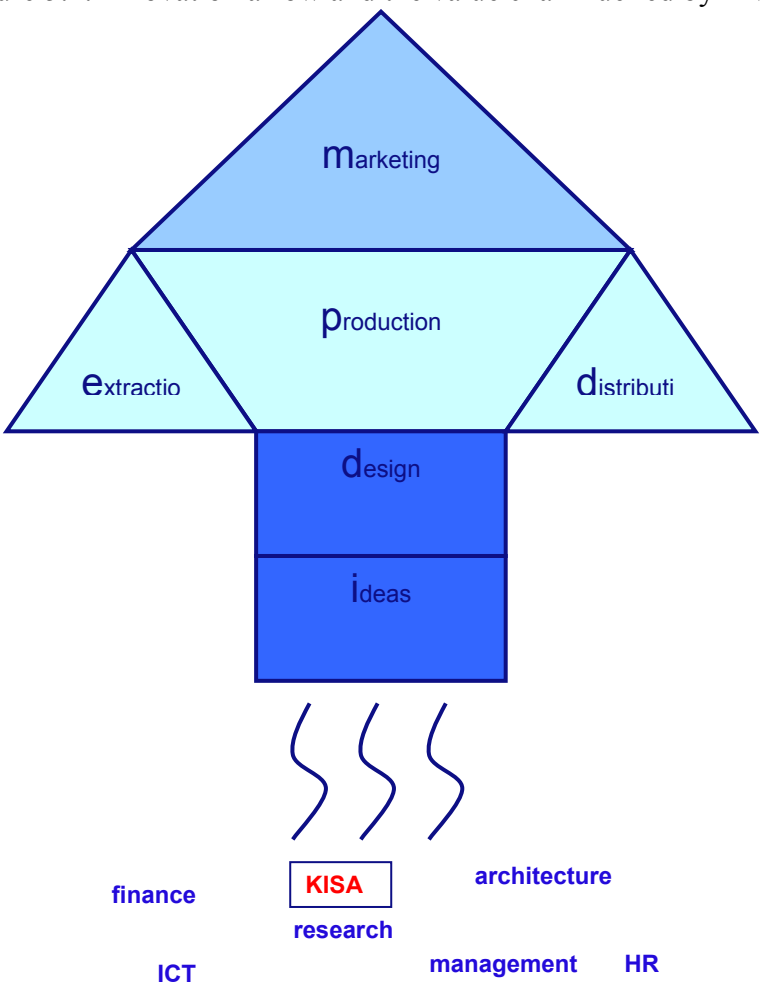
19 The bulk or up to 90% of the value in manufactured products derives from intangibles, such as software, licensing, patent royalties, design costs, etc.

Figure 5.1 Scope of user-driven models in the value chain



KISAs as vectors of knowledge and (thus) innovation will need to harness this aspect of user-driven innovation.

Figure 5.1. Innovation arrow and the value chain fuelled by KISA



Out of the dense content flows in rapidly proliferating social networks on the internet, entire new ecosystems for user generated information, news, knowledge, A/V material and other virtual goods emerge, with exotic names like the blogosphere, Wikipedia, Youtube and Virtual Worlds. Across these ecosystems user-producer relations are being redefined and, as the barriers for new entrants slowly fade, a rich variation of new, more open types and platforms of (knowledge intensive) services looks set to dominate innovation in the network economy.

In the case studies discussed below we will explore the role of KISAs against the backdrop of a rapidly evolving network society.

5.3 Case Study Approach

The selection of sub-sectors and KISAs builds on prior work of the OECD on KISA and reflects discussions with IPTS and the project team in the inception phase of the project. The final choice of sector/KISA combinations represents a spread across formal and less formal sectors, T-KIBS and P-KIBS and geographic scope. All the cases exhibit in varying degrees the underlying trend of user empowerment depicted above.

5.3.1 Sectors and KISAs

The following sectors and KISAs were identified for the case studies.

Personalised Healthcare: The first "sub-sector" concerns the relatively recent, highly innovative and transitional industry of Personalised Healthcare and Personal Healthcare systems (PHS) . KISA in home based healthcare innovation scenarios have been studied in Finland, Norway and Spain as part of the OECD study. The PH concept focuses more squarely on the technological (T-KIBS) aspects of homebased healthcare. It also reflects the transition towards more personalised, user centric and user-driven services. The KISA under observation are the ICT services. ICT services are

Food Technology: The second sub-sector is food technology. The Food-sector is a formal sector that shows rapid innovation cycles where KISAs are expected to play a major role. The KISA under observation are the R&D services. New Food technologies such as functional foods satisfy a need for conscious, healthy living, an important vector of innovation in Europe.

Eco industries: Sustainable development scenarios drive the growth of green or eco-industries. Sustainable innovation in the production of sustainable goods and services is high on the European agenda[20]. The KISA that we explore in this case study is marketing. Portraying a green image to more informed, environmentally conscious customers is another key aspect of the empowered user trend.

5.3.2 Personalised healthcare

As European society grows older, dealing with chronic illnesses that require long-term attention is expected to put increasing pressure on healthcare systems. While more patients are expected to suffer from long-term conditions which do not require permanent hospitalisation, homes are expected to join or even replace hospitals as primary healthcare locations, a trend that should also help answer the challenge of a declining healthcare workforce[21].

The European Commission has been supporting research and development activities for the application of Information and Communication Technologies (ICT) in health since the 1990s. Over the last decade, it has promoted person-centric healthcare systems - so-called 'Personal Health Systems' (PHS) - the aim of which is not to replace but rather support health professionals via monitoring and diagnostic data which can help them to make accurate decisions.

[20] http://ec.europa.eu/environment/enveco/industry_employment/pdf/ecoindustry2006_summary.pdf

[21] http://www.euractiv.com/en/health/personalised-healthcare/article-171796

PHS is a relatively new concept. It is currently centred on the use by patients of wearable or implantable systems, such as body sensors that measure physiological information like heart or respiratory rate as people do their normal activities. The systems process the information automatically and send it to health centres where physicians can remotely evaluate the individual's health status. According to the European Commission, the aim of these personalised systems *is "to help health professionals and individuals monitor more efficiently chronic conditions like diabetes and heart failure outside the ordinary hospital environment".*

Personalised Healthcare is primarily concerned with the devolution of patient monitoring and treatment from the hospital to the home and ambulatory environment. Solutions, such as body worn sensors for clinical and healthcare monitoring, improve the quality of life by enabling patients to lead independent lives. By taking healthcare out of the hospital environment, personalised healthcare solutions play an increasingly important role in delivering high quality and cost effective healthcare.

5.3.3 Innovation in personalised healthcare services

According to the European medical technology industry association **(Eucomed)** "Personal Health Systems and Homecare" is the fastest growing sector in healthcare, with a 19% share of the European market compared with 5-6% for the medical devices industry. In addition, the global market for telehealth was $7.7 billion in 2006, which represent a 241% increase from 2003's figure of $3.2 billion.

According to the **European Health Telematics Association (EHTEL)**, the wider use of telemedicine services is currently being held back for the following reasons, among others: long testing phases for telemedicine pilot projects, the lack of a global vision of the role of eHealth in the healthcare transformation process and poorly documented and unproven returns on investment models. EHTEL also cites the unclear and restrictive legal environment and the lack of reimbursement schemes for telemedicine by statutory as well as private health insurance schemes.

Although the vision to take healthcare out of the hospital, bring it to the home and embed it into people's lives through Personal Health Systems is clear, "little deployment has happened so far. The barriers to deployment originate at different levels and are associated with a multitude of technological, cultural, legal, political and market-related factors," argues a recent stakeholder conference report[22].

Personal Health Systems, i.e. *products and services that are enabled by ICT and improve or preserve the health status and performance of individual consumers outside institutional care, have evolved rapidly over recent years*[23]. Home technology has grown from what used to be a thermometer and, later, instrumentation for measuring own blood pressure and blood glucose, to wearable sensors and systems for continuous tele-monitoring by healthcare providers. Advanced and miniature sensors, portable and wearable electronics, active and intelligent implants such as defibrillators, as well as RFID and biodiagnostic systems at the point-of-care, are examples of state-of-the-art Personal Health Systems and technologies. Integration of sensors into compact devices, together with wireless gateways, ubiquitous communication technology and penetration of mobile phones

[22] http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=3469

[23] http://ec.europa.eu/information_society/newsroom/cf/document.cfm?action=display&doc_id=323

and wireless technologies, deliver mobility solutions that open up immense potential for technology-enabled proactive healthcare and independent living.

> **"PHS transform the patient from a passive health information provider to an active information user".**
>
> *Quote from the 2007 EU conference report on PHS*

Whereas much of these technologies have proven their potential in healthcare applications, research challenges still remain as regards to bringing these systems closer to the users and their needs, improving their usability and diminishing complexity through better design and integration of applications and services.

The Commission's Lead Market Initiative (LMI[24]) adopted in December 2007 identified eHealth as one of the areas in which high-growth potential markets for research and innovation-rich goods and services could be created, with the public sector driving the demand.

5.3.4 ICT KISA in personalised healthcare

According to an EC eHealth report (eHealthNet, 2007[25]) personalised healthcare such as "Telemedicine and homecare, personalised health systems and services, such as disease management services, remote patient monitoring (e.g. at home), tele-consultation, tele-care, tele-medicine, and tele radiology" is one of four component of a growing eHealth industry. The European eHealth industry has leading positions in personalised health systems, medical equipment and in several sectors of integrated eHealth solutions. Telemedicine/homecare are a main focus Those companies which have potential for success in these fields include both large European-based companies of specialised eHealth solutions that are world leaders in their fields as well as the estimated 5,000 European small- and medium-sized enterprises (SMEs) that operate in various sub sectors of eHealth.

Telemedicine and homecare is the segment with the greatest potential for financial and clinical impact, and is due for immediate explosion. Telehealth is moving beyond the hype and is considered a serious solution by healthcare purchasers.

The major challenges for the emerging sector are described in the eHealth Communication and Action Plan (COM (2004) 356 final). The eHealth Lead Market Initiative focuses on the following key challenges:

A) Market fragmentation and lack of interoperability
B) Lack of legal certainty
C) Insufficient availability of financial support
D) Procurement issues

The Continue Health Alliance[26] represents over 150 technology, medical device and health care industry leaders dedicated to making personal telehealth a reality**.** Their mission is "to establish a system of ***interoperable*** personal telehealth solutions that

[24] http://www.euractiv.com/en/innovation/lead-markets-gateway-growth/article-167684

[25] http://www.ehealtheurope.net/img/document_library0282/LMI-report.pdf

[26] *www.**continua**alliance.org*

fosters independence and empowers people and organizations to better manage health and wellness". They are betting on a fast growing market for the provision of products and services related to personalised healthcare.

The industry stakeholders' group consulted in the eHealth Lead Market Initiative made clear recommendations regarding obstacles and solutions in the development of a single EU Market in eHealth. The role that ICT KISA could play is in the development of open, interoperable frameworks. Specifically on technological standards and regulations, the industry group advised to address the challenges in the area of semantic interoperability between healthcare systems in large-scale pilot projects for realistic applications, stimulate the use of one medical terminology standard in Europe, with translations in national languages, use the experience from certification the healthcare industry to accept self-certification also in the domain of interoperability". Apart from technical challenges the lagging adoption is increasingly due to socio-cultural and institutional barriers..

ICT services are the only KISA in the health sector that is frequently sourced externally. A gradual introduction of open ICT platforms for personal healthcare could be a driver both for integration of internal and external expertise and increased interaction with end-users for example through personal medical information gateways.

5.3.5 Innovation in Food Technology

The European Food sector is the largest manufacturing sector in the EU with a production value 815 billion euro, employing 4 million workers. It has the lowest level R&D investments at 1% of industry's total investments. R&D spending in the EU's food & beverage industry is close to stagnation.

In terms of scores on the ten core innovation indicators compared to the CORE-NACE[27] average, the food and beverages manufacturing industry performs significantly below average on three indicators: share of total sales from new-to-market products, share of firms that use patents (as share of all innovative firms and share of total firms represented in the survey) and the share of total sales from new-to-firm products (share of total firms only). The share of firms engaged in intramural R&D and the share of co-operating firms is slightly lower than the CORE NACE average. By not including the micro-enterprises, almost four-fifths of the food and beverages industry does not appear in the CIS statistics. Well above average, on the other hand, is the score of the food and beverages manufacturing industry's share of firms that use trademarks and design registrations. The food and beverages industry also scores slightly higher on the share of public subsidies received. What should be borne in mind in interpreting these results, however, is that a relatively large share of firms of 78.6% is micro-enterprises (less than 10 employees) and not included in this sample. Although this phenomenon is also found in other industries and especially so in services (e.g. real estate, hotels & restaurants, retail trade & repair, and construction, see Eurostat 2008), the food and beverages industry is in this respect rather different from other manufacturing industries.

[27] CORE-NACE includes NACE sections C (mining and quarrying), D (manufacturing), E (electricity, gas and water supply), I (transport, storage and communication) and J (financial intermediation) and NACE divisions 51 (wholesale trade and commission trade, except of motor vehicles and motorcycles), 72 (computer and related activities), 74.2 (architectural and engineering activities and related technical consultancy) and 74.3 (technical testing and analysis).

Figure 2 Table 2. Innovation performance food & beverages industry: results for all firms*

Innovation Indicator	Average CORE NACE	Average Food and Beverages NACE DA15	Difference to manufacturing average	Percentage GAP (DA15/CORE NACE)
R&D expenditures (% total turnover)	1.20%	1.24%	0.04%	103.13%
Share of firms that receive public subsidies to innovate	8.19%	8.46%	0.27%	103.29%
Share of firms engaged in intramural R&D	19.82%	17.21%	-2.61%	86.82%
Share of companies co-operating with each other	9.00%	7.71%	-1.29%	85.71%
Innovation expenditures as a percentage of total turnover	2.15%	2.19%	0.05%	102.20%
Share of total sales from new-to-market products (% of turnover)	6.20%	3.36%	-2.83%	54.28%
Share of total sales from new-to-firm but not new-to-market products (% of turnover)	7.66%	6.09%	-1.57%	79.52%
Share of firms that use patents [1]	6.92%	4.30%	-2.62%	62.12%
Share of firms that use trademarks [1]	9.52%	15.01%	5.49%	157.63%
Share of enterprises that use design registrations [1]	7.85%	10.96%	3.11%	139.57%

* As contained in CIS4 sample.

The food and beverages industry belongs to the most fragmented and diversified industries in Europe ranging from a multitude of small family-owned micro-enterprises operating in local, regional and national niche markets to a small number of multinational companies sourcing and selling worldwide some of which considerably invest in R&D. 78.6% of all food and beverages manufacturers are micro-companies with 1 to 9 employees which is large relative to other manufacturing sectors; 3.6% are medium-sized companies with 50 to 249 employees. While the first is high for a manufacturing sector, the latter is comparatively low, even though these distributions appear to be typical for manufacturing if looking at the whole sector at the one-digit NACE D level.

Import drivers of Innovation in the Food and beverages sector include[28]:

Consumers, their lifestyles and trends: Convience, Health & Nutrition, Food service
Globalisation and increased trade: Food safety, traceability, standards
Growing competition in the food industry
Retail consolidation: product identification
Technological capacities: IT, GMO etc

Table 1 below presents a list of innovations and challenges facing the Food sector.

[28] IFAU/Europe INNOVA (2007)

Table 1 Innovation topics and challenges (INNOVA Sector Innovation Watch[29])

	Eco-Innovation	Biotechnology	ICT & Nanotechnology	Other
Food innovations	Sustainable food production Solutions to bio-energy-food competition Biomass, animal waste	Functional Food & Nutraceuticals Personalised Foods Improvement of nutritional bioavailability Functional natural ingredients (e.g. flavonoids, Q10) Natural preservatives (e.g. green tea, rosemary extract) Research about the interaction of different foods and ingredients GMOs Animal cloning	Bioinformatics for food science Modifiable foods (nanotechnology)	Convenience foods Meal replacement drinks Public health Obesity Healther foods and beverages
Non-food innovations	Climate change, scarcity of water, bio-diversity Knowledge-Based Bio-Economy (KBBE) Energy efficiency in production Bio-friendly packaging Improvement in logistics / food chain management Recycling versus increased (costs of) transportation	Improved food processing Improved food safety and testing Edible packaging	Personalised services Smart labels and smart packaging Sensoring/ Nanosensors / Immunosensors/ RFID technology Smart logistics Web-based marketing and sales Pathogen detection and sensors Nanotechnology for food processing	Open innovation Lead markets Chain management Food distribution Processing innovations (e.g. healthy frying) User-friendly labelling Eco-labelling Target group product development and marketing Research on consumer perceptions and trust Communication User-led innovation Integration of consumers and consumer groups into the food development process Improving the attractiveness and working conditions in the industry

The share of R&D personnel is an important indicator for innovation potential, since without adequately qualified personnel product and process innovations are difficult to perform. However, Eurostat data is available only for a limited amount of countries, with a strong bias towards Central and Eastern Europe and therefore not regarded representative for the EU as a whole. The share of R&D personnel in the food and

29 Innova Interim report Task 1 (2008)

beverage manufacturing industry (NACE DA15) is lower compared to the total R&D personnel in the manufacturing sector (NACE D).

5.3.6 R&D KISA and Food technology

The fragmented food industry structure gives rise to concerns about the transfer of research results and innovative technologies to especially SMEs operating in the sector, which might not avail of the financial and human resource means to collaborate with universities and other research centres directly (e.g. HLG, 2008). To overcome such problems the High Level Group on the competitiveness of the Agro-Food Industry has recently proposed the establishment of techno-scientific mediators, together with clusters, techno/science parks and guidelines for technology transfer. In order to improve public-private partnerships and promote high-level food education, a Knowledge Innovation Community for the food sector within the European Institute of Technology (EIT) and a Joint Technology Initiative (JTI) for the food sector has been proposed.

The product palette from the food and beverages manufacturing industry ranges from niche and traditional specialty products to highly innovative and modified ones like convenience and functional foods. Also the customer preferences of foods and beverages spans a very wide spectrum that ranges from fast food to slow food, from vegan to meat specialties, and from innovative "organic" beverages to the latest alcoholic cocktail innovations. In general, there is a clear distinction between innovative food and beverages companies and traditional ones that put much emphasis on continuity rather than on innovation and change (CIAA, 2006a). *This seeming dichotomy is especially apparent in the food industry which is characterised by highly innovative and research-intensive activities (e.g. functional and novel foods) on the one hand and many 'business as usual' activities on the other (processing of meat, grains etc).*

In each and every industry, companies that want to invest in innovation have to consider in advance how R&D and other innovation-related expenses can be recovered and whether the new product will have sufficient chances of success. Even if innovation also poses risks, in some industries opting for no innovation is even riskier. This applies especially to ICT, computer technology, entertainment electronics and automobiles. Here a company that does not innovate will almost certainly loose out. This appears to be different for - at least parts of - the food and beverages manufacturing industry where well-established products still are sold side-by-side to new ones. The latter would compare to the unimaginable (!) case of an electronics outlet selling plasma/LCD TV-sets next to cathode-ray-tube technology and hints the difference of the food and beverages manufacturing industry in terms of innovation strategies. Unlike many other products, foods and beverages that were introduced a long(er) time ago can still be popular and generate a profit. This may be one explanation why the share of sales from new-to-market and new-to-firm products is below average in the food and beverages manufacturing industry compared to the CORE-NACE value (see Tables 2 and 3).

A second and related explanation is the fragmented nature of the industry with almost four-fifths of firms being micro-enterprises. These SMEs have limited financial and human resource capacity to deal with the uncertainty and risks associated with innovation and R&D (e.g. HLG, 2008: 13). Apparent delays in regulatory procedures for the authorization of innovative products or ingredients in Europe, leading to long lead times (ibidem: 14) might further limit the willingness of SMEs to involve in innovation and R&D activity. What we have observed in the CIS4 survey findings

further supports this argument, the share of sales from new-to-market products being about 45% lower than the share of sales from new-to-firm but not new-to-market products. This phenomenon can also be due to fears of being the first one with a new product on the market. The logic behind this could be that food and beverage companies feel safer about introducing a new product if similar products have already proven successful with customers, which may be closely related to another important peculiarity of food and beverages: human ingestion (see further this section). This being the case, however, might decrease firm's incentives to be the first one on the market with a new product. In general these findings support the observation that the food and beverages industry as a whole focuses rather on incremental than radical innovations.

The degree of collaboration with other industry sectors (e.g. ICT, biotechnology) is an interesting indicator to measure the extent of potential cross-fertilization of ideas, products and processes between industries. Especially innovations in food and beverage packaging, processing and safety evaluation are closely related to ICT (e.g. RFID tagging for food chain management) and biotechnology (processing, preservation, testing). CIS data reports on the innovation cooperation with suppliers as well as clients, as well as reports on the importance of suppliers and clients as sources of information for innovation, but do not point to specific industries.

5.4 Impact on skills

ICT KISAs could help unlock innovation in the growing personalized healthcare industry by focusing on the development of open, interoperable platforms and by addressing user centric and other non-technical issues when implementing PHS. KOALA[30], an ongoing Dutch Tele-care/cure initiative concluded that technologies are mature but that the technology push methods of PHS roll-out interfere with the adoption of the technology. ICT services in PHS will then require a balance of social and technical skills layering network skills and customer centric skills on top of ICT platform proficiency.

ICT-related indicators (e.g. e-skills) are already very important today and expected to become even more important in the future. E-skills are a necessary condition for innovativeness and less innovative industrial sectors and firms are likely to lag behind in ICT-related indicators. Publicly available Eurostat data only focus on individuals rather than on industrial sectors. The European Commission's e-business w@tch does, however, provide data on the usage of ICT and ICT skills in the food and beverages sector (European Commission, 2006). *The findings show that especially SMEs and small companies show a lack in e-skills among the employees and that only 50% of large companies reported practicing regular ICT training. Company size and costs are named as the main barriers to ICT implementations (European Commission, 2006).*

The share of employees with higher education was lower in food and beverages manufacturing than the manufacturing average. According to the Europe INNOVA (2008), the share of employees with higher education in the food, beverage and tobacco manufacturing sector was with a 6.6% share almost half of the manufacturing average with a 13.7% share. Although Eurostat's Labour Force

[30] http://www.koalaweb.nl/documents/Koala_internet.pdf

Survey (LFS) contains further details. This data is not publicly available at Eurostat's website, however.

What is perceived by the Food industry itself is a lack of food engineers and researchers, with a need to promote the interest in food-specific scientific qualifications in the early stages of education (HLG, 2008:10). Generally there is a need to further develop industry specific skills. Measurement in terms of specific indicators of these skills is so far still in its infancy. Further data investigations will follow under the current Europe INNOVA project.

6. Scenarios for KISA

This section draws very heavily on the texts of a number of previous studies that are reviewed below. Direct quotes are indicated as such, but our debt to these studies is greater: the arguments presented below often follow these studies to a considerable extent. We are selective in emphasising those elements most relevant to the present study, however.

6.1 The RAND-Europe Study

Based on analyses of trends in four sectors - agriculture, health care, public security, and transport - RAND-Europe (2006) identified three main trends shaping the type of skills required in 2015:

- The half-life of knowledge is decreasing;
- The amount of information is increasing; and
- Concurrent pressures of generalisation and specialisation of the workforce.

Professionals across many sectors are facing increasing amounts of data, and using new tools for their work which demand new knowledge. They are also confronting more turbulent environments, rather than fairly stable ones; visions of the future are required, as is large spectrum of knowledge, to inform strategic decisions, which may lead to less specialisation. (But new sorts of specialist knowledge will also be required as new technologies and techniques are introduced.)

The RAND Europe study developed scenarios by the classic method of identifying two highly important but highly uncertain drivers, dichotomising these, and creating a 2*2 matrix from the combinations. The first dimension relates to the development of science and technology - high versus low user-friendliness of advancing technologies; the second concerns workplace developments - increased/decreased centralisation (sharing of responsibilities and delegation to other practitioners in the organization versus tighter control on workflows and centralized responsibility). The 2*2 matrix has four quadrants, with names capturing the relationship between the dimensions of work and technology: *autonomy* (decentralised and user friendly), *control* (centralised and user unfriendly), *decision support* (centralised and user friendly), and *expertise* (decentralised and user unfriendly). Each was developed into a different scenario, outlined in terms of technology, economy, legal issues, organisational issues and national/European orientation.[31]

The RAND Europe study discussed the nature of several professions in each scenario, but also noted three common features.

1. In all scenarios, advancing technology creates demand for professionals who "provide services or supportive jobs to maintain technologies that are used in a specific sector; these professionals would require a multidisciplinary background, or at least they require both insight in the sector as well as in the technologies used; the design of user friendly systems would require knowledge of technology, ergonomics and business processes; likewise, the development of control systems requires knowledge of technology, organisational flows, and legal restrictions." Specialisation or generalisation (perhaps not surprisingly) is seen

[31] The authors point out that the scenarios are not mutually exclusive, noting that different developments could take place in different European regions and sectors - different organisations and groupings of organisations may adopt different strategies for tackling the issues of technology and work organisation, there may even be different trends for different sets of professions.

as more closely linked to the way in which centralisation/decentralisation evolves than to the direction of S&T development.

2. Life long learning is likely to be in demand as a result of the decreasing half-life of knowledge (this will be more severe the more complex the technology). Professionals' state-of-the-art knowledge may become obsolete after a few years. Given this, educators may be advised to focus on more general principles rather than the details of specific technologies, which may be more efficiently acquired in practice in workplace settings.

3. The emphasis on technology above should not be read as underplaying the growing importance of expertise in "business skills, creativity, systems analysis, organisational understanding, legal skills, negotiation skills", etc. Exactly which of these are most important is liable to vary across scenarios.

Among the points about differences in professional activities (KISAs) across the scenarios are the following:

1. The **Autonomy** scenario is characterised by "self-organisation in complex organisations, which implies adherence to professional standards, or a broadening of the knowledge to apply in different realms, creativity to seize opportunities or to solve problems".
2. In the **Decision Support** scenario, professionals' jobs are facilitated by technologies that are tailor-made to fit the context of that job, and simultaneously governed "by strict guidelines that prescribe actions to be undertaken (… often embedded in the software or technology that is used). This may make professionals' jobs easier, but will also allow a broader range of activities to be undertaken by the same people."
3. The **Control** scenario requires "specialists to have a deep knowledge of the technologies that they are handling, as well as of the influence that these technologies have on the wider system (value chain) surrounding the professionals: it requires insight in the factors that control their environment as well as the factors that they control".
4. The **Expertise** scenario requires professionals to possess "a large amount of knowledge to effectively work in their organisations; furthermore, this knowledge needs regular updating as the half-life of knowledge decreases. Not only are these experts required to know a lot about technical issues, but also organisational and legal issues, which allows them to work efficiently and effectively in a decentralised setting."

All of these issues are illustrated and further elaborated in the sectors which the RAND Europe study addressed. However, the study pays little attention to issues of outsourcing or offshoring of KISAs (even while there is some discussion of globalisation and its challenges). The study, then, contains many interesting analyses and insights concerning possible developments in professional work, with substantial skills implications. But it does not confront many of the issues in KISA analysis very closely.

6.2 Scenarios of KIBS Organisation: the first EMCC Study (and the earlier studies it reviewed)

An EMCC sector study of KIBS (2005; see also Miles 2005) reviewed a number of earlier scenarios for KIBS, before advancing its own. Note that the focus here is KIBS rather than KISA.

6.2.1 Toivonen: KIBS Organisation

Toivonen (2004) considered three possible (not necessarily mutually exclusive) scenarios for the future role of KIBS:

1. **A two-layered structure of KIBS.** The differentiation grows between KIBS specialising in highly specific types of problem, technology, etc., and KIBS who are coordinating and integrating these inputs.
2. **KIBS as shapers of their clients' business**. KIBS deepen their client relationships, becoming more important in terms of client strategies and not just providing inputs to individual problems and business decisions.
3. **In-house services (or rather KISA provided by non-KIBS) become more serious competitors** to KIBS. Here, large firms from various sectors are providing KIBS-type services in external markets, competing with specialised KIBS firms.

This latter scenario is clearly very closely related to the issue of KISA conducted elsewhere than in the KIBS sector. The first two scenarios have a great relevance to the structure and distribution of KISA professional work.

6.2.2 Kox: Business Service scenarios

Kox (2002) two scenarios differ in terms of the growth prospects for business services:

- "Powerhouse" – in which business services perform well domestically and internationally, and business services' growth rate draws even further ahead of the average of other market sectors.
- "Mediocrity" – where business services' growth rate falls towards the average of other market sectors.

6.2.3 Zaring: eco-efficient services

Zaring (2001) examined contexts within which more eco-efficient producer services might be facilitated or hindered, in terms of three scenarios:

1. **Europe in the Fast Lane** (European companies are generally quite large ones. They produce services that find markets in many parts of the world, in a context of liberalised global markets).
2. **The Sky is the Limit** (As in the first scenario, large firms are operating on a global scale - with standardised products where possible - but production is located where production costs are lowest, as far as possible; and this is a scenario of low environmental awareness but high confidence in technological solutions).
3. **Small is Beautiful** (This scenario marks a very different path of development. Regional markets and medium-sized companies are important; demanding customers value individual approaches to their needs; under regulatory pressure, firms need to internalise environmental costs, adopt extended producer responsibility, and orient themselves to sustainability.

6.2.4 EMCC1 – three new Scenarios for KIBS

The EMCC study went on to develop a set of scenarios concerning future developments in European KIBS, synthesising the Toivonen and Kox scenarios and adding further insights based on trends and drivers analyses. Below we summarise some key features relevant to the skills agenda.

KIBS Leadership – featuring continuing growth of, and reliance on, the KIBS sector (features of Toivonen's second scenario and Kox's "powerhouse"). Most KIBS subsectors continue to grow more rapidly than the rest of the economy, in terms of value-added, job creation, and international trade, with a rapid rate of formation of new firms (in the context of growth of larger and transnational firms).

Growth in demand is fuelled by developments in technology, trends in user industries (growth in firm size, efforts to "downsize", management focus on core competences, and the ability to recruit and retain skilled employees) and in markets and operating environments (transport gridlock, high energy prices, new social challenges and policies to do with security, with regulatory and policy changes). Qualitative shifts are also apparent in demand, with more KIBS taking strategic roles in client decisions, and some taking the lead in orchestrating clusters of firms and projects. There will be demand for the high skills required to effect such leadership. KIBS employees will feel valued and be able to negotiate good working conditions. There is some offshoring of more routine elements of the KIBS services to low-wage areas of the world. But a large share of functions is conducted in core areas of the EU and other industrial regions. There may be some growth of services specialising in "localising" and otherwise adapting commoditised services, with many standardised services provided by "offshored" offices located in low-wage economies. Many previously sheltered KIBS will be exposed to international competition, but there will also be opportunities for "export" of EU KIBS – even from small firms - to other EU countries and wider world regions

KIBS Plateau - involving a reduction in KIBS' growth to levels similar to those of other parts of the economy, and of their socioeconomic role, with a shift to in-house provision of services by users. Larger KIBS firms might shed staff, who would attempt to set up as small KIBS businesses themselves. Drivers for this could be include greater provision of services by firms and other agents (including Universities and government research laboratories) outside of the KIBS sectors (Toivonen described this as a trend of "clients becoming competitors".) Another possible driver would be a reduction of KISA outsourcing by clients, perhaps in response to concern that the "hollowing" of firms has gone too far – they need to have internal KISA capacity to retain organisational memory and enhance flexibility. Relatively easy-to-use technological solutions, allowing for "self-servicing" of KISA functions (recall the RAND Europe scenarios), and increased availability of skilled labour could also play a role (especially if labour market regulations permit more rapid recruitment and laying off of expert staff). Wider economic changes might also play a role here – economic problems and lower technological change, and perhaps government efforts to reduce regulatory burdens (that require KISAs to help meet these demands). Or, as becomes the focus of a later set of EMCC scenarios, offshoring of KISA functions to low-wage parts of the world, could impact seriously on KIBS located in Europe. Under these developments, qualitative changes in KIBS' roles are also likely, with their relationships to clients being less strategic and more contractual. The KIBS workforce would be under pressure to work more intensively, possibly within more insecure contractual relations.

Two-Tier KIBS - increasing prominence for a set of KIBS intermediating between more specialised KIBS firms and their clients. Such KIBS operate as lead suppliers, subcontracting others to provide specific inputs. They act as brokers, and often more strategically as integrators of service provision. In the latter case, they come to play a substantial role in defining the service outputs and inputs that are to be provided. Many KIBS firms aim for high productivity and innovativeness by specialisation – in particular services tailored to particular branches of industry, or to services that perform specialised organisational functions. Some of the specialised firms would grow to a large size. They modularise and reproduce solutions for their clients; internally, they are liable to display high internal division of labour: experienced and qualified professionals are supported by growing

numbers of more junior staff. Decision support and project management systems are liable to be introduced both for specialised services and integrative functions. Different working conditions and pay levels may characterise the two tiers of KIBS. The KIBS that are system integrators and project managers are responsible for quality control of the specialised service providers. Managerial skills associated with management of large and complex product systems and multiple suppliers (and clients) will be in high demand. Skills that enable managers to understand the complex of client requirements, and to build shared visions and organise networks of partners and multiple supply chains), to work with inter-organisational and cross-professional teams, will be in high demand.

The three EMCC scenarios are, the author notes, ones which will be realised to different extents, in different combinations, in various countries, regions, and sectors. Thus, we might anticipate a range of future developments around different KISA professions in the KIBS sectors. The implications of the scenarios for the conduct of KISA within user firms or in more specialised KIBS firms – or in nonKIBS firms that are selling their in-house KISA more widely – could be spelled out in more depth.

The EMCC studies are reviewed and quite heavily drawn upon in Korte et al (2008), in a study with the promising title of "New Professional and Business-Related Services: Status and Prospects". As it is, the study is not very oriented to forecasting developments in KISA, and does not address questions of skill requirements: it is more a review of the growing (rather than newly emerging) KISA sectors. It does indicate that adequate knowledge management and the availability of high-skilled workers will be important success factors for KIBS providers. The study anticipates that the drivers of outsourcing and growing needs for new knowledge (new technologies, regulatory requirements, complex markets and social arrangements, etc.) will continue to drive the growth of KIBS, though the possibilities of offshoring meaning that growth would be shifted out of Europe is treated as a major uncertainty. Among the positive features of this study should be mentioned some discussion of the limits of NACE and ISCO frameworks for grasping KISA (e.g. the difficulty in dealing with environmental services), and an examination of the role of standards for KIBS.

Standards could be a neglected theme in considering the future of professional work, since standardisation in services should enhance coordination between different phases of the service-providing process, with resulting in economies of scale, efficiency and increased service quality. They would support transparency of services offering, which would have advantages to customers – though might restrict creativity and innovation. They should enhance prospects for international trade.

6.3 Scenarios of KIBS Organisation and Offshoring: the second EMCC Study

A further analysis of the KIBS sectors was undertaken by Robert Huggins Associates (EMCC, 2006a - accompanied by a mapping study of the area EMCC, 2006a, together with a series of firm-level case studies, some of which discuss scenarios developed for the individual firms/sectors). Four scenarios were here presented, with much more preoccupation around the issue of offshoring than the earlier EMCC exercise.

The four scenarios were constructed around three themes - globalisation, skills development in emerging nations and technological progress – and were:

1. **Increase in European offshoring activities throughout KIBS sector** (whether this involves outsourcing of activities by KIBS firms themselves, or the development of new overseas bases for KIBS companies). Offshoring is liable to affect KIBS labour supply and demand and business competitiveness (in the EU and overseas).
2. **Retrenchment** This scenario involves a reversal of offshoring activities, with KIBS companies scaling down offshoring operations for reasons such as poor cost-effectiveness, productivity or customer relations.
3. **Technological advances, intellectual assets and network capital.** This scenario considers the implications for KIBS and their strategies, associated with further developments in terms of technology, intellectual assets and network capital. With some similarities to the discussions in the RAND Europe study, this considers how increased automation and other technological change- and the use of intellectual assets and network capital - may influence employment and skill levels, methods of service delivery, and competitiveness of KIBS sector. Changes in the way in which are used may also be significant drivers in this sector.
4. **Worldwide narrowing of skills gap.** Here, economic growth in emerging countries is associated with greater investment in education in these countries; there is thus improvement in workforce skills and some "converging level of skills development worldwide". This, in turn, is liable to increase supply and demand of KIBS around the world.

Surprisingly, the scenario report, while being much more extensive than the brief account of scenarios in the earlier EMCC study, does not provide a synthesis or overview of features of the scenarios. There is some discussion of skills, especially in relation to scenario 4, but this is not very specific. However, the accompanying "mapping" report (EMCC, 2006b) does discuss developments here, including those involving skills. It should be noted that (as in the scenario study) the focus seems to be mainly on consultancy-type KIBS, however. Among the points noted as trends in skill requirements and work organisation, the study indicates that:

- Many KIBS companies use more flexible staffing models that culminate in a leaner workforce. Purely academic skills and credentials are less important than a combination of communication skills and of the experience in solving business problems that is required to efficiently produce positive client outcomes. KIBS could benefit from 'competency frameworks' to systematically assess the skills, personality traits and intellectual abilities required for professional roles, to supplement traditional recruitment processes.
- Many KIBS are expanding their service offerings to provide a fuller range of services, which means recruitment of staff from a wider variety of backgrounds, and the development of more vocational skills (to develop practical solutions) and social and network-based skills (for collaborative working arrangements with clients). KIBS work is therefore increasingly consultative, with the company working in partnership with clients to solve their problems, requiring high levels of competence and trust.
- As services and clients are becoming highly diversified, KIBS are liable to follow different development paths (e.g. specialisation). The most likely strategy for the consultancy industry is close collaboration between the KIBS organisation and the client firm, as KIBS establish high levels of client-firm specific knowledge and "deliver whole packages of improvement". But within many KIBS subsectors there are conversely pressures to distance relationships with client companies, and KIBS seek to standardise services to benefit from economies of scale (e.g. using modular solutions that can be customised to client needs).

In general, increasing numbers of highly educated, reliable and innovation-focused employees will be required by KIBS. Educational institutions and training

programmes should thus provide both relevant technical and scientific skills and knowledge, and networking and social skills, together with business know-how. The initiative for such development may well stem from large companies and/or industry associations. "KIBS-focused qualifications and training schemes" and associated accreditation would enhance the mobility of KIBS professionals within the EU. Nevertheless, KIBS are liable to cluster in particular locations, with implications for Universities and other bodies in these sites.

6.4 Lessons from these Scenario Studies

The studies discussed above are valuable in providing detailed analyses of trends and drivers influencing the KIBS sector – most of which will be relevant to KISAs more generally. Broadly, the key drivers concern:

The technologies in use for KISA, and the technologies where KISA support is required by clients;

The organisation of the KIBS sector, in terms of the roles of rims (specialisation/integration), firm size, and their own use of offshoring to accomplish functions;

Demand for KISA on the part of clients, and client strategies (and management philosophies) in relation to internalisation of KISA versus externalisation to KIBS, to offshoring internal KISA and/or using overseas KIBS, and in terms of possibly moving into commercial supply of KISAs to other firms.

Demand is in turn influenced by such factors as technological change, regulations, turbulence in markets and levels of economic growth, client firm internationalisation, etc.

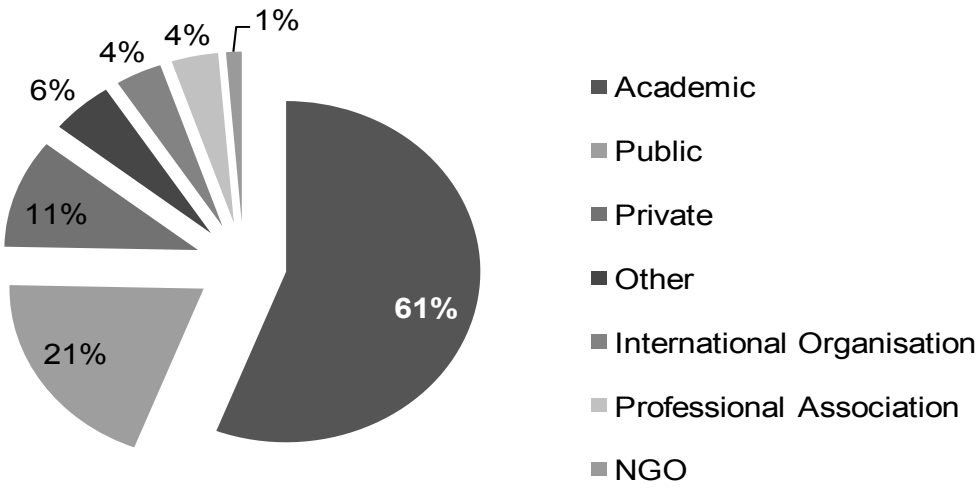
Availability and quality of training in KISA skills, modes of provision of training (on-the job and in formal institutions, life-long learning, etc.), and possibly by professionalisation in KISA work itself and the strategies of KISA users in terms of management control of professional work.

Such drivers have evident implications for the skills that KISA will require in different scenarios. The studies reviewed provide insight into the drivers of KISA development. Accordingly, these listings were mobilised in the project's scenario workshops.

7. A Survey Study

The KISA online survey was aimed at public and private sector experts in the field of foresight, services, labour market policies and education and training. There were 71 responses to the online survey from over 28 countries: 59 of those from 18 EU countries and 12 from non EU countries. As can be seen in Figure 7.1 the overwhelming majority of responses (61%) came from the academic sector with the public and private sectors providing twenty-one percent and eleven percent response rates respectively. We had hoped for a higher response rate and with a more proportionate equitable spread across the sectors. The short time exposure of the online survey was, we feel, a major factor in limiting rates of response. We would like conduct a more thoroughgoing survey at a later stage to try and capture responses from those sectors not well represented here. Nonetheless, we present below what we found out as useful in offering some illumination in how people are viewing future developments in knowledge intensive service activities and skills formation.

Figure 7.1 Survey Respondents



7.1 The Drivers

We look first at what were considered to be the six major generic drivers of changing the future landscape within which knowledge intensive service activities will be operating. We have taken in each case the first ten factors located and ranked as significant by respondents under the generic headings offered in the online survey. These were:

Social Factors
Technological Factors
Economic Factors
Environmental Factors
Political Factors

Table 7.1 reproduces the results.

Table 7.1 Drivers affecting the Development of KISA

7.1a Social Factors

Rank	Factor
1	Ongoing individualisation
2	Increased networking
3	Disparities in income levels
4	Disparities in educational levels
5	Disparities in healthcare accessibility
6	Disparities in access to legal representation
7	Free and independent and competent journalism
8	Economic migrants empowered and informed;
9	Changing demographics resulting in changed living patterns.
10	Growing numbers of single households generating new demands

7.1b Technological Factors

Rank	Factor
1	Faster and more mobile computation
2	Knowledge about different software environments, online services
3	IT processing, storage & bandwidth driving more powerful global sourcing
4	Web 2 technologies; medical sciences; integration and globalisation;
5	Further miniaturization, Growth in communication technologies at cheap prices, global communication
6	Networking technologies driving social dynamics towards more 'fluid' but at the same time, more controllable contexts in which other levels of sense-making will help increase a demand for knowledge-intensive activities
7	Rate of introduction& integration of existing & new technologies
8	Increased pace of diffusion of innovation
9	Increasing systems complexity including security issues
10	Hybrid fields: nano-biotechnology, nano-electronics, nano-medicine extending manufacturing production and innovation .

7.1 c Economic Factors

Rank	Factor
1	Need to enhance productivity
2	Global sourcing issues
3	Rise of new knowledge economies outside EU
4	New social configurations and group dynamics will not be amenable to econometric evaluation: value issue
5	Economic growth in Europe & increasing demand for raw materials, Increased competition
6	Competition and Competitiveness
7	Ubiquitous software
8	Change in industry sectors; requirements of new skills for new jobs: processes of deindustrialisation especially from Eastern European countries.
9	Intellectual Property Rights
10	Cost implications of software licensing as move to a new model of 'on demand' applications available from central servers, rather than being stored on individual hard drives.

7.1d Environmental Factors

Rank	Factor
1	The fight against pollution
2	Carbon and global warming
3	Impact on migratory movements of global warming
4	Complex decision making and increasing complex challenges involving changes in the physical world (from catastrophes to global warming, etc.) will drive more efforts towards scientific communication & information: will increase the number of professionals in knowledge-intensive activities targeting the everyday citizen
5	Limited resources
6	Continuing resource depletion not being met
7	Climate change and its impact on natural disasters, water shortages etc impacting urbanisation processes, desertification of rural areas and agriculture.
8	Drive towards sustainability, efficient use of materials and resources
9	Increase in business opportunities (and therefore in job growth) in the area of sustainability will require new consultancy skills.
10	Climate Change

7.1e Political Factors

Rank	Factor
1	Fight against corruption
2	Terrorism & regional separatists movements
3	China - more of the same or political change; Africa - inability to deliver and remain in flux; Europe able to be a true economic trading block?
4	Security issues will demand more knowledge-intensive activities at all levels of authority: to prevent unfair use of information, documents, decision processes
5	EU and Government regulations, Pressure groups
6	Decentralisation of management of labour markets: coordination of different levels of government in relation to labour markets.
7	Relations with emerging economic powers
8	Maintaining political Stability
9	Migration
10	Emerging economic power blocs will present continuing challenges

Many respondents indicated that, in regard to socio-economic factors, the successful maintenance of high or even full employment levels, together with effective policies to cope with demographic changes (including economic migration) was sine qua non in determining KISA growth. Further, there was real urgency in understanding how to align rapid change and diffusion in new technologies to real human needs. Most particularly, changing patterns in working life and the increasing systems complexity of working life and distributed human interaction made both locating and understanding the new bundles of skills emerging and the knowledges they require, imperative. Environmental issues, for example, are becoming crucial drivers as the EU and national regulators increasingly require environment-compliant assessment of products, services and systems. Accomplishing compliance will require integration into the design processes of products, software architectures, entrepreneurship approaches, legal infrastructures, R&D approaches and methodologies et al.: all areas where KISA are fundamental. However, the current urgent attempts at recapitalisation and stabilisation of the global financial systems, and the concomitant shrinkage in the global economy, indicate that we are entering a period where there

will be unpredictable consequences for the whole economic system. The services sector in general – and some financial services and KISA - may be drastically re-configured. We turn now, however, to what the respondents of the KISA online survey saw as major growth areas in KISA and associated skills.

7.2 Expected KISA growth and skills

7.2.1 Expected Growth

At the outset of the survey, respondents were asked to "please indicate the five KISA that you believe are likely to have the largest potential for employment growth in the EU in the period to 2020". They were provided with a list of 19 KISA[32], in four groups (together with an "other" category):

IT Services- IT Hardware consultancy; Software Publishing; Software consultancy; Data processing services; Database activities; IT equipment maintenance and repair; Other computer related activities

Architecture and Engineering - Architectural services; Industrial process design services; Product design services; Other Engineering services and related technical consultancy

R&D and testing- R&D (natural sciences and engineering); R&D (social sciences and humanities); Technical testing and analysis

Professional services - Legal activities; Accounting, book-keeping and auditing activities, tax consultancy; Market research and public opinion polling; Advertising; Business and management consultancy

Respondents' votes for the KISA that were expected to grow most are displayed in Table 7.2.: The two KISA which more than half of the respondents voted for were Business and management consultancy, and Software consultancy. 30% or more voted for R&D (natural sciences and engineering); Industrial process design services; R&D (social sciences and humanities); Product design services; and Market research and public opinion polling. At the other extreme, very few (15% or least) considered that KISA such as IT Hardware consultancy; Software Publishing; Accounting, book-keeping and auditing activities , tax consultancy; IT equipment maintenance and repair; Other computer related activities; and (especially, and perhaps surprisingly) Architectural services were liable to grow extensively. We suggest that these latter cases are mainly KISA which might be expected to be automated, thus even if the activities were in more demand, actual employment increases might be low.

Respondents from different sectors ranked KISA growth somewhat differently. Academic sector experts viewed, industrial process design services, software consultancy, business and management consultancy as the areas of most expected future growth. The top expected growth areas of KISA for the public sector experts were business and management consultancy, R&D (natural sciences and engineering), R&D (social sciences and humanities), software consultancy and industrial process design services. For the private sector experts, business and management consultancy, Software consultancy and R&D equally in the natural sciences and engineering and social sciences and humanities were seen as certain growth areas.

[32] Taken from the set of KIBs outlined in chapter 2.

Table 7.2 Ranking of Expected Growth of KISA

ranking	Knowledge Intensive Service Activities	votes
1	Business and management consultancy	62%
2	Software consultancy	51%
3	R&D (natural sciences and engineering)	49%
4	Industrial process design services	41%
5	R&D (social sciences and humanities)	32%
	Product design services	32%
7	Market research and public opinion polling	30%
8	Data processing services	28%
9	Database activities	25%
	Other Engineering services and related technical consultancy	25%
11	Legal activities	23%
12	Technical testing and analysis	20%
13	Advertising	17%
14	IT Hardware consultancy	15%
	Software Publishing	15%
	Accounting, book-keeping and auditing activities; tax consultancy	15%
17	IT equipment maintenance and repair	13%
	Other computer related activities	13%
19	Architectural services	6%
20	Other	1%

Now consider what is said in terms of skill requirements for the KISA where most growth was anticipated.

7.2.2 Business and Management consultancy

In business and management consultancy (activities include provision of advice, guidance or operational assistance to businesses and the public service (NACE 74.14): the expected growth in employment in this KIBS sector would be moderately high – especially in the KIBS sector (rather than its in-house equivalents) (Figure 7.1) Respondents generally expected growth in requirement for all types of skills, with consensus about the importance of social skills; complex problem solving and systems skills are also liable to play key roles followed by technical skills, resource management and basic skills (Figure 7.2)

Figure 7.1 Survey Responses – Employment Trends in Business and Management consultancy

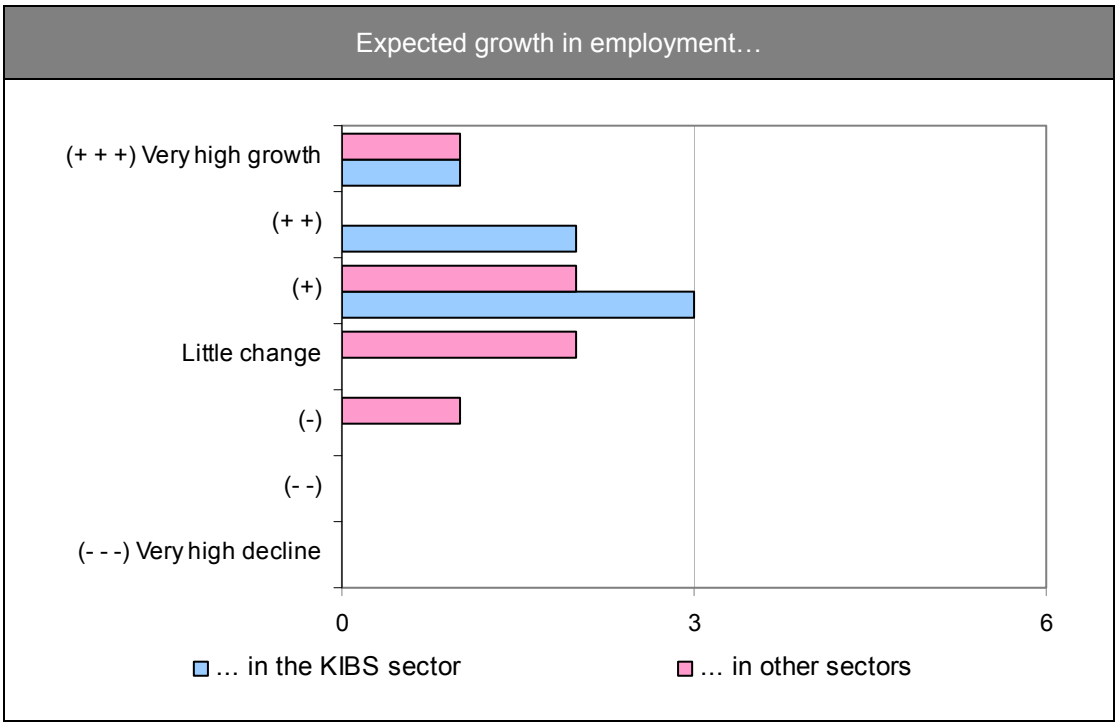
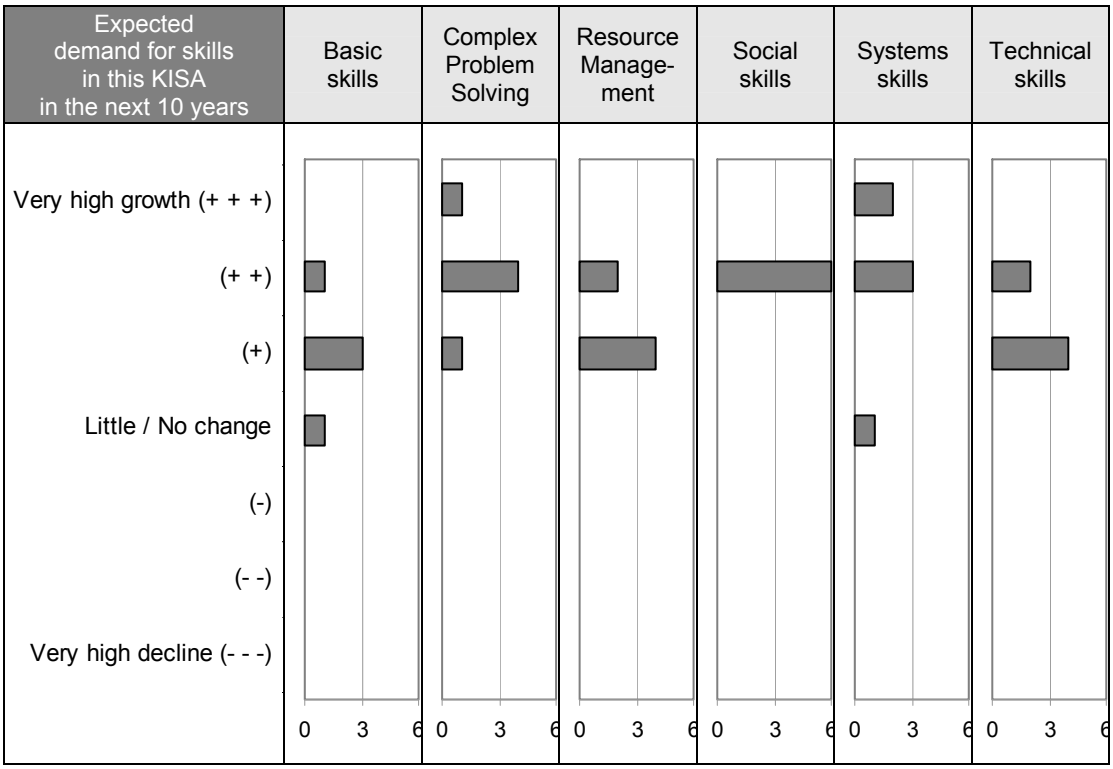


Figure 7.2 Survey Responses – Skill Demands in Business and Management consultancy



7.2.3 Software Consultancy

The area of software consultancy, including maintenance of software and computer programming, was also expected to achieve higher employment growth in employment than in in-house KISA (Figure 7.3). Again, skill requirements were expected to increase across the board by most respondents. There were expectations of increased demand in this sector for Complex Problem Solving and Technical skills (these would be software skills) followed by Systems skills, Resource Management and Social skills. The demand for basic skills will increase only moderately (Figure 7.4).

7.2.4 R&D (natural sciences and engineering)

In the area of R&D (natural sciences and engineering) analysis of the online survey responses indicated that here were expectations that growth in employment in this KIBS sector will be higher than in in-house KISA (Figure 7.5) Accompanying this growth there were expectations that demand will increase for particular skills in Complex Problem Solving and Resource Management, Social skills and Systems skills will become more important additional requirements than basic and technical skills. – see Figure 7.6.

7.2.5 Industrial process design services

Expected growth in employment in KIBS sector will be somewhat higher than in in-house KISA sectors, according to those completing this section of the survey (Figure 7.7) Basic skills would be less demanded in the future, while demand for others would increase, as indicated in Figure 7.8.

7.2.6 R&D (social sciences and humanities*)*

It is interesting to see that those completing this section of the survey anticipated that growth in employment in this KISA would be **much higher** in KIBS than in other sectors (Figure 7.9) Demands for Complex Problem Solving, Resource Management, Social skills, Systems skills and Technical skills will increase (Figure 7.10)

7.2.7 Product design services

This is the only high-growth KISA where employment growth is anticipated by those completing this section of the survey to be roughly similar in KIBS and in-house KISA (Figure 7.11). Figure 7.12 demonstrates unusually mixed reactions with regards to the demands for various skills, with some respondents expecting high increases in requirements, and other anticipating declines (could this be due to automation?).

7.2.8 Data Processing Services

Perhaps surprisingly, this was a KISA where high growth in employment was expected in KIBS sectors would be very high. Interestingly there was also expectation that this growth would also take place in other sectors as much as in KIBS (Figure 7.13) In this KISA demand would greatly increase for Systems and technical skills, as well as for Resource Management skills (Figure 7.14).

Figure 7.3 Survey Responses – Employment Trends in Software Consultancy

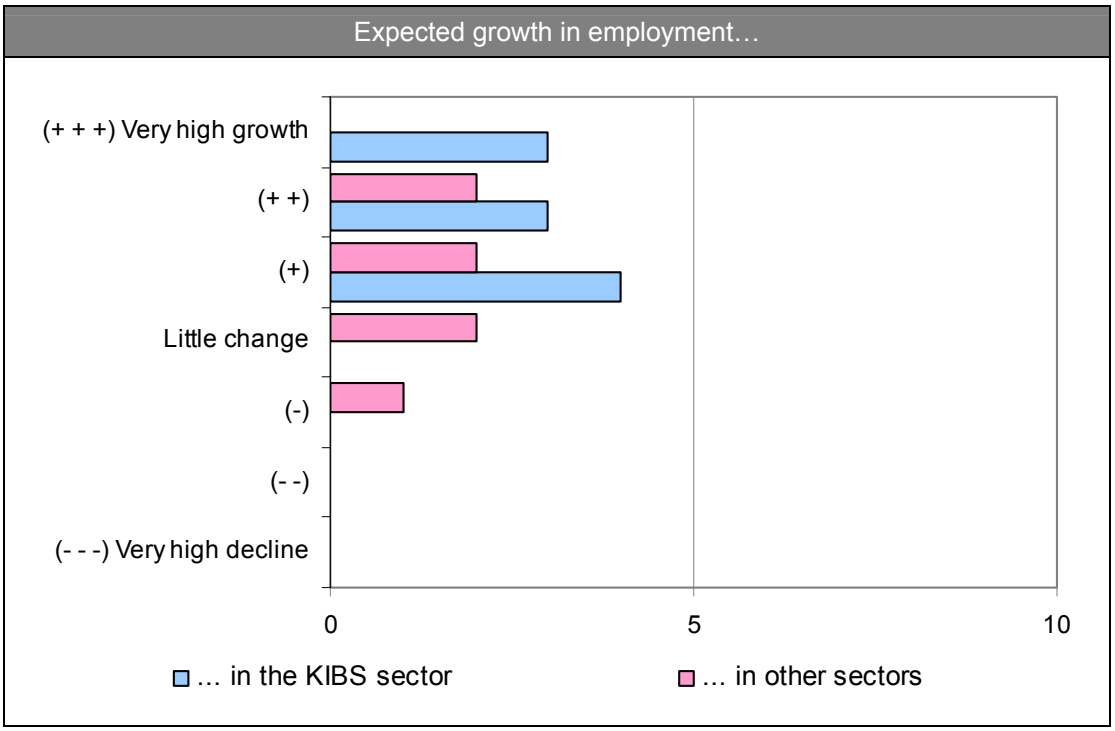


Figure 7.4 Survey Responses – Skill Demands in Software Consultancy

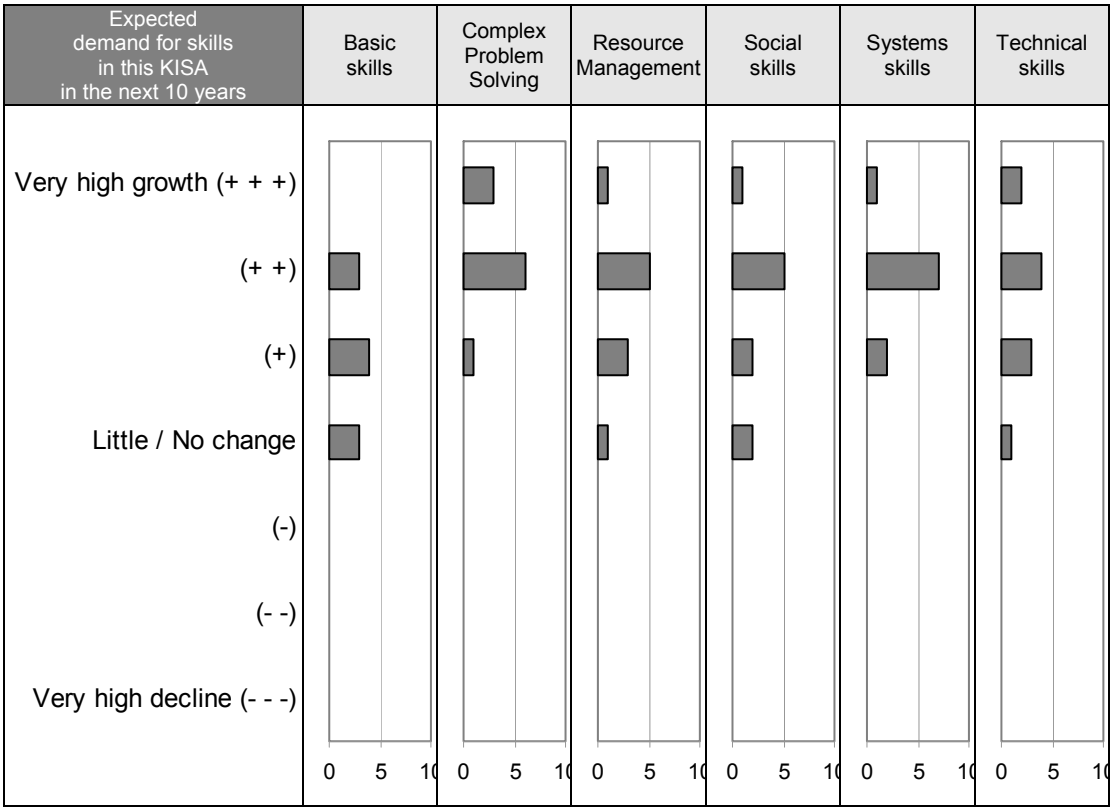


Figure 7.5 Survey Responses – Employment Trends in R&D (natural sciences and engineering)

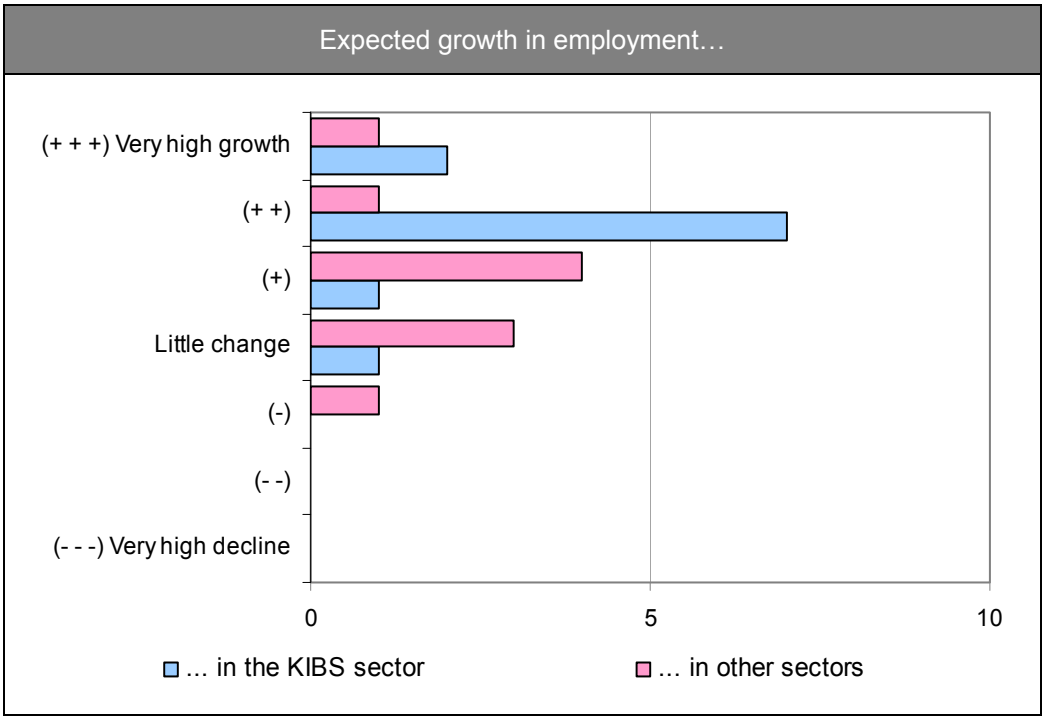


Figure 7.6 Survey Responses – Skill Demands in R&D (natural sciences and engineering)

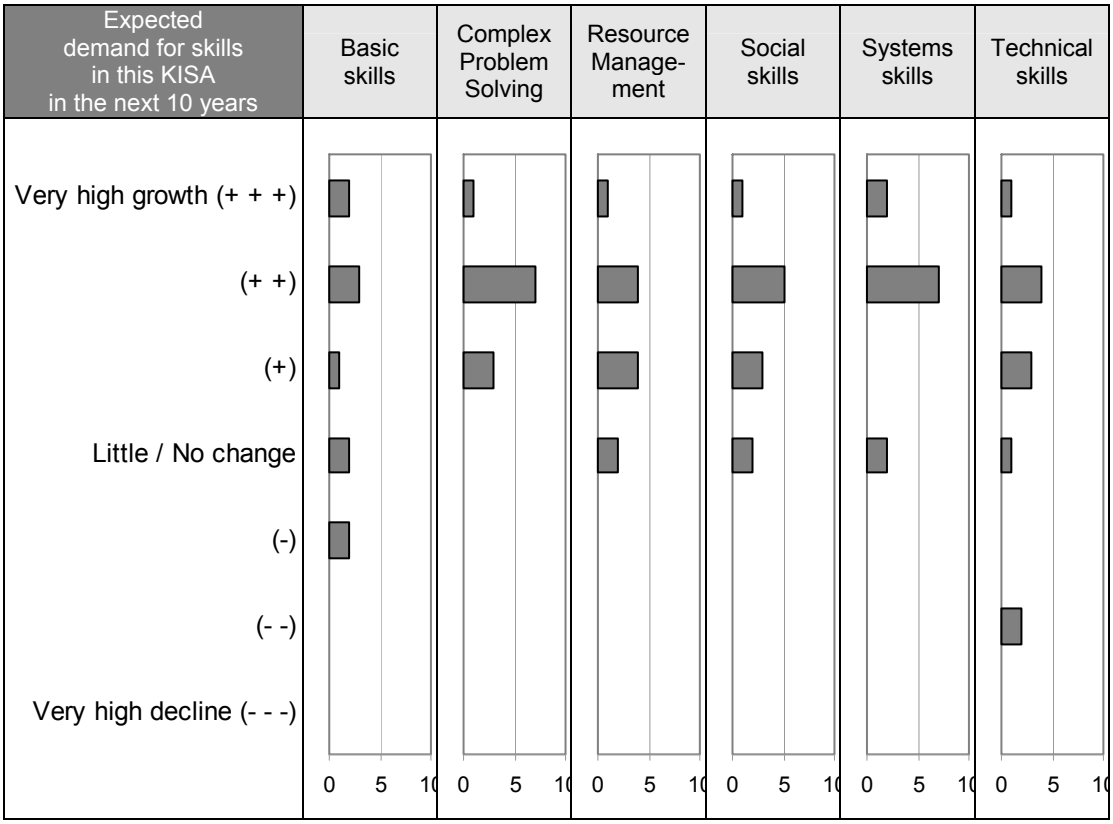


Figure 7.7 Survey Responses – Employment Trends in Industrial process design services

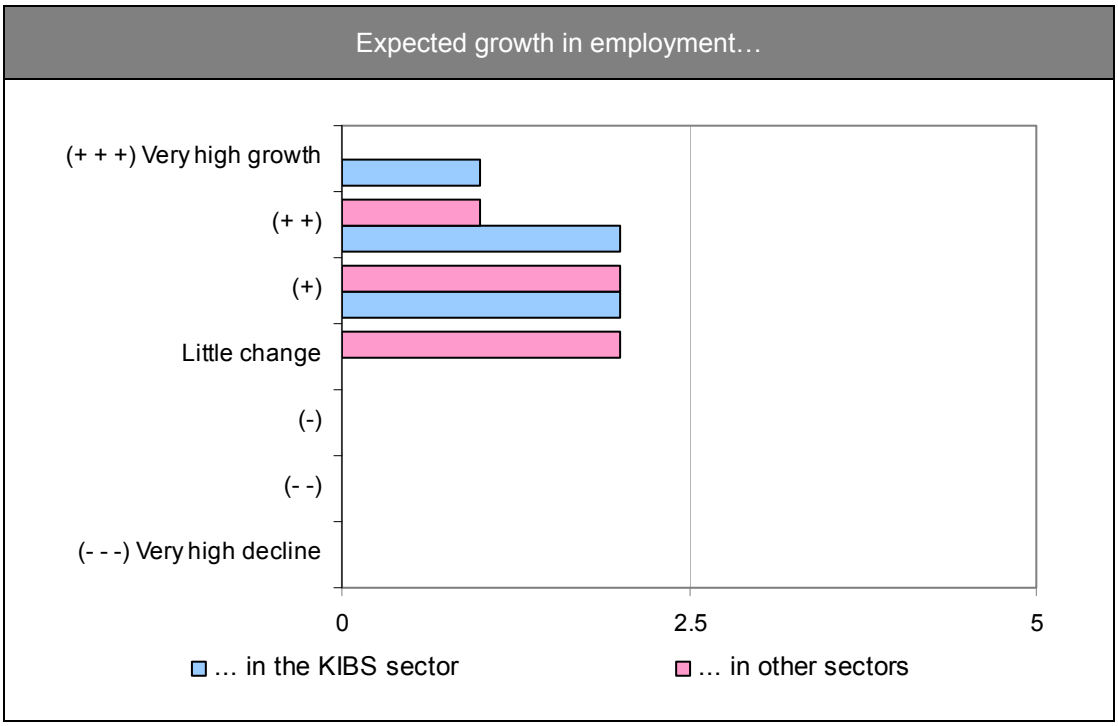


Figure 7.8 Survey Responses – Skill Demands in Industrial process design services

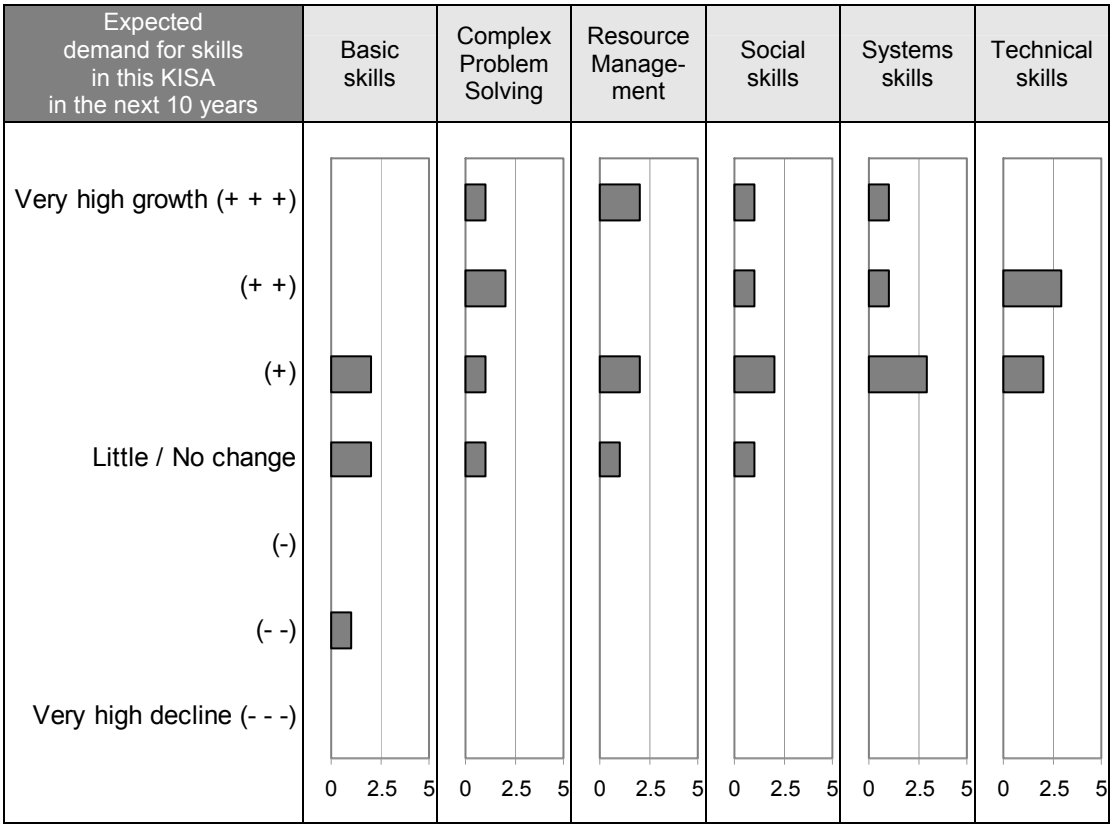


Figure 7.9 Survey Responses – Employment Trends in R&D (social sciences and humanities)

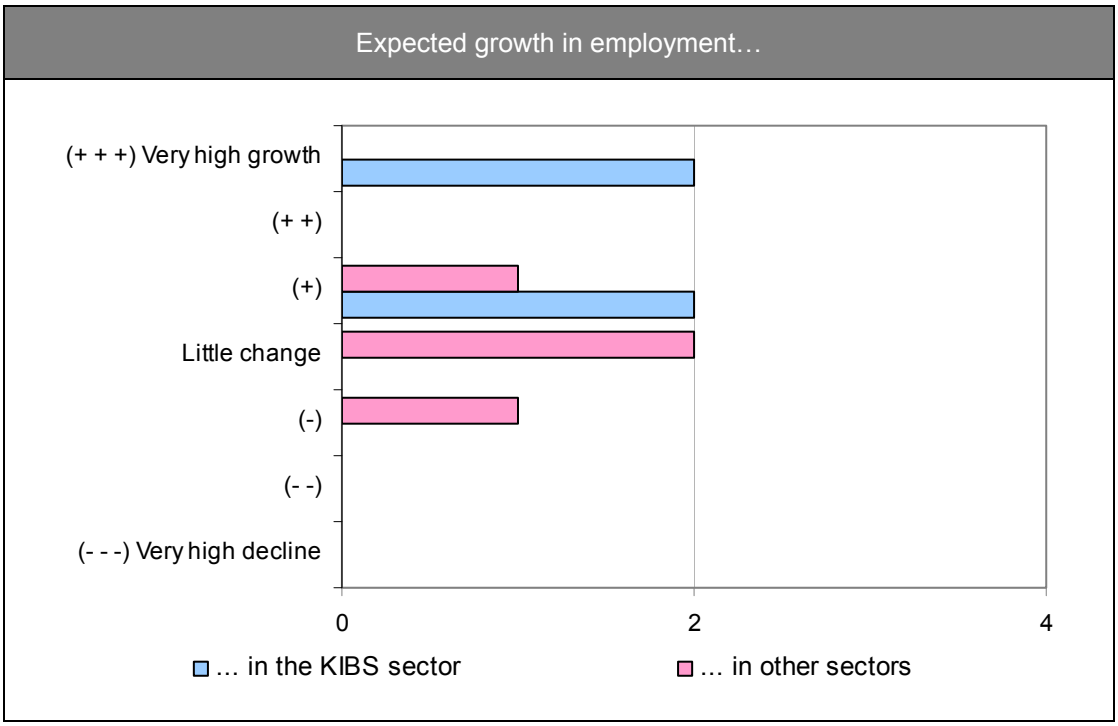


Figure 7.10 Survey Responses – Skill Demands in R&D (social sciences and humanities)

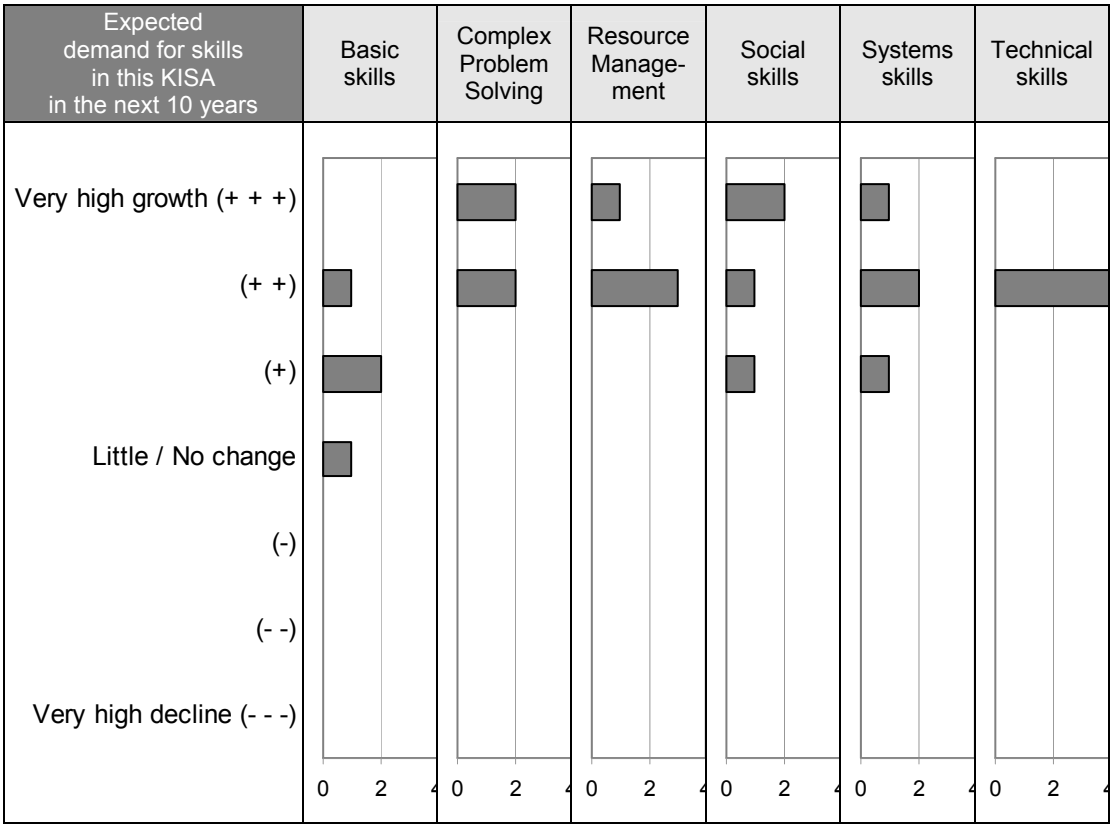


Figure 7.11 Survey Responses – Employment Trends in Product design services

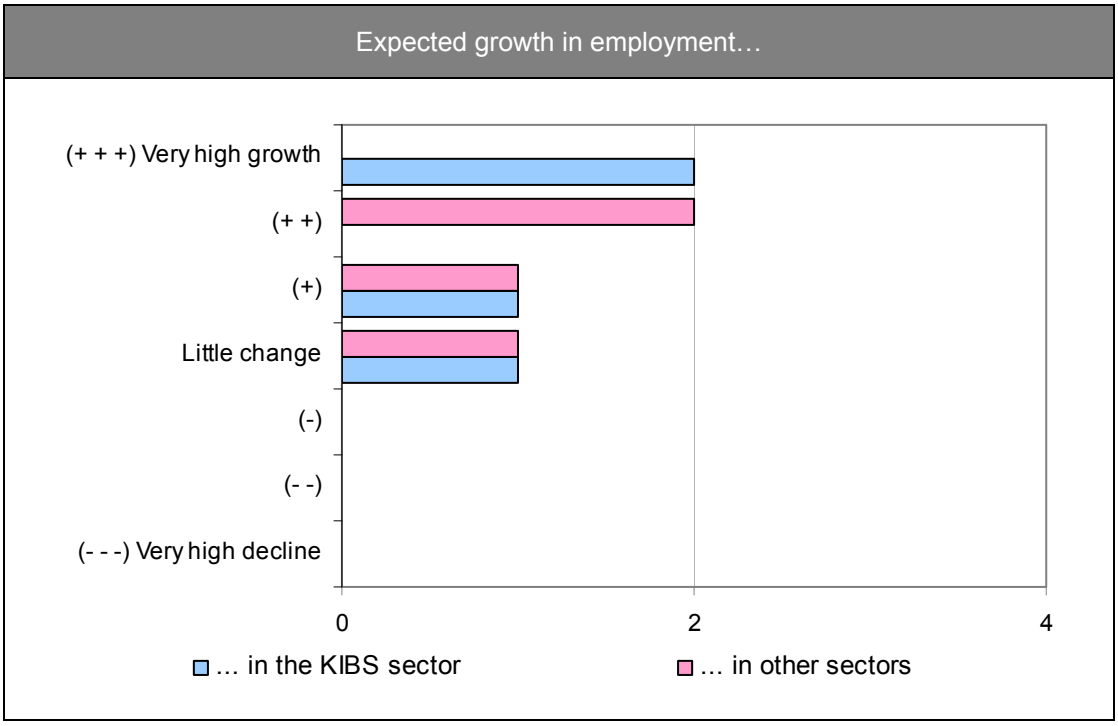


Figure 7.12 Survey Responses – Skill Demands in Product design services

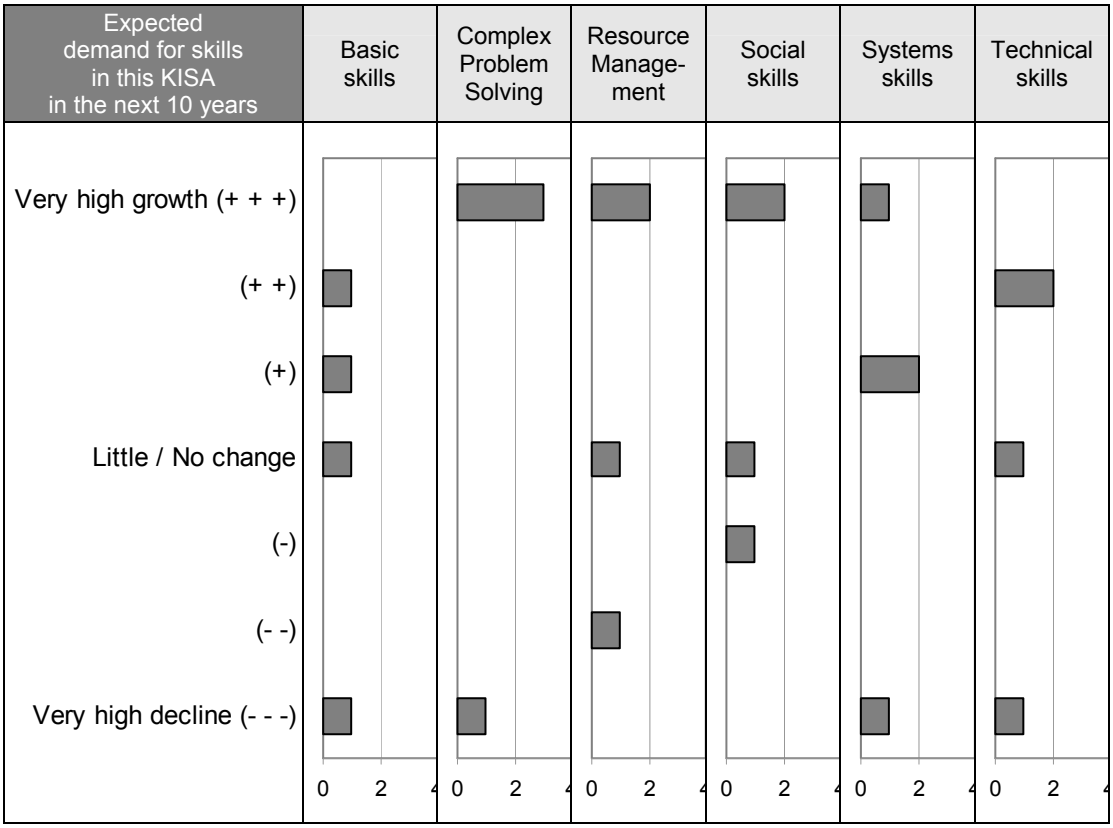


Figure 7.13 Survey Responses – Employment Trends in Data Processing Services

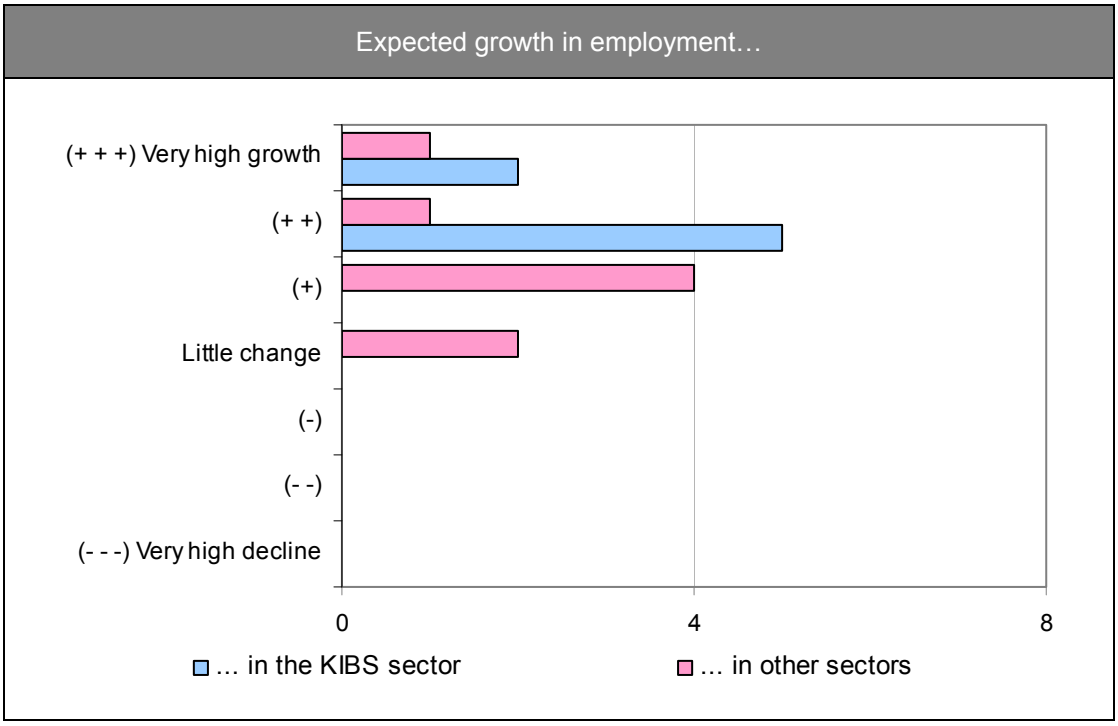
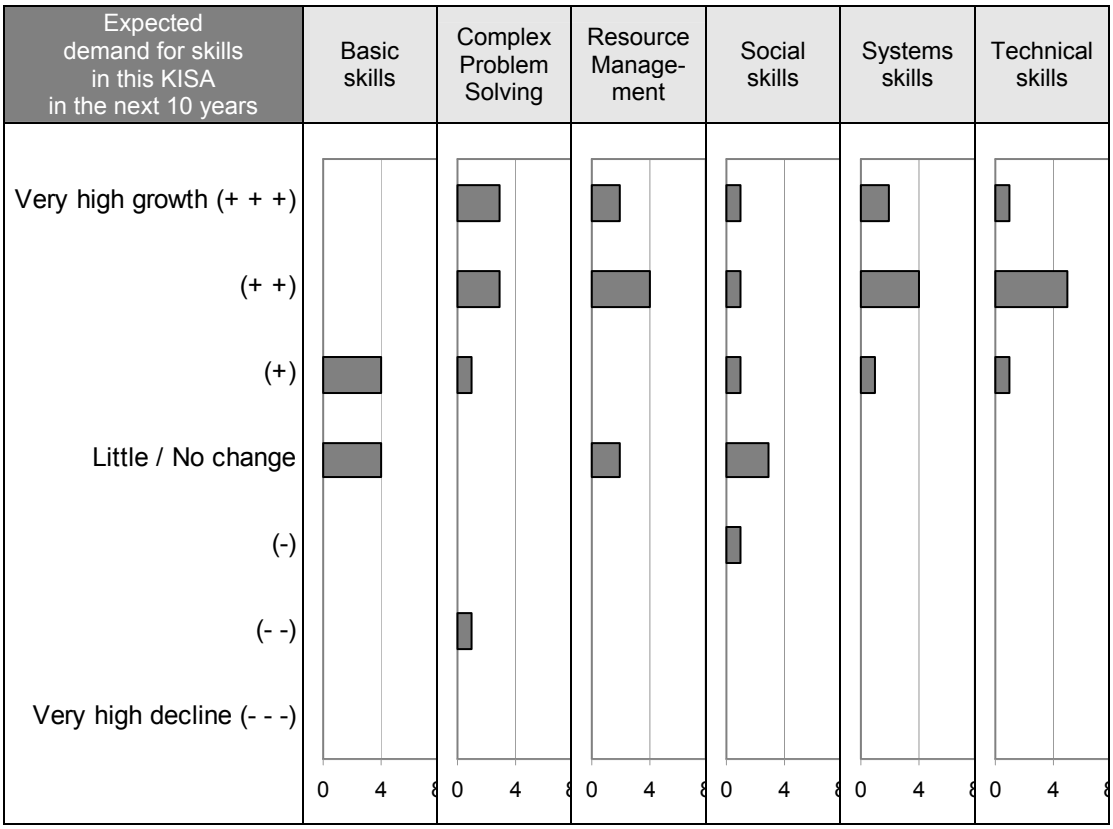


Figure 7.14 Survey Responses – Skill Demands in Data Processing Services



7.3 Conclusions

There is general agreement in seeing demand increasing for complex problem solving skills, resource management and systems skills. The next challenge is to ascertain what actually make up the constituent elements of these skills in the differing contexts and how to train for them.

8. Debating KISA Futures: Towards new scenarios

This chapter outlines the processes and results of a pair of scenario workshops conducted in the course of this study, both in September 2008. The first, in Manchester, mainly focused on developing a set of KISA scenarios. The second, held near Amsterdam, focused on exploring implications for KISA work and skills.

8.1 Manchester Workshop

8.1.1 General Discussion

It was agreed that we could focus on the KISAs associated with the core activities of the specialised KIBS sectors in NACE 72-74. While there are other KISAs, to do with, for example, financial, telecommunications, and cultural services, there was optimism that the main features of these KISAs have much in common with those identified.

On the basis of earlier scenario studies (chapter 7), a set of uncertain but important features of future KISA emerged. The following list was presented to the workshop:

Overall growth in demand for KISA, reflecting both economic growth and developments in technology, regulations, etc.

Change in extent to which KISA are supplied through KIBS or through in-house services, reflecting relative costs, specialisation, etc..

Change in extent to which KISA are supplied through domestic, other European, or offshored service suppliers, reflecting cost, quality and reliability of supply (among other factors).

Structure of KIBS sector: extent to which a division exists between integrators and lead suppliers, and more specialised KIBS whom they contract into projects.

Strategic role of KIBS sector: extent to which firms play role in coproducing client strategies, as opposed to more distant contractual relationship;

Extent to which KISA themselves are standardised and routinised, as opposed to requiring creative problem-solving (even when modular elements of solutions are being configured together)

Nature of professional work in KISA – extent of division of labour, type of technology support, degree to which work is autonomous or rigidly standardised, etc.

The workshop then discussed key developments in the possible evolution of KISA over the next decade or so. (Participants were asked to think of the period to 2020.) These are captured in the following notes.

Issues concerning the nature of KIBS and KISA

The old sectoral and national accounting frameworks, as well as the basic idea of growth, exclude many human activities that are key determinants of the "quality of life" and of wealth in more narrow terms. There are dangers in thinking about the future solely in terms of these categories, which could mean that analyses are severely constrained and important determinants overlooked. How one best goes about encompassing these wider activities, not captured in formal KISA definitions of sectors and occupations, requires more attention. One approach would be to take a "working and living conditions" approach that looks at time allocation of people in all areas of wealth-creating activity, including non-monetary activity. (For example, we could look at the extent to which KISA-type work experiences –

solving complex problems using specialised knowledge, for instance – are experienced in nonKISA occupations, nonKIBS sectors,[33] and in informal economic activities like domestic and voluntary work.) This would, at a minimum, reveal much more clearly that KISA is happening across a very wide range of everyday tasks, including caring and learning activities broadly understood.

The idea of "knowledge-intensive" as it used in KISA and KIBS analysis is open to challenge, in that it seems to be very largely based on formal credentials as opposed to other forms of knowledge and learning. (Admittedly, there is a strong correlation between the preponderance of such formal credentials and experience of challenging problem-solving work: but this is not a perfect correlation, and largely hierarchical and taking credentials as an indicator of skill levels and knowledge-intensity is inevitably far from a perfect solution.) Another way of looking at knowledge-intensity relative to the individual's own learning and personal refinement of tacit as well as codified knowledge. This would imply developing ways of assessing the accumulation of self- and community knowledge over time and through experience. There was some suggestion, however, that such "wisdom" is heterarchical, and not subject to the same type of assessment as industrial era high-skill to low-skill ranking. The question is open as to how far the O*Net approach can help deal with this.

Nature of professional work

Much KISA work will be more interactive and directed towards specific needs of clients. This makes the nature of the professional critical. A possible starting point is some idea of 'professional qualifications and certification/compliance' that can be used as frameworks for maintaining standards.

The issue of Taylorisation of professional work was discussed, with divergent trends seen as possible. New knowledge is emerging more rapidly: new knowledge, ideas and innovations which are not standardised. In contrast, existing knowledge can be standardised more quickly, using management techniques such as those involved in knowledge management. There are incentives to codify knowledge: it makes it easier to manage, easier to replace staff, and potentially easier to copy. This implies means that 'not codifying' is one way to protect a service innovation, particularly a complex service, and may be used by professionals as a way of maintaining their own value and making them hard to replace. In any case, there is debate about how far and how fast tacit knowledge can be codified, since this knowledge often involves much social sensitivity and awareness of context-specific language and routines.

The issue of the extent to which KISA development reinforces social inequalities was given some attention. The Taylorisation of professional work might make such work more accessible to low qualified and less skilled workers.[34] Taylorisation would be most likely to develop through automation – KISA support systems – and through more 'rational' process development and improvement, rather than through making humans perform mechanical repetition as in classical Taylorism. Some Taylorisation of professional services is already evident: the use of analytic science to support operations and management within legal

[33] Data on work experiences across all sectors and occupations is presented in Parent-Thirion, A., Fernández Macías, E., Hurley, J., and Vermeylen, G., (2007) Fourth European Working Conditions Survey, European Foundation for the Improvement of Living and Working Conditions, Dublin available at: http://www.eurofound.europa.eu/pubdocs/2006/98/en/2/ef0698en.pdf

[34] There was some discussion of how well KIBS and KISA facilitate social inclusion and the labour market integration of the low qualified, migrants, indigenous and disadvantaged groups? These groups have little access to KISA, meaning potential lost opportunities and growing problems.

organisations, for example, the use of paraprofessionals to carry out more routine elements of the tasks.

A tendency away from traditional professionalism towards more 'business-like' approaches was discussed. Successful KIBS work may require the rare *T-shaped specialists* (who combine deep knowledge in one field with a broad spectrum of more shallow knowledge in many other fields, and who are capable of working productively in multidisciplinary/ multiprofessional teams). The ability to work across traditional professional and disciplinary fields is seen to be a growing trend in KIBS. While KIBS firms will often require professionals trained in economics, engineering or law, combined skills are also highly appreciated.

As will be discussed again later, the question arises of how far project-based networks of collaboration the new business model for KIBS? Whether big KIBS firms disaggregate – or conversely "cottage industries" increasingly become subsumed into big firms was debated, with divergent views about trends and possible countertrends, and about variety across sectors.

Geographical location

This topic also attracted a good deal of discussion. The workshop discussion was much less preoccupied by the question of offshoring than has been much of the recent literature. It did, however, pick up the theme of virtualisation and networking of knowledge-intensive services as possibly – not definitely – limiting the extent of their geographical concentration. Three main points were discussed:

The geographical location of KISA will be determined by a combination of several factors. One significant factor is the **strategic importance** of the services (some, for instance, must be under the control of a company's nationals for security or other reasons). Another factor is the extent to which a 'job' or task can be **standardised** allowing formal specifications (and how far these specifications can be rapidly prepared and revised) that can be reproduced in different environments. The scope for Foreign Direct Investment in countries with relatively low wages and well-developed skills (and good telecommunication and transport links) is highly relevant with regard to development of some KIBS. But limits are placed on this by a growth in importance of the local level in "skills ecosystems": customers still want to have face-to-face contacts, so the availability of services and KISA networks can be a key factor for attracting and retaining industry and achieving local competitiveness. Furthermore, cultural differences in terms of the range and type of services used, users' knowledge and expectations of KIBS are liable to result in a persistence of geographical differences in many KISAs.

There was lively debate, then, about the extent to which a spatial centralisation will be prevalent in KIBS. While some types of KISA work can be done online, in which case close proximity is less relevant, other work requires frequent face-to-face contact (for example as increasingly complex and ever-evolving project-based problems have to be solved, often with coproduction across several KIBS and clients). Another factor here is the mobility of KISA workers themselves, with professional workers probably becoming more mobile – the Richard Florida "creative class" argument may come into play, with various locations competing to be desirable places for such highly skilled workers to locate.

KIBS are liable to be complementary to production of goods and other services. If increasing agglomeration applies to KIBS, and knowledge spillovers apply here, we might see a relative few regions in the EU become dominant in KIBS. Where would these KIBS clusters be in the EU and elsewhere – and how far would BRIC (Brazil, Russia, India, China) countries become important players in KISA? The workshop participants were by no means agreed as to just how far centralisation

trends might proceed, however: while some centralisation was widely expected, this might be a matter of many rather than few centres.

Division of labour among specialised firms

The division of labour is much more influenced by the wage levels of people in particular regions than by the degree to which they populations possess specific KISA-related skills, it was suggested. People capable of KIBS work, for example, might be attracted to other opportunities which came sooner or is better paid.

There was considerable discussion about the rise of “networked” or “virtual” organisations, collaborating on projects on a more or less temporary, project-specific basis. The expectation that many KIBS activities will take the form of networked professionals collaborating on a temporary (project) basis was forcefully expressed; another view was that this should be seen more in terms of the orchestration of activities across smaller and bigger KIBS firms. It appears, so far, that subcontracting and collaboration among the various categories of KIBS is a key. An important development may be the 'service integrator' (as opposed to systems integrator); the emergence of effective integrators may well accelerate the development of KIBS. (This might well result in cycles of agglomeration, mergers and acquisitions, and the reverse trends, as seen in other industries.

There is, however, liable to be a contradiction between the need for openness to generate new ideas, and the interest of each firm for exclusive use of new knowledge.

Many KIBS employees derive their reputation from previous association with big firms e.g. IBM.

The phenomenon of the 'KIBS-ification' of manufacturing companies was noted, with the point being made that many of these companies do more than just create KISA internally for their own use. They also provide consultancy services linked to their solution offerings, “product services” such as aftersales service, training, complementary services of various kinds. In this they are not just driven by customer need or the search for extra income – we can see that they are also chasing new knowledge generated by users, which can feed back into product improvements and innovation. Another driver may be the demand for more ethical and/or sustainable business, which would force manufacturers (and service providers) to seek higher value-added and maintenance of relevant product services, leading to changes in industry structures and emergence of new KIBS.

The fluidity of networks in KIBS in the future is a major issue. The trend for professionals with appropriate skills to increasingly come together to accomplish specific projects, and then disperse, was seen as very probable by some participants. Such virtual organisations raise questions as to how the project is coordinated, who is the major orchestrator, who assumes risks and responsibilities, how are profits distributed? Will it be the case that individual workers will be responsible for their own skills development – since firms may be reluctant to invest in training employees as they will not be able to internalise the benefits from this training. This again links to the geographical concentration of KIBS: do virtual organisations result in deconcentration (much work can be done anywhere) or do the requirements of trust and face-to-face contact imply a spatial clustering? Will KIBS concentrate in fewer regions in Europe, causing an increase in inequality between European regions?

Strategic role of external KIBS

Many KISA are not particularly strategic or crucial, but do simply need to be done, even when appropriate in house capacity is missing in users. The fees that KIBS can charge reflect the extent of scarcity on the relevant labour market; it cannot be taken for granted that clients will remain willing to pay high fees into the future. This may support offshoring and/or in-house KISA supply, including efforts to automate elements of expensive KISA.

There was some suggestion that supporting technology, like Information Technology (IT) might be less a strategic matter in the future of KIBS/KISA - although Information Systems (IS) that necessarily use such technology will probably remain so.

Research – in the broadest sense as the quest for new knowledge - will become more strategic as a management tool. In this line, *open-source* KIBS will possibly be advantaged over proprietary KIBS, and not just in the IS area.

Outsourcing of expertise will occur because an organisation identifies a need it can not meet, or alternatively determines that it is unable to develop an in-house capability that has the economies of scale necessary to be effective. If this is just done on a cost basis, it might lead to the hollowing out of the necessary skills for an organisation to make appropriate strategic decisions as has happened with much of government based IS development

A Selection of Key Features

In break-out group work, a list of some eleven items which participants considered to be important possible future features of KIBS was formulated. They were then asked to vote on how important each was, using the groupware tools (each participant was allowed to cast five votes for items they felt to be particularly important). The result was that five of these features were considered to be particularly important ones:

1. Will all KISA activities end up in networked professionals collaborating on a temporary (project) basis or will we still need smaller and bigger KIBS firms? (Subcontracting and collaboration among the various categories of KIBS is key.)
2. Which regions in Europe will become specialised in KIBS? Is having one or two regions which are highly specialised in KIBS desirable? Will this lead to inequality between regions?
3. What is the role of tacit knowledge (through face-to-face contact) in KIBS? Is this sort of knowledge becoming more or less important? Does online networking and interaction mean that it will become less important?
4. [Will] Externalising KIBS may have the result of organisations losing an ability to innovate themselves [?] - understanding those requirements is a strategic necessity
5. [What is] The role of KISA in Innovation: move from specific to generic knowledge [?]. As a service sector KIBS may have intrinsic innovation or piggyback on the innovations of their clients. The first is maybe dependent on economies of scale but the latter is dependent on having feedback systems which "re-genericize" the knowledge generated by customising for the most innovative clients.[35]

[35] We should note that this is not, of course, the opinions of a large and random sample of experts – it represents the views of workshop participants after discussing and debating issues among each other. It captures the perspectives developed in the workshop, then, and this and subsequent charts should be interpreted as such. It should also be noted that in these charts, the participants were voting on a particular formulation of the topic that was developed in the workshop. The exact phrasing is certainly not as precise and clear as would be expected of the formulations that would be used in a survey or more scholarly writing on the subject. Indeed, some of the items compound together more than one idea, which introduces some ambiguity into the results – although this also reflects the groups' thinking concerning the interrelationship of specific themes.

In discussion, we summarised these five key features under the following set of labels:

Role of Virtual Networks
Regional Concentration (vs. delocalisation)
"Cartelisation"/Long Term Relationships
Technology encapsulating knowledge
KIBS role in innovation

Participants then voted on how uncertain they were about the future evolution of each of these five features, in terms of a five-point scale (from 1=most certain to 5=most uncertain). Just considering the mean scores on these scales, all were regarded as moderately uncertain: the means ranged from 2.62 to 3.12 (i.e. slightly on the "uncertain" side of the mid-point). The most uncertain item was number 2 above (which regions become specialised in KIBS), followed by number 4 and number 1 (networking versus larger firms); numbers 3 and 5 trailed behind in terms of uncertainty.

The first thing to say about these results is that they make it clear that there are many important yet uncertain ways in which KISA may evolve into the future. This is precisely the sort of situation that calls for scenario analysis!

A second point to make is that there was considerable variation among participants. Where it came to the most important features, only the first item was selected by more than half of the participants, though just under half of them endorsed the other four features. But practically all of the eleven items that were initially formulated were endorsed by a third or more of the participants.[36] When it came to uncertainty, every single one of the five items had at least one person checking the "most uncertain" option, though in the case of all topics - apart from the one concerning which regions would specialise in KIBS – there were more participants expressing high confidence in the future path of development than very high uncertainty. The "moderately high uncertainty" group (mark 4 out of 5) was the one that typically drove the results in the direction of greater uncertainty.

In the discussion of these results, a number of other points were raised. For example, it was felt quite likely that different KISA could evolve in very different directions. In general, small firms will prefer not to be tied to one supplier; and big firms would be expected to prefer large KIBS partners. This latter point may be attenuated if (some) large firms feature more internal diversification, with profit centres having a fair degree of independence in sourcing services. More generally, the issue was debated as to how far we might expect some development of looser "cartel-type" groups, with KISA clients and KIBS (some of which are spin-offs and demergers) closely associated in long-term partnerships.

Similarly, business models for KIBS might well vary across and within different types of KISA. Both network forms of organisation and larger firms could coexist, and a shift in favour of one or the other is not necessarily liable to be associated with strong

[36] The items which we have not listed in the above text were: (a) In order to remain competitive in activities with rapidly advancing knowledge an ability to innovate through the use of or assimilation of external KIBS is necessary; (b) KIBS: where is the emphasis: on knowledge, on specialisation, on intensity and what about future possibilities to codify?; (c) The issue of off-shoring. Will the BRIC countries become the most important players for KIBS off-shoring. How is it possible to off-shore and to retain knowledge at the same time?; (d) What is the role of tacit knowledge (through face-to-face contact) in KIBS? Is this sort of knowledge becoming more or less important? Does online networking and interaction mean that it will become less important?; (e) What is professional knowledge? a person able to deliver? or person with a specific qualification?; (f) Multidisciplinarity - responsiveness to clients.

trends towards regional centralisation or decentralisation. Likewise, the impacts on innovation are liable to be complex ones, although in general the extent to which there is real coproduction of knowledge was expected to be associated with higher levels of innovation. Policy frameworks could well play a role in the balance of these different features.

8.1.2 "Drivers" of the evolution of KISA skills requirements

Introduction

One aim of this first workshop was to explore the main "drivers" of KISA development and growth, how important various and different drivers are seen as being and how much uncertainty is associated with them and what scenarios can be derived from them.[37]

The earlier scenario analyses which were reviewed in the study (Chapter 7) provided useful detailed analyses of trends and drivers specifically seen as important influences on the KIBS sector. Their key drivers concern:

The **technologies** in use for KISA, and the technologies where KISA support is required by clients;

The **organisation** of the KIBS sector, in terms of the roles of firms (specialisation/integration), firm size, and their own use of off-shoring to accomplish functions;

Demand for KISA on the part of clients, and client strategies (and management philosophies) in relation to internalisation of KISA versus externalisation to KIBS, to off-shoring internal KISA and/or using overseas KIBS, and in terms of possibly moving into commercial supply of KISAs to other firms.

Demand is in turn influenced by such factors as technological change, regulations, turbulence in markets and levels of economic growth, client firm internationalisation, etc.

Availability and quality of **training** in KISA skills, modes of provision of training (on-the job and in formal institutions, life-long learning, etc.), and possibly by professionalization in KISA work itself and the strategies of KISA users in terms of management control of professional work.

These drivers have evident implications for the skills that KISA will require in different scenarios, and offer insight into a range of useful drivers that can be mobilised to focus more on developing KISA scenarios for sectors and KISAs of particular interest. More generally they indicate what might be emphasised with a focus on KISA skill requirements. Ascertaining and establishing what drivers of KISA skills needs are relevant is clearly not straightforward: a list of drivers might be rated in terms of the perceived impact on demand for a particular type of KISA, in different types of environments (where a KISA might be in-sourced or outsourced, the regulatory framework operating). There is also the element of uncertainty, in that it may be unclear whether a driver will develop in a particular way (e.g. will this demand-promoting factor [continue to] grow in significance?) and/or just what its impact will be (will this driver lead to more or less of this outcome?)[38]

[37] "Drivers" is not a term used much in social science, where the complexity, feedback relationships, and fuzzy boundaries of most objects of studies leads to the term being seen as involving too much simplification. It is, however, widely used in futures studies and scenario workshops in particular, since it provides a useful structuring framework for discussions and analysis.

[38] Often this latter type of question reflects uncertainty about the development of different parts of a complex driver – for example climate change could evolve in very different ways, and social responses might also be quite diverse.

Examples of impacts of drivers on KISA skill needs: an Aide Memoire concerning drivers had been made available prior to the workshop and among its main points were:

Demographic trends and employment retention and arrangements: ageing of populations and workforces have industry-changing impacts on the supply of labour, market demand and competition, and productivity. As growth in labour supply slows, attracting and retaining workers becomes critical. The level of job vacancies can indicate whether there are problems with worker attraction and retention. Remuneration and leave entitlements are two factors that affect attraction and retention. Employment arrangements (permanent, casual or contract employment) affect skills development, productivity, innovation and competitiveness. These arrangements may engender flexible professional development solutions specific to sectors as transferable skills and essential underpinning skills in business, problem solving, communication and technology are required. Employers may only be willing to provide training for the additional enterprise-specific skills they require and additionally employers will seek solutions to capture and share and retain the corporate knowledge built up by casual and contract staff. Labour hire companies and personnel agencies may also become increasingly responsible for the skills development of the workers they supply. Employees and employers may demand reliable, recognised generic mechanisms for recording skills, training and qualifications which have change implications for current education and training structures and arrangements.

Technological change: technology and the rate of technology adoption by all types of enterprises is an important driver of training. Digital technologies, online transactions and convergence impacts on all enterprises and requires changes in skilling of workforces. New business models generated by e-business channels provide different ways of thinking about marketplaces, interacting with customers and managing staff resources. Enterprises need to consider the nature of the skills required by their workers. Workforce training is required every time a new technology (hardware, software or systems) is introduced into the workplace and ongoing training is needed to ensure that technologies are used effectively. Technology blurs the boundaries between many industries and generates the need for skills and knowledge across a number of specialist areas to exploit the integration of activities across sectors.

Regulatory changes: levels of regulation, licensing requirements and the rate of regulatory change have increased in all sectors. Skills formation strategies, particularly for SMEs, have become increasing necessities in areas such as business, finance, ICT, privacy and intellectual property, often requiring recognised industry training. Regulatory compliance is particularly challenging for the large number of SMEs within the innovation and business industries and managers and supervisors need the skills to develop risk management strategies, and mechanisms to ensure the ongoing competency of their workers

Market pressures: globalisation has provided access to a far wider range of goods and services, often at lower prices, than would be available from domestic producers alone and has provided businesses with a larger pool of capital and greater access to overseas technologies. Small businesses and franchises need strong business and financial management and planning skills to compete successfully. High level customer service skills are required in all industries. Employees are now required to update and broaden their product knowledge continually as the number of products and services offered increases. Customer service staff, for example, need skills to

help consumers with new sales and service channels (e.g. information kiosks, online banking, self-service call centres). Skills that allow innovation, productivity improvements and cost efficiencies will be highly valued across all industries.

Workshop Analysis of Drivers: the Manchester workshop addressed the question of drivers in a combination of plenary discussion and break-out group work, the participants identified a set of particularly important drivers. Again, the assessment of importance was determined by asking participants to distribute five votes across the ten items. The first three of the drivers listed above received votes from a majority of participants. Votes were distributed fairly widely across other topics – though the last two received very few nominations. The top ten of these drivers (in order of importance) were seen as:

1. Public policy and regulation (regulatory frameworks)
2. Technological development
3. Demand side: Responses to the challenge of environmental and other global issues will create market for new enterprises in architecture, engineering and design
4. Shocks to the economic cycle like oil and banking crises
5. Increased competition.
6. Increasing complexity and need for innovation requires the application of tacit knowledge which can be accrued through close proximity.
7. Availability of trained professionals prepared to take risks and change the way they work
8. Desire for increased flexibility on behalf of firms but also workers.
9. Increasing possibility of remote working because of development of I.T.
10. Market transparency

The role of public policy and regulation is extremely interesting, since it has not been emphasised in earlier scenario studies (except insofar as policy may be a driver of demand for services that help clients deal with regulations, for example).[39] There seem to be several other elements here, however, which were touched on in the workshop but could be fruitfully explored in further discussion:

The role of policy in facilitating or discouraging "cartel-type" developments (which could be problematic in terms of competition policy).

The role of policy in promoting regional clusters, attractive locations for KISA work and/or markets for KIBS, etc. – that might impact the extent and location of regional concentration.

Public sector "outsourcing" of KISA – the extent to which this develops, the "rules of the game" in terms of standards and demands for, say, accreditation, open-source, particular types of service contract; and the ways in which it is governed and coordinated (e.g. some KIBS firms are employed to coordinate the work of others).[40]

Other public policy issues concern, for instance, training systems and employment law.

It may also be speculated that the emphasis on policy and regulation in part reflects the fact that the Manchester workshop was held during a major financial

[39] Though it does appear in some of the les futures-oriented studies of skill needs and KISA.

[40] See Julius, D. (2008) Public Services Industry Review – Understanding the Public Services Industry: How big, how good, where next? London: Department for Business, Enterprise & Regulatory Reform (BERR) online at: http://www.berr.gov.uk/files/file6965.pdf for a study that documents the extensive scale of public sector outsourcing – some of it to the KISA addressed in this study, some of it to KIS more associated with public and community services, and some more focused on administrative and operational services.

crisis, where much of the structures underpinning deregulated financial markets was seen to be coming apart, new policy initiatives were being widely demanded, and the financial services sector and associated KISA roles across sectors were seen as liable to be thoroughly reorganised.

Compared to the uncertainties associated with future policy developments, future technology development was seen as relatively straightforward – indeed, there were arguments against the notion that most KISAs might be confronting new disruptive technologies in the near future. Technology development was expected to progress in the sense that information technologies would become more powerful and less expensive. More uncertainty surrounds the extent to which systems will be developed that would support the capture and deployment of what is currently tacit knowledge in many KISAs, and to which virtual networking might finally be able to substitute for a great deal of face-to-face contact. These factors probably account for another rather surprising outcome of the discussion. When we asked participants to vote on how uncertain they felt about the drivers – about how they might evolve, or what impact this might have on KIBS future development – there was very little difference in the means score awarded each of the most important drivers. All of them received mid-range scores indicating moderately high levels of uncertainty.

8.1.3 Four Scenarios: from the Workshop

In order to develop an understanding of the factors that could influence the path of future KISA activities and associated issues of innovation growth and skills configurations, the Manchester workshop devised four future scenarios.

One standard method of scenario analysis in workshops of this sort is to devise alternative scenarios around major drivers that are given high scores on both importance and uncertainty. This approach has its critics – for instance, scenarios may be just "mirror images" of each other, but is usually quite effective. However, as just noted, the exploration of importance and uncertainty of drivers did not result in two clear drivers emerging as most prominent in this respect. In retrospect, it would probably have been possible to organise the discussion so that the top three drivers were compounded together to give two major dimensions of change (say, regulation + demand, and style of technology use), but time limitations made this impracticable.

As an alternative approach, a focus on major features of KISA was chosen. The disadvantage of this approach is that the scenarios do not necessarily represent polar extremes, so some of the possible variety of alternative futures may be lost. However, it does offer the possibility of crystallising issues arising around major possible paths of KISA development. The discussion of KISA features into the future had specified five critical (and uncertain) possibilities for development:

1. Role of Virtual Networks
2. Regional Concentration (vs. delocalisation)
3. "Cartelisation"/Long Term Relationships
4. Technology encapsulating knowledge
5. KIBS role in innovation

Given the size of the workshop, only four of these could be taken as starting points for scenarios. The fifth feature is more to do with the impact of KISA than with their structure and organisation. This is an important issue, and does relate to work in the KIBS, but could be seen as arguably secondary. Thus it was decided to work with the first four features as a basis for development of four scenarios. The workshop

organisers presented a first view of how each of the features might be manifest in scenarios where one or other of them might be dominant, with a request that an effort be made to capture a wide range of variation in terms of the development of each feature across the scenarios. The initial presentation of possible relationships between the features was discussed by the workshop, and a number of modifications made, with the result that Figure 8.1 captures the starting point for relations between the features anticipated for the different scenarios.

The workshop was reconstituted as four break-out groups. Each was asked to develop one of the scenarios (participants selected which group they joined). The task was to identify a plausible version of this scenario, a realistic vision of a future where it might come into being, if possible without having to evoke "wild cards" like disruptive technologies or political events. They were asked to name these scenarios, and to describe what they would look like in terms of general business and economic environments, and the operation of KISA therein.

The following parts of this section reports on those scenarios and the brief narrative. These notes were provided by the group responsible for each scenario during the workshop, without major editing. They are thus rather rough in some parts, but should capture the discussions in Manchester effectively.

Figure 8.1 Alternative Scenarios and their Configurations

Feature:	VN	RC	CA	TK	(INNOVATION Role)
Scenario					
1. VN	++	?	-	+	+
2. RC	- (?)	++	+	- (?)	- (?)
3. CA	-	+	++	- (?)	+ (?)
4. TK	+	- (?)	- (?)	++	-

Scenario 1: "Knowledge Navigator"

This scenario is underpinned by the increasing ubiquity of advanced information technology systems, leading to constant disaggregation and reconfiguration of services and the subsequent complexity of the information landscape for both users and providers.

The main drivers for this scenario were seen as being (in the participants' own terms):[41]

Advanced and ubiquitous ICT development

[41] The following scenario accounts represent a very light-touch edition of the participants' inputs in the workshop.

On going development of the semantic web++ (collection of information, sharing of information, mine information)
Pervasive tele-presence
Industry /sector specific processes and definitions of quality
Service discovery and marketplace
Identity and trust management (technology and social acceptance)
Collective mechanisms for managing identity and trust
Easy 'routinised' virtual supply chain management for KISA
Requirement by customers for customised services (based on personal requirements, location, resources)
Requirements by public service providers and users for more flexibility, lower cost, greater personalisation
Demand for more sustainable products and services (co-produced locally in resource and human terms)
Demand for improvements in quality of life

Increasingly new services will be formed through KIBS of different sizes and organisational settings, dependent on their offerings. New formations may encourage existing services to disaggregate where they see advantages as new service providers will naturally move towards lower cost, lower risk and more flexible networked services. Virtual networks will also provide a route for augmenting existing service offerings so KISA will also include a mixture of some very hard coded requirements and others that will require human mediation and translation. KISA will often also be customised to individual client requirements, although attempts to reuse wherever possible will ensue.

Overhead reduction may override economies of scale leaving the natural size of a KIBS as 'small', impacting on KISAs, innovation and skill configurations.

Regional governments may seek to reinforce 'localism' to maintain employment, retain populations, encourage local specialisation and meet environmental regulatory requirements. Regionalism will seek to reinforce trust and tradition in order to retain many regional specialisations. Opportunities will increasingly exist for regions to develop specialisations (geographical stickiness) but for many KISAs geographic distribution will provide a means for both inter and intra-regional competition.

The development of virtual networking frameworks will seek to exploit local physical networks (which might lead to a see-saw effect in localisation-distribution-localisation). However tele-presence may restrict geographical distribution of services (where trust is partially dependent on colloquial attributes). Centralised state services will increasingly disaggregate, enabling social change (more personalisation for example and more 1-1 relationships). New models of public expenditure and distribution (to avoid the worst of social exclusion for example) will arise. The gap between the haves and the have-nots will widen unless new mechanisms for reducing exclusion are developed and deployed - the social worker, for example, will become a part time service integrator.

Quality of life, health concerns, and environmental concerns will be seen to be increasingly met by cooperating 'villages' of specialisations. Individuals will become their own service integrators (for example in health care) for much of what they consume.

The dichotomy of external KIBS acquisition vs. in-house supply does not apply particularly well to this scenario since the 'in' and 'out' dichotomy fades into dual approach and, in a sense, a lack of distinction between the two when services are unbundled and the size of "firms" is really solo or micro, not a firm. Therefore, KIBS are both give and take - supply and consume. In this scenario, KISAs are not likely to be off-shored outside of the EU as many of these services will be regionally based.

Knowledge intensive service activities postulated within this scenario are seen as highly supportive of the innovation process in clients (and both supply driven and demand driven innovation) and are very likely to be engaged in clients' strategy formulation and decisions. Other points included:

> The dichotomy of external KIBS acquisition vs. in-house supply does not apply particularly well to this scenario since the 'in' and 'out' dichotomy fades into dual approach and, in a sense, a lack of distinction between the two when services are unbundled and size of "firms" is really solo, not a firm. Therefore, KIBS are both give and take - supply and consume.
> KISAs are not likely offshored outside of the EU as many of these services will be regionally based.
> KISA will not mainly produced in a few core regions and localities within the EU, instead, it will probably be distributed - although there will be some regional concentrations of specific offerings
> KISA will be mixed in terms of organisation – not just through and by virtual networks, although these will provide a route for augmenting service offerings
> KISA also will not be organised within industrial cartels, but instead in a rich mixture of different ways
> Certainly KISA will have to be supported by advanced information technology systems
> KISA will also include a mixture of some very hard coded requirements and others that will require human mediation and translation
> KISA will also be customised to individual client requirements, although it will attempt to reuse wherever possible
> KISA is certainly going to support innovation process in clients (and both supply driven and demand driven innovation) and is very likely to be engaged in clients' strategy formulation and decisions

Scenario 2: Cartels

This scenario explicated KISA in terms of the often over-lapping areas of clusters and cartels. Clusters may be geographic in extension but are technology or product centred in dynamics. Cartels are organisation-based and may be focused on a central product or as in the case of for example, IBM, they may be a focus of a brand which sells solutions. As cartels are brand-led – the leading partner may have a core technology or only a market presence – in either case the boundaries of the cartel leader are often shifting, as high-value processes are bought in or developed and low-value processes are sold off or out-sourced. The cartel is a collection of suppliers along the value chain which is dominated by the ability of the cartel leader to sell the products which bear its mark. Nokia, BMW, VW, currently have a fixed product range but Philips, Unilever, IBM, are examples of generalists.

The main drivers for this scenario were seen as being:

The interchange between customisation for leading clients and the re-genericization of the solutions arrived at for wider circles of customers.
Lead members actively involved in setting and policing standards all along the value chain because they are the ultimate originator of innovation and the ultimate guarantor of quality.
Active enforcement of industry standards driven by the lead partners. This may have different cultural forms e.g. in Japan vis-à-vis the West, with Japan having freer interchange of personnel and knowledge based on trust which is itself based on dependency, while Western partners along the value chain may embed representatives in firms along the chain with more clearly defined roles and prerogatives. Cartels promote and enforce rapid trickle-down of innovation but only within the fixed parameters of the lead partner.

Cartels are able to generate brands which can extend their palette of products and services. This can produce a dynamic which can market a wide range of KIS offers and so produce a dynamic market. Brand extension and the "foot in the door", followed by selling a wider palette of services could lead to alliances of different KIS activities.

Cartels may have originated from a firm anywhere along the value chain but at the present time the lead firm attempts to gain exclusive access to the final consumer in order to garner the information from the use of products and the developing needs of customers. This might mean that service tasks which used to be carried out by intermediaries may be drawn more closely into the cartel.

Cartel gatekeepers have access to high-end users, drive and test new methods, so they can revise their boundaries and impose the pattern they prefer from time to time. Cartelisation seems to have synergy with Technology Encapsulation: the cartel leaders can use the information from lead users to develop technology which encapsulates their technology and so draw both consumers and suppliers more closely into dependency on their brand-system. In differentiation of technology-based and service-based KIB/KIS, there is a continuum with many KIBS as hybrid either because their products are inherently hybrid or because the Foot-in-the-Door approach leads them to develop a wide palette of services and products to exploit their brand within any user group they can access.

In many service-end KIBS, growth may be driven by regulation which makes in-house adaptation increasingly costly. External KIBS can put more resources into developing generic responses to new regulation. Thus this is a variant of the argument for out-sourcing per se, that mass providers of services can innovate where it is not worthwhile for in-house services to apply resources to innovation. This is another reason for using the Foot-in-the-Door approach, because access to the problems and needs of high-end users allows the genericization of solutions that have been developed; and this will help the market position of the cartels which can tap into this resource. In the technology-based KIBS such as Architecture and Engineering, some areas of R&D, the active value-chain knowledge management and innovation-diffusion techniques intrinsic to cartels can feed in to the necessary management of information exchange and knowledge standardisation among partners in major construction, engineering and R&D projects.

The issues of whether KISAs are going to be acquired from KIBS (as opposed to being supplied in-house), or off-shored outside of the EU, were not viewed as particularly relevant within this scenario. KISA were seen as having a global

orientation, and could be partly organised in virtual networks, where those networks were outside cartel networks, as well as within these. Thus elements of scenario 1 can coexist with this scenario. (The view that this is not relevant may make a lot of sense when we are focused on skill requirements of KISA – the implication is that these will be roughly similar whatever the organisational arrangements. Of course, there are big issues posed for management in terms of which arrangement should be, and is, adopted.)

As with scenario 1, and indeed all scenarios (to greater or lesser extents) advanced and ubiquitous ICT is seen as underpinning these developments.

Scenario 3: Growth but Inequality

This scenario is posited on growth trends continuing particularly in regional clusters and increasing fluidity between sectors. Major drivers for this included:

Existing industry is already concentrated
The pool of 'talent' (workers) is also concentrated
Positive feedback: Quality of life and spillover in region makes it a more desirable place to be, resulting in further concentration and further improvement of quality of life and spillover. (The downside may be, that concentration then starts to make the region less desirable).
Public policy initiatives can support or limit the development of regional specialisation: some policy initiatives promote regional specialisation and concentration as a means to increase growth, other initiatives may seek try to promote greater equality between regions.
Concentration promotes the fluidity associated with virtual networking. It makes it easy to move smoothly between one virtual project and the next.
Higher energy prices increase transaction costs thus driving concentration.

The notion of a 'sector' or sector differentiation will become increasingly irrelevant and the boundaries between sectors will be much more fuzzy and fluid. Differentiation may in fact develop between similar and dissimilar business processes: seemingly unrelated industries may have similar business processes. As a consequence it will be even harder to say that something is KIBS and something else is not. Sector divisions may become virtual and also temporary. There will be a large number of small firms and a small number of large firms with larger firms acting as coordinators but not seeing it as beneficial to acquire smaller firms as dynamism means the firm would be stuck with those assets when the market changes. Competition will be between regions rather than between firms and industries and between networks of collaborating firms rather than between firms: whoever can maintain the best network prevails.

A dichotomous labour market may increasingly develop reflecting fluidity, of older and more long-term employees mixed with younger people who do an apprenticeship made up of shifting between firms/projects. Highly skilled workers and experts may shift between projects with some firms retaining a few people on long term bases in order to maintain continuity of organisational memory. Highly qualified people may continue to be increasingly attracted to a small number of regions in which the quality of life is quite high and the opportunities are many. KIBS firms need to employ such people as the proportion of graduates employed by KIBS firms is very high. Thus for this reason (and others) KIBS firms are increasingly concentrated in small number of

regions. These regions become more productive and richer, the opportunities multiply further and the quality of life increases (apart from over-crowding). A fluid and network based lifestyle evolves in such regions, but at the expense of other regions. Regions must specialise in one particular type of business process in order to compete. Competition is between regions and between networks of firms. Regions which are able to evolve the best networks become most successful.

Scenario 4: Organic Growth, or Neural Networks–Virtual Networks

This scenario was given two the labels. **Organic Growth** is intended to stress the natural development of new forms of organisation, and **Neural Networks** to emphasise the dominance of knowledge-based virtual networks structured like links between neurons. Like the other scenarios, it is underpinned by the ubiquity and growth of advanced information technology systems, but it differs from them in how these are used.

The main drivers were viewed as being:

> Economic crisis: including episodic crises of globally capitalised market economies, shedding of professional labour by KIBS and risk aversion
> Individual professional preferences including work-life balance, quality of life and other QWL issues: autonomy, choice, ethics and ethos
> Advanced and ubiquitous technology is major facilitator. Extensive social networking among young people will translate into professional networking as they enter the labour market. ICT is more than a tool, new developments create paradigmatic changes in work
> Willingness of client firms (and big KIBS players) to contract work to individuals and SMEs. Here there are issues of confidence and regulatory frameworks

A diversity of networks is anticipated here. Some would be spoke and wheel; some multi-node; there would be both structured hierarchies and autonomous democracies. Individuals and firms (solo, micro or larger) need to network to keep informed of market changes and aiming to reduce risk through 'co-operation. Major players are perceived as downsizing to reduce risk during “crises” induced by changes and shifts in global capitalisations in all markets and thus seek to shed overhead in face of possible recessions and downturns. This may intensify trends in autonomous working by KISA professionals in KIBS.

Virtual networking from some angles was seen as inconsistent with regional concentration but nonetheless concentration around major client locations (chasing the business) or around locations where the priority is quality of life could be anticipated. The critical factor is the degree to which there is a need for regular client contact. Customised KIBS activities and those depending on tacit expertise will increasingly be undertaken by networks whilst routinised or standardised KIBS activities will be increasingly be associated with cartelisation. In terms of technological-knowledge innovation and viewed from within this scenario technological developments facilitate networking and in reverse networking enables access to a broader base of expertise, conducive to innovation.

In general the distinction between Technology based-KIBS and Professional KIBS is seen as less important than the routinised versus customised differentiation. Routinised offerings tend to be commodified. Knowledge management for the big KIBS companies may really be product management. The implications for T–KIBS may be less associated with networks, or limited to hierarchical networks, especially

where routinised, but may be associated with virtual networks for customised technical solutions, For P-KIBS the implications are that networked organisations may be the dominant model for them, where customisation lends itself to developing autonomous networks.

Comparing the Scenarios

The text descriptions provided above were supplemented by a set of ratings that were elicited from the four groups. First, they were asked for each scenario, how far KISA would be:

acquired from KIBS as opposed to be supplied in house,
off-shored outside of the EU,
mainly produced in a few core regions and localities within the EU,
organised in virtual networks,
organised within industrial cartels,
supported by advanced information technology systems,
codified and documented in precise rules, routines, and standards,
customised to individual client requirements,
composed of reproducible modules,
supporting innovation process in clients,
engaged in clients' strategy formulation and decisions.

These parameters were derived from the group discussion and the earlier literature review, as key issues underlying KISA structure over the next decade or so. Each group rated on their own scenario, which they naturally knew and understood more extensively. These results are also summarised in easily-comparable form in Table 8.2 below, in which "extreme" results (mean scores above 5.5 or below 2.5) are emboldened.

Table 8.2 Characterising Four Scenarios

	Mean scores for each Scenario:			
How far will KISA be:	**1**	**2**	**3**	**4**
offshored outside of the EU?	**2.25**	2.75	3.00	4.00
mainly produced in a few core regions and localities within the EU?	**1.25**	3.75	**5.60**	3.17
organised within industrial cartels?	2.75	**6.25**	3.00	**2.50**
acquired from KIBS as opposed to being supplied in house?	4.00	3.25	5.20	4.67
Codified and documented in precise rules, routines, and standards?	**5.50**	**6.25**	3.20	3.83
Composed of reproducible modules?	**5.75**	5.25	4.40	3.67
Organised in virtual networks?	**5.75**	3.25	5.00	**5.67**
Engaged in clients' strategy formulation and decisions?	**6.00**	**5.75**	**5.60**	5.17
Customised to individual client requirements?	**6.25**	5.25	**6.40**	5.00

Overall, the only feature with no "extreme" ratings was the one concerning in-house KISA versus outsourced KIBS. While there were variations across scenarios – scenario 2 features more in-house KISA, scenario 3 more KIBS –the distinctions are not marked. But, indeed, there are only two cases where a feature has scenarios with divergent extremes – the cartelisation feature (which is only considered to be

really prominent in scenario 2), and the regional concentration issue (marked in scenario 3, very low in scenario 1). Actually, there is a fair consensus on several of the features across the scenarios, with the last three items in the list above all getting fairly positive ratings, meaning that participants saw them as very likely features of their scenarios; offshoring, in contrast, was seen to be relatively unlikely or only slightly developed in all of the scenarios.[42]

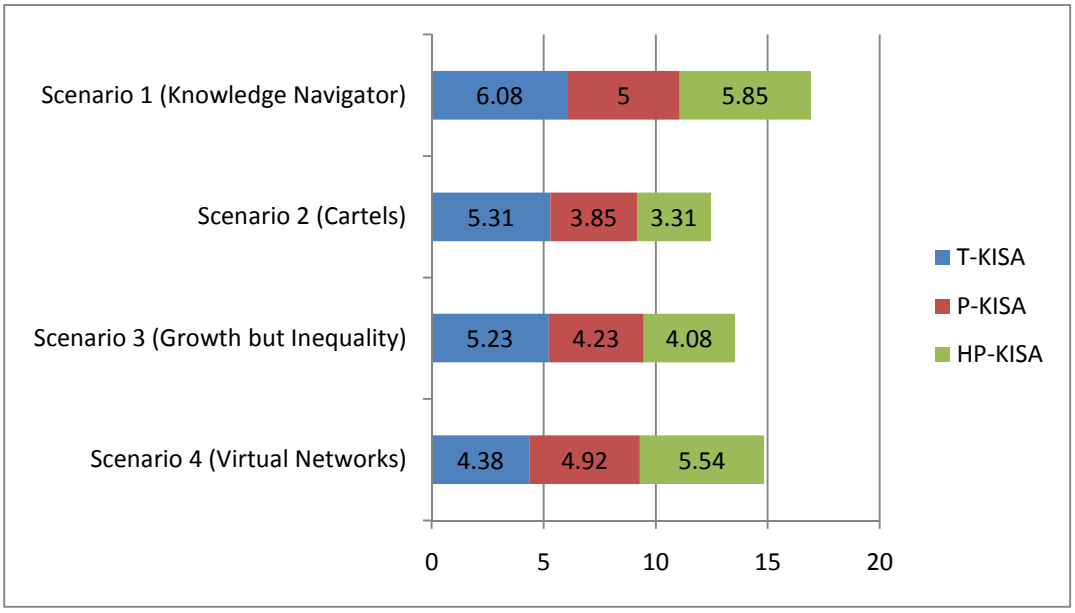
In a final part of the scenario analysis, the participants were asked to individually assess how far they expected the future to reflect elements of each scenario. The logic of this question is that it does not make much sense to vote on the likelihood of a scenario, per se. No scenario is going to be precisely mirrored in the future, so the *likelihood* of a scenario is zero. However, we might expect a scenario to be more of less captured in future developments, with the outcome probably constituting a mixture of the different scenarios. So asking as to the extent to which a scenario might be realised seems an appropriate approach.

Furthermore, the workshop had been stressing that different outcomes might be apparent for different sorts of KISA. Of course, the range of KISA is rather wide, so initially, the organisers proposed that we simply explore futures for technology-based (T-KISA) and more traditional professional P-KISA. However, it was suggested in the workshop that a third category be added – those KISA requiring *hybrid* skills (here labelled HP-KISA), and this was accordingly added. (On subsequent reflection, this addition suggested that there was some uncertainty as to whether we were discussing KISA themselves, or the professions that crystallise around sets of KISA. This in turn highlights the issue that a KISA might be understood at very different levels of granularity – as the whole collection of activities involved in a service operation, as some subset of these, or as a highly specialised single activity. Most professional jobs involve competence in a range of activities, of course.)

Thus, participants were asked to use a 7-point scale (from 1=not at all, to 7=completely) to indicate "In your judgement, how far will the future development (to 2020) of T-KISA, P-KISA and HP-KISA resemble each of these scenarios? For each scenario please indicate the extent to which we are likely to see its features reflected in the future of T-KISA, P-KISA and HP-KISA. The results are displayed below, in Figure 8.2, which presents them in terms of the mean rating each scenario received.

[42] The degree of similarity of the four scenarios in terms of so many of the features discussed here is rather surprising. This may well result from using specific features as a way of differentiating scenarios, as opposed to deliberately setting up a polarisation (of different poles of features or drivers). The result is that our scenarios are more matter of different emphases being put on one or other feature, rather than really contrasting visions. (The second workshop considered how to further demarcate the scenarios, and eventuated in three distinction visions.

Figure 8.2 Extent of Realisation of Each of the Four Scenarios



There are several notable features of these results.

Six of the twelve judgements have a mean score of 5 or more, suggesting that a large share of the elements of all scenarios are expected to be reflected in the future development of one or more types of KISA.

If we take 3.5 as the mid-point of ratings, then it is notable that there is only one case where the weight of judgements goes against a scenario (scenario 2 for HP-KIBS).

Overall, scenario 1 was seen as being more predominant than the others – as more likely to characterise the future - for each of the types of KISA. Scenario 2 was seen as least reflected, for P and HP -KISA types (though even here it was close to the mid-point).

Scenario 4 is the only case where features were thought to be more prominent in the future of P-KIBS than that of T-KIBS. (Perhaps the implication is that P-KIBS are more liable to be organised through virtual networks of professionals, and less centralised in large firms, because of elements of tacit knowledge and/or trust relationships.)

8.2 **Amsterdam Stakeholder Workshop:** Further Drivers and Scenario Analyses

8.2.1 Skills and Drivers Re-examined

There was some discussion about the utility of the concept of "knowledge worker", and whether we needed improved definitions based upon activities and tasks rather than qualifications and abstract job descriptions. The point was made that there are different ways of going about constructing classification schema, as well, which we attempt to capture in Table 8.3 below. Different frameworks can be located in such a matrix (e.g. the discussion suggested that O*Net is in the lower left hand cell.)

Table 8.3 Measuring Skill Requirements in Occupations

	Classification or Measurement based upon:	
Classification or Measurement focussed on:	**Normative account**	**Empirical account**
Assessment of Activities	Judgements of what activities have to be performed to achieve a given standard in the role (excellence, satisfactory, etc.)	Empirical assessment of what tasks are actually carried out.
Assessment of Credentials or Revealed capabilities	Judgements of what is needed to perform the role adequately (or successfully, optimally, etc.)	Empirical assessment of what qualifications and attributes are brought to the tasks.

The point was also made that "skills" are rather reductionist categories, that in practice people develop and use bundles or clusters of knowledge, and that KISA professions generally require particular sorts of bundles. "Competencies" is a term sometimes used to refer to these bundles. New terminology that is widely agreed on would be helpful – this may be forced into existence by the pressures of change. For example, the development of distributed network environments is liable in particular to facilitate low cost collaborative systems in which individuals, firms, co-create, co-produce and market new services and products.[43] It was also pointed out that such efforts to define and assess skills and competences take place in a system where different actors and interests are engaged and sometimes in conflict; thus more transparency achieved in descriptors may well widen entry to accessible knowledge, which could reduce the advantage currently held by some "owners" of specialised knowledge.

The question of tacit knowledge was confronted, with some helpful points being made about different forms of tacitness. Some forms of "know-how" are hard to codify because they involve sensorimotor skills (the famous case of riding a bicycle) or other learned practices that require awareness and coordination of one's internal and external states. Some involve awareness of social signals, codes and contexts, which might be possible to codify (though there may not be facility with the available vocabulary for describing these things), but which depend upon rapid judgement and reaction. Some involve attention to details of context and the material being worked with that are poorly codified simply because there is such a range of precise circumstances that only the broadest rules about dealing with specific situations can be communicated, and again practice (or observation of other's practice) is usually the way in which learning is fostered – though here there is scope for mentoring, role-playing, and exploratory dialogue to explicate these variations and their implications.

The scope for transforming tacit to codified knowledge was also discussed: while there is growing possibility to track, capture and formalise many sorts of practice – from video recordings to neural nets – we find (a) that the time taken to codify knowledge for specific circumstances may be too long to make this viable for some applications and (b) that new forms of practice and new contexts continually emerge to push back the boundaries and generate more areas of tacit knowledge. Routinised tasks in KISA and elsewhere may be subject to codification and then automation, decision support, or increased division of labour. But nonroutine tasks may proliferate at the same time. We have little idea of the evolution of these two processes.

[43] Reference was made to Tapscott D, & Williams A,D WIKINOMICS How Mass Collaboration Changes Everything (Portfolio, 2007, expanded version 2008) - see the blogs at http://www.wikinomics.com/blog/index.php/author/don-tapscott/

In the workshop, we presented the set of "drivers" – factors that were believed to be important factors in the future of KISA – as elaborated in the Manchester workshop. The question was posed – are these also important in shaping the future of the skill requirements in KISA? There was some elaboration/amendment of the driver list, and then a voting procedure was employed, where each member of the workshop was allowed to allocate a number of votes (four) across the drivers identified as important. The results are presented in Table 8.4 below.

In subsequent discussion, it was revealed that there was some unreliability associated with these judgements of importance, in that some participants were voting on "importance if this happens" (this was the intended task, while others were voting on "likely importance" (which includes also an estimate of probability of the event or trend – evidently instructions to focus on *importance IF it happens* were not made clearly enough. Nevertheless, some features can be interpreted clearly enough.

The picture that emerges is one where the future of KISA skills is very strongly influenced by KISA being supported by IT systems that provide decision support and advanced tools for tackling complex problems. This might also involve their being composed of reproducible modules (that can be recombined in various ways), but this received fewer votes. The modularisation process could be associated with high division of labour and some deskilling of elements of KISA work, or it might involve a higher level of customisation of many KISA that are now available in fewer varieties. The further development of customisation to individual client requirements was seen as having major skill implications, too. Modularisation might be associated with KISA being performed to a large extent by "paraprofessionals" or "technicians", (whose work is designed, coordinated and integrated by senior professionals) – this would affect the skills required of the workforce considerably. KIBS would be more closely linked to clients - supporting their processes, strategy formulation and decisions – and if this develops, it would impact skills requirement significantly. This would also be the case were KISA to be increasingly sourced from external KIBS firms (as opposed to being supplied in- house). Finally, the organisation of KIS projects through virtual networks of professionals was also a potential trend redolent with skill implications.

Table 8.4 Importance of Drivers

Votes	Driver: KISA (or KIBS) are:
7	supported by information technology systems that provide decision support and advanced tools for tackling complex problems,
7	supporting innovation processes in clients,
6	involved in clients' strategy formulation and decisions
5	sourced from external KIBS firms, as opposed to being supplied in- house by employees in the user firms
5	performed to a large extent by "paraprofessionals" or "technicians", (whose work is designed, coordinated and integrated by senior professionals),
5	customised in many details to meet individual client requirements,
5	organised in virtual networks, with professionals associating to carry out specific projects,
3	composed of reproducible modules (that can be recombined in various ways),
2	acquired by offshoring service production to locations outside of the EU,
1	mainly produced (within the EU), in a few core regions and localities,

1	codified and documented in precise rules, routines, and standards, so they can be more easily learned, diffused within organisations, and quality controlled,
1	conducted within larger KIBS firms,
1	organised within industrial "cartels", with long-term relationships among groups of firms (including KIBS and their users),
0	subject to automation by application of information technology to perform large parts of more standardised services,
0	supportive of smaller as well as larger business clients

8.2.2 Overarching Scenario Analysis

Given that we did not have enough participants to consider four distinct scenarios independently, two break-out groups were set up and asked to proceed on the basis of comparing two scenarios each. The scenarios developed in Manchester were outline, and one group compared **Virtual Networks** vs. **Regional Concentration/Clusters;** while the other compared **Cartels** vs. **Knowledge Navigator**. In each case the participants were asked to construct and compare:

A PLAUSIBLE version of each scenario (drawing on the summary from workshop 1).

How these scenarios differ in terms of KISA development, production and/or use – participants were asked to think about at least ***three*** *important ways in which they differ; w*hat the *drivers of change* might be (again, the suggestion was that they identify at least **three** differences in terms of how drivers operate and/or what they are.

Many specific results were delivered, but at the outset it may be helpful to set out a major conclusion in terms of the scenarios.

The insight developed in the workshop was that the four scenarios in effect represent different ways in which the **common feature** of technology support for KISA may be developed into the future.[44] This technology support encompasses decision support, but equally if not more critical is the use of networking technologies to allow for collaboration and combination of efforts among dispersed sets of KISA professionals. A scenario based simply on rapid development of such technology support is productive in terms of identifying drivers and examples of such support. But it tends to underplay the shaping influence of different socio-political arrangements on how the technology support is developed. One perspective is that we in reality have three scenarios, representing different balances of forces in stimulating technology application to KISA. (Of course, we could then envisage a fourth scenario in which the three are in some balance; we could also envisage scenarios with more or less rapid and successful application development.)

The three distinctive paths for development of technology applications for KISA, then, can be seen as:

Bottom-up: networking organised largely around professionals operating much more as virtual organisations coming together around specific projects. While there would be some agents acting as system integrators, brokers, and clearing

[44] This reflects some ambiguity in the term "Knowledge Navigator" – does it refer to an individual/style of work, a technological infrastructure, or what? If it is understood as a human entity, then there was considerable expression of opinion that such capabilities are liable to operate within all the scenarios to some degree or another.

houses, various forces would prevent their gaining dominance or oligopoly over the KISA space. Professionals would collaborate on the basis of a clear assessment of each other's competences, track records, originality, etc.

Clusters: networking organised largely around professionals experiences in working together due to propinquity, and facilitated in so doing by initiatives from local or regional authorities and voluntary organisations (like chambers of commerce in some countries, though in others they are less voluntary!). Such initiatives lower transaction costs, provide common facilities, perhaps build on subsidies, procurement, and local comparative advantages.

Strategic partnerships (since "cartel" is a loaded term): networking and coordination achieved largely as a result of long-term relationships (which may or may not include ownership, joint ventures, collaboration in large projects, etc.) in and across value chains. Again we would anticipate some reduction of transaction costs – though challenges about competition arrangements may be raised – and pressure toward common tools and standards (possibly developed within the partnership with strong proprietary elements) would be extremely likely.

The workshop did not develop concise labels for these three directions of development, once this understanding of their key differences was developed. On the basis of the foregoing discussion, we would suggest something in the order of, respectively: Professional Communities; Situated Clusters; Organisational Aggregates. Further – and more catchy - suggestions would be most welcome.

As before, it was stressed that different scenarios might be more or less characteristic of specific types of KISA (partly in relation to the tacitness of knowledge, partly in relation to the rapidity of change being experienced) and (perhaps les so) in different locations. Furthermore, one significant point that was made was that in any of these scenarios there are likely to be insiders and outsiders, in terms of knowledge about how the systems work. The existence of information and knowledge inequalities is inevitable: the critical question is how far these are structured and persistent inequalities, and whether they reinforce or undermine other forms of social inclusion/exclusion.

8.2.3 Comparing Scenarios

Many common drivers were experienced across all scenarios, it was agreed – for instance, all of the top three mentioned earlier were present in all cases. A more subtle view of scenarios was hinted at: that drivers can be seen as generating change, which then brings other drivers into play (or enhances their relevance or visibility)– in specific contexts, sectors, etc. Such evolutionary changes lead to requirements for different bundles, clusters or profiles of skills evolving (or coevolving) alongside this.

Virtual Networks and Regional Clusters Compared

The VN scenario would require that we overcome – or for various reasons are prepared to live with – a number of problems that are liable to be associated with the formation and reformation of these bottom-up networks. There would be issues of transaction costs in setting up and coordinating networks, for example; there would be "weakest link" dangers of bottlenecks, cost and time overruns, and complexity involved in integrating the works of professionals unless they were using many common standards on common platforms, and engaged in much dialogue. The implication is that desire for higher quality and more customised or creative solutions means that simple price competition is not so important in this scenario – thus it

might depend on relatively high levels of growth and affluence – though technical solutions that lower transaction costs might make price competition more important.

KISA workers will require, in addition to high technical skills, entrepreneurial attitudes and capabilities, abilities to work in various roles in projects, interpersonal competence. A generally entrepreneurial culture that supports establishment of new businesses is implied in this scenario. This is a scenario with relatively high levels of fragmentation of activity across small units – in which key professionals have to be highly multiskilled – with relatively low levels of regulation – though service offers will need to be transparent to potential clients.

The rapid evolution of open platform versions of new IT systems was seen as an important driver here, itself being underpinned by wider social factors: demand for freedom and independence in working practices from professional workers, and increasing entrepreneurialism. Such systems would provide low cost bases for starting up businesses which offer innovative new solutions to newly emerging needs. They would be especially important in the VN scenario, but likely to continue to evolve and play a role in other scenarios.

The RC scenario involves higher levels of spatial clustering of economic activities, which allows for some reduction of transaction costs both within networks and between them and their clients. This might reflect greater complexity of projects, with larger-scale activities, involving a greater range of technical and professional knowledge, being more influential. (For example, major infrastructure projects – coping with economic restructuring, effects of climate change or policies to reduce carbon emissions, etc.) The privileged knowledge about customers and local contexts is an important factor in this scenario. There was also anticipated to be an important influence of regulations in this scenario.

Many of the drivers discussed would be expected to have similar impacts on both scenarios, but participants suggested that public policy & regulation would be likely to have very different effects on them. RC is very much driven by local/regional policy interventions, while both scenarios might be supported (especially VN) by competition policy measures that inhibit the development of “cartels”.

In terms of skills, the two scenarios would each continue to require specialists and generalists; to forecast demand for the other profiles is difficult without more solid evidence concerning their current distribution and trends in this. The various profiles where high levels of skill in one technical field is combined with a range of other skills were seen as blurring into each other – but whether this reflects a general shift toward “wedginess” or our difficulty in differentiating among profiles is less clear. When pressed, the scenarios were seen as differentiated in that the VN scenario would require entrepreneurialism on a wide scale (even for many specialists), while the RC scenario might emphasise pi-shaped and wedgie profiles.

A summary chart based on the contrasts developed by this group is presented in Table 8.2.

Cartels and Knowledge Navigator Compared

The term “cartel” was not intended to refer to the traditional collusive conglomeration of supposedly independent entities, acting together to fix prices, production levels, and the like. The notion discussed here concerns the establishment of relatively long-term strategic partnerships driven more by the needs to share information (re-

using both tacit and codified knowledge developed in prior collaborations), use common standards, and rapidly establish trust relationships and common frames of references, to bid for and undertake projects of varying size and complexity. In principle this should allow for lower transaction costs, though reduced competition might have negative effects on prices – thus the argument was made that this again is liable to be a scenario where quality competition would be prominent. The "cartel" here is one that associates together KISA suppliers primarily – the scenario analysis would presumably be different is the "cartels" involved also major KISA users.

Table 8.2 Comparison of RC and VN scenarios

Regional Clusters Scenario	Virtual Networks Scenario
KISAs differ in terms of:	
concentration	fragmentation
Regional clusters	global networks
Co-ordinated	anarchic
Privileged knowledge of Customers/ users	Knowledge led
Regulated model	de-regulated model
Low risk	high risk
Drivers *(prima facie hypotheses)*	
Public policy and regulation	
Compliant model	Not easily impacting
Increased Competition	
Economies of scale	opportunity versus diseconomies of scale
Complexity and Tacit K	
Economies of scale	opportunity V diseconomies of scale
Increased Competition	
Proximity	access to new domain knowledge
Flexibility	
? for firms - stability	? for workers - insecurity
Skills Profiles	
more generic knowledge	specialist knowledge
traditional relationships	managing at a distance relationships
more tangible knowledge assets	intangible knowledge assets
less emphasis on cultural understanding	cultural understanding
∏ & Wedge[45]: generalist less needed	Specialist & T entrepreneur generalist = More diffuse profile
Possible skill needs	
Problem solving	
Social competences	Technical competences
Systems Management	Knowledge management

There was some debate as to whether the Cartel scenario involves more routine KISA activity, or more customisation of services to clients. (One possible combination of the two is that there could be a modularisation process, whereby numerous individual elements become produced in more standardised ways, but can be combined in increasingly diverse customised configurations. This was summarised as the apparently paradoxical "generic solutions to customised problems".) The cartel network allows for rapid location of knowledge to deal with client-specific problems. In this scenario the lead actors (large firms) would be able

[45] These terms are discussed in the following chapter,

to impose similar technologies and standards for interoperability through a hub-and-spoke type of network.

To elaborate a little on these lead actors, and their relation to KISA professionals – this scenario was taken to imply that the power to dominate and organise the value chain is no longer dependent on control of particular materials, technologies or patents, etc. Rather, it derives more from privileged access to the new information generated by the most innovative end-users (whether these are private consumers or business or other organisations). The "cartels" are centred on innovative market leaders, who retain this lead by developing new products and customised packages of products for innovative users, and by quickly being able to convert bespoke solutions developed for the needs of specific users into generic packages for wider markets. This is a dynamic process in which the cartel-leaders acquire new partners to take advantage of new opportunities. At the same time, they would be expected to divest themselves of sectors which become subject to standardisation and competition from low-cost entrants. The cartel-leader will also manage the process of development of new standards along the value-chain and to act as ultimate guarantor of the quality of the product.

The KISA "cartel" has a foot-in-the-door relationship to its end-users. With large organisations out-sourcing a range of KISA, a successful and reliable supplier has the possibility of extending their coverage from one kind of service to another. IT suppliers can become system solution and process management suppliers, accountancy suppliers can become purchasing and sales solutions suppliers, cleaning suppliers can become security, building maintenance, and engineering project management suppliers, and so on. The workshop mentioned the 95/5-50/50 model (in many KISAs, 95 percent of firms are small or micro-businesses and only 5 percent large firms – but sector employment and output is divided more equally between these two classes.). This was seen as implying that there is scope for innovative service provision driven by the rapid diffusion of new solutions generated by experience with high-end user sectors. Individual KISA professionals and firms may become suppliers of components in generic solutions to out-sourcing clients' needs.

The "Knowledge Navigator" scenario (which, as noted, tended to blur into the other three) was seen to be very much an open-platform model. (This was also stressed in VN above, so the version of KN sketched in here may share much in common with the VN scenario). The scope for starting up businesses with innovative approaches to newly emerging needs might reduce the power of the cartel-driven model – though the role of the lead player in managing standards, quality and performance along the value chain and in producing "genericised" packages based on what were originally client- specific solutions, made a case for scenarios. In The KN scenario discussion, it was postulated that the attraction of independence might mean that the best talent would not be retained in the cartels. (Thus it was suggested that in the Cartel scenario, there might need to be internal approximations to the open platform environment **within** large organisations. This would provide large organisations with access to innovations of open platforms, and from entrepreneurial individuals, while retaining the ability to rapidly turn bespoke solutions into generic solutions and to ensure the quality of these solutions when presented to a wider user base.)[46] This group thus envisaged a greater role for entrepreneurial skills both outside and inside large organisations. These would be required to deal with fluid boundaries and the

[46] The workshop participants saw parallels in the way in which many large players in It services are opening themselves to the open-source/open-platform movement, and being prepared develop more fluid boundaries and partnerships.

variety of project-based co-operations (both between independent firms and between semi-independent partner-firms - or profit centres within large organisations).

An important social driver and precondition for this development might be the emergence of a generation of school-leavers for whom this sort of environment is standard. Their fluency and facility in this medium will begin to influence what it is possible for organisations to do. The "Knowledge Navigator" thus does not only refer to support tools in network environments.[47] It also refers to the professional with navigational skills – and participants were arguing that young people have easier relationship to changing knowledge landscapes– this is a driver because is changing the environment for recruiting and retaining professional KISA workers. (Such individuals were seen, for example, as related to the explosive growth of dotcom applications in recent years.) The future is liable to see large organisations having to accommodate a workforce which is moving more rapidly into using new IT processes – not so much as a matter of government education and awareness initiatives, but more because of autonomous social developments. Such developments might foster KN development away from the Cartel scenario, and thus presumably point more toward RC and especially VN scenarios.

In comparing the two scenarios, it was noted that a continual emergence of new professional activities and technical skills (and thus of skill profiles) is typical of most KISA.[48] Activity determines person specification (who is required for a given task); but also the person may determine, shape, or influence the KISA, especially given that many of the tasks are ill-defined, offer scope for creativity, and are what sociologists have labelled "semi-autonomous" work. Across the two scenarios, a number of skills were seen as required in common, in addition to the standard technical skills. These included: skills in – Networking; Information brokerage; Entrepreneurship; Problem solving; Policy analysis; Systems thinking and analysis; and Standards setting (understanding. Forging, and implementing standards).

The KN scenario would see especial increase in wedgie and generalist profiles, though these were seen as likely to increase in both cases. The cartel scenario would have more capacity to handle specialist skills, with wedgies operating within and on the boundaries of the "cartels". In small companies, where there are fewer specialists, these would need to move more toward wedgies with the increase in activities requiring problem-solving solution-seeking capacities. Being too specialist could mean unemployment, since specialities becomes redundant as new products emerge. (This would reinforce longstanding arguments about lifelong learning). However, some specialist capabilities may be shifted sideways into other professions, as has happened in the past.

8.3.3 Three or Four Scenarios?

As noted earlier, the workshop discussion of the four scenarios led to increasing awareness that many features of "Knowledge Navigator" (KN) – KISA as highly supported by technology support for KISA (decision support systems, networking, standards) are common across scenarios. This is so marked that the other three scenarios could be interpreted as particular ways of realisation of the KN scenario.

[47] One comment was that we need to distinguish between networks that link different platforms and networks that link different firms.

[48] Reference was made in this context to the analysis of the fragmentation of scholarly knowledge in Andrew Abbott's Chaos of Disciplines (2001, University of Chicago Press).

These three paths for development of KISA, involving the technology development along with other features, are (names suggested subsequent to the workshop):

Professional Communities: Networking is organised on a bottom-up basis, to a large extent. Professionals come together to operate as virtual organisations around specific projects. Particular sets of professionals may often collaborate in this way, in changing configurations as projects succeed each other. Collaboration is based on trust, on reasons to believe in each other's competences, track records, originality, etc. Not all players in this scenario would be equal, let alone being single individuals. Some agents would be larger than others, some would act as system integrators, brokers, and clearing houses. But in this scenario, there are many such players, and power is widely dispersed.

Situated Clusters: In this scenario there is considerable influence from initiatives undertaken by local governments and other regional actors. Such initiatives lower transaction costs, provide common facilities, perhaps build on subsidies, procurement, and local comparative advantages. The networks make a lot of use of information technology to liaise and communicate, but the KISA professionals are typically familiar with each other on a face-to-face basis, they (mostly) inhabit the same urban area or region. (There may be mechanisms for collaboration across regional partners, especially where there is a common project or value-chain relation between the economies of the two areas.)

Organisational Aggregates: Here long-term strategic partnerships, largely constructed by large business organisations (or groups of organisations) are the basis for establishing networks and developing and diffusing common technologies and standards. Various sorts of business relationship are liable to coexist – ownership and spin-offs, joint ventures, collaboration in large projects for common clients (including public funding agencies), etc. The relationships may be mainly "vertically" organised around value chains, though other structures are possible (e.g. the East Asian zaibatsu and chaebol structures which cover many sectors of the economy). The larger players will play an important governance role, for example in making arrangements about intellectual property, about common tools and standards, and so on.

Figure 8.3 Three or Four Scenarios?

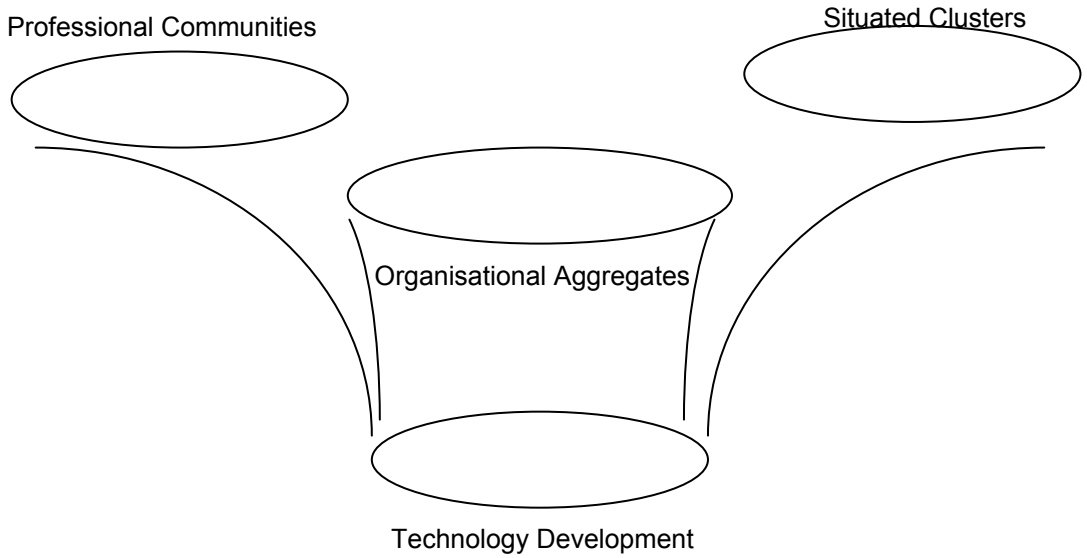


Figure 8.3 graphically depicts how these three scenarios might be seen as alternative realisations of the "Technology Development" trajectory (which was originally seen as the "Knowledge Navigator"). The question arises of whether there is still some value in retaining the fourth scenario. It might make sense to examine a possible future in which there are very rapid developments of technology support, perhaps involving some major breakthroughs in terms of the codification of large areas of KISA work, and perhaps in terms of application of other emerging technologies (e.g. locational technology to determine where people and artefacts are at given moments). Future work could examine whether there are distinctive features of such a scenario, or whether it is ultimately subsumed into one or other of the three alternative scenarios.

A specific point that arose especially in the Virtual Networks scenario, but was also discussed in terms of Knowledge Navigator and other scenarios was the influence of the rapid evolution of open platform versions of new IT systems. The suggestion is that this means that there is a low cost basis for starting up businesses which offer innovative new solutions to a variety of newly emerging needs.

9. Implications for KISA skills

9.1 Skill Profiles

The literature reviewed earlier drew attention to the importance of skills profiles, of combinations of skills and capabilities. Similarly, discussion in the workshops stressed the need to think about competences – specific combinations of skills. In response to this, an effort was made to develop a framework which would allow us to talk about these in somewhat more precise terms. Accordingly, a set of notional skill profiles was developed – Figure 9.1 outlines the framework as presented to the workshop.

The notion was that while there are probably infinite combinations of specific skills, we can differentiate meaningfully among several ideal types of skill profile. (It would be fruitful to consider the sorts of statistical analysis – cluster analysis of skill descriptions of jobs? – that could provide an empirical basis or validation for such clustering.) Drawing on efforts to classify skills into various groups, the proposal is that there are certain specific skills associated with particular KIBS specialisms (accountancy, architecture, computing services, etc…), and a range of generic skills associated with management of people, projects, interorganisational and interpersonal relations, communications, and so on. (These are, admittedly, the specialisms of some types of management profession – but they are not typically the activities supplied as services by a specialised KIBS firm to its clients.) Delineation of these skills is an important theme for research, but for present purposes we suggested merely that we can envisage a range of such skills, together with the specialised technical skills of KISA professions. Figure 9.1 thus depicts these as a series of columns, each reflecting a distinct class of skills. (In practice, the classes may be rather fuzzy, and not so clearly demarcated.)

The members of the proposed set of clusters were given nicknames for easier comprehension:

Specialist - this is the classic highly-specialised professional worker, with huge depth of skill in a particular technical domain – this might be law, computer software, architecture, etc. – but with relatively low levels of other skills required of professionals in the organisation, such as project management, marketing, interpersonal communication, resource allocation, etc.

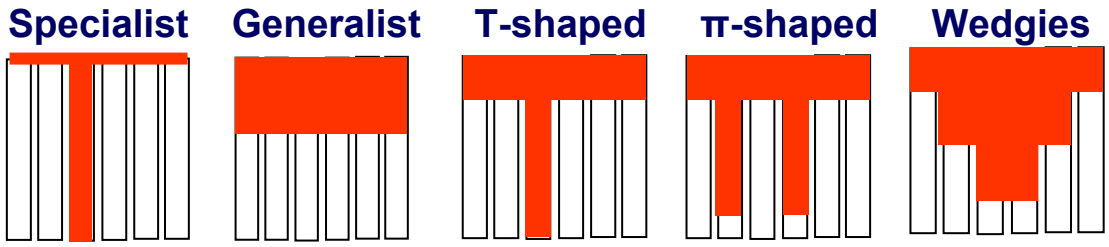
Generalist - this is perhaps the classic general manager, with a broad range of skills but limited depth in any of them. Such an individual has more than lay knowledge of the specialities that characterise their organisation's services, but is also skilled in the range of other activities mentioned above.

T-shaped - it was frequent mention of this category that drove us to thinking about emerging skills profiles: what we were hearing from industrialists in particular, was that they required people whose deep specialist knowledge was complemented with broader generalist knowledge than that of the specialist – people who could manage and market services as well as master the deep technical specificities.

π-shaped - this hypothetical profile implies individuals who have deep knowledge of one or other of the management and other professional areas, in addition to deploying profound technical skills from a specific technical speciality.

Wedgies – this profile lies between the Generalist, T-shaped, and pi-shaped categories: it features moderately deep knowledge of several fields, together with more detailed skills in a few, and generalist capabilities as well.

Figure 9.1 A Preliminary Classification of Skill Profiles



The workshop discussed these profiles, and participants agreed that for immediate practical purposes, they formed a reasonable basis for further work. At the very least, the approach underlined the need for new ways of describing jobs and personal competences. The discussion, further, underlined the fact that there is very little solid evidence concerning how clusters of competence are constituted and composed, and how they vary across sectors and professions, and over time and space. It is very likely that there are variations by context – for example, it was suggested that small firms will put more emphasis on "wedgies", because of the leadership issues they confront.

The approach was put on trial in the workshop, with two break-out groups being asked to estimate how far each of the sets of profiles is likely to characterise specific types and contexts of KISAs, and how this might be changing. Two break-out groups were set up, one being asked to contrast smaller and larger firms, and one being asked to contrast T-KISA and P-KISA. [49] Each was asked to say what percentage of professionals (and paraprofessionals – i.e. technicians) fell into each skill cluster. Table 9.1 displays the results of the estimates that these groups – with many reservations and much uncertainty – arrived at.

Table 9.1 Estimates of the distribution of capability requirements at professional and paraprofessional levels

Profile:	Specialist	Generalist	T-Shape	∏-Shape	Wedgie
Group A					
SMALL FIRMS*	20	20	20	11	32
LARGE FIRMS	24	25	19	14	18
Group B			The group below combined these two categories		
T-KISA	15% growing	10% declining	35%		40% declining
P-KISA	5% growing	10% slightly declining	35% Slightly growing		50% declining

*Figures do not total 100%

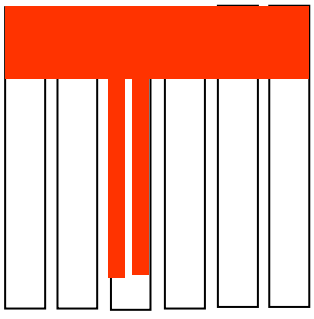
[49] At the time of this workshop, the C-KISA category had not been differentiated from other P-KISA.

The participants stressed that these estimates were very much guesswork, informed by their own specialist and localise experiences: there was very little general overview to draw on. Some support for this view comes in the points of divergence between the two groups: Group A considers specialists and generalists more common than does group B; the reverse is true for wedgies.

Why are there these differences between the groups? In part this might simply be a reflection of our ignorance – we are guessing in the dark, and these guesses are practically random ones. But it may also reflect some lack of precision in the categories with which we are dealing, so that (for example) group A's specialists and generalists are wider categories than those employed by group B. Perhaps group A's Specialists have a little more generic skill, and its generalists a little more specialist skill (making them more like wedgies) than group B's. The discussion suggested that this was at least part of the answer, and that work with categories such as these is rendered difficult by the lack of standard language and metrics for making such attributions. (One solution here might be to develop much more elaborate descriptions of each profile, perhaps around "archetypal exemplars" or each ideal type. It was interesting to hear the groups debating how far the "specialist" was an unsocially skilled "nerd" type of character – this tended to be the view, though people were by no means confident about this.) A related point was that we might profitably differentiate further among groups.

In respect of this point, one particular distinction was drawn, resulting in another possible profile. The combination of more than one type of technical specialist skill was seen as something distinctive from the pi-shaped profile. We gave the nickname "toothcomb" to the individual with more than one specialist technical skill – software expert *plus* architect, lawyer *plus* accountant, or even networking management specialist *plus* software development specialist, and so on. (Figure 9.2) The point is thus underlined that there are various classes of skills within domains – e.g. there are various classes of managerial skills, as well as of technical, interpersonal and other skills. Each class of skill can be mastered to greater or lesser extents. In thinking about how to asses the "depth" of skill possessed, such indicators were suggested as: complexity of labour performance as revealed by knowledge and independence required; degree of supervision needed; responsibility to verify work of others; decisions required about materials and processes.

Figure 9.2 The Toothcomb Profile



Thus, the discussion of profiles effected a helpful clarification of issues around skills and skill combinations, while demonstrating that there is still work required on establishing a framework that can effectively be used across sectors, occupations,

and contexts. One point that was articulated clearly was the need to avoid treating profiles in too static and rigid a way: skill clusters and the constituents of profiles are constantly being reconfigured by technological and organisational change. In addition to seeing skill profiles and competences at the individual level, it was also pointed out that we need to be able to examine how different skills are put together in workplaces, organisations, groups and teams (when do a set of workers become a team whose individual skills are orchestrated?). From such perspectives, there were several suggestions made:

Smaller organisations typically do not have sufficient range of skills within their skill profiles, so are forced to outsource their requirements.

Larger organisations may choose to build on their legacy skills to change and develop new skills rather than starting with a blank slate (in other words, there is a path dependence, a "skills corridor" analogous to the "technology corridor" described by some researchers).

In many cases what the firm needs is not established employees who are deep specialists, but rather people who know what specialisms are needed and how to find them.

Jobs are not "given": they may be built around people in existing firms and virtual organisations, as much as around technical requirements – configurations of different jobs will thus be formed in relation to the availability (and power) or human resources.

The requirements for specific skill profiles or capabilities varies across (different types of) big firm ecosystem, and at the peripheries in small/micro or solo businesses.

Do the skill profile requirements vary greatly across the scenarios? In many respects the drivers that were seen as important in shaping KISA skill requirements still operate, to a great extent, in all scenarios. For example, Information technology development is seen as a given in all scenarios. However, we might debate about whether it would be faster or slower, more or less oriented to open-source or proprietary standards, and more or less supported by large investments into interoperability and common resources and standards, and so on. These different patterns of development are liable to shape the demand for skills overall top some extent, and to shape the precise constellations of skills quite substantially – though often at a level of detail well finer than that captured in statistical and vocational classification schemes. In all scenarios, too, it is anticipated that KISA work will continue to be – and even increase in – requiring autonomy, self-organisation, interpersonal, and similar skills. In some scenarios the emphasis might be more on entrepreneurialism and in others more a matter of conforming to the procedures established by a central organisation. There might be more access to "associate professionals" and technicians in some cases than in others – indeed, in the even of regional clustering, we could find both highly efficient labour markets and ones where there is such high demand for skills that there are local shortages.

We can move a little beyond the workshop discussion to suggest a few ways in which scenarios might differ in terms of skill requirements – even while they share in much of the general increase in demand for IT-related skills.

Professional Communities: In this scenario networking is organised on a bottom-up basis, to a large extent. Professionals will need considerable skills in self-management, and marketing, and entrepreneurial capacities in general. Interpersonal skills are particularly necessary given the strong emphasis on collaboration. This scenario might resemble the RAND Europe study's **Autonomy** scenario, featuring "adherence to professional standards, or a broadening of the knowledge to apply in different realms, creativity to seize opportunities or to solve

problems". There could also be elements of the **Expertise** scenario, where professionals are required to know a lot about technical issues, but also about organisational and legal issues (enabling their work in decentralised settings). This sounds like a growth of demand for T-and π-shaped workers.

Situated Clusters: Networking here is highly shaped by initiatives from local and regional actors. KISA professionals are typically familiar with each other on a face-to-face basis, and inhabit the same urban area or region. This again has elements of the **Expertise** scenario, perhaps combining these with features of RAND's **Control** scenario. This is one in which specialists are stressed, possessing deep knowledge of the technologies that they are handling and of their influence on the wider value chain that shapes their environment and is affected by their work.

Organisational Aggregates: Here networks are developed in the context of long-term strategic partnerships, largely constructed by large business organisations. Professionals will need to be able to flourish in these settings – there could well be a high division of labour with associate professional support, and there would be considerable emphasis on using common tools and standards (possibly largely proprietary ones). This might resemble RAND's **Decision Support** scenario, in which professional work is facilitated by technologies that are tailored to job context. But this is not entirely liberatory to the professionals, who have to follow strict guidelines and routines that may well be embedded in the technology being used. This is liable to lead to considerable job broadening (more wedgies?).

Table 9.2 below sets out to explicate how the three scenarios might differ, and what they share in common, across a range of features. As with any summary of this sort, the accounts are sharp, while the reality is liable to be more blurred. It is important to recognise, too, that there is liable to be internal diversity in all of the scenarios. Different KISAs may be characterised and organised in different ways, different regions may have different experiences and strategies, and the same goes for different cartels. It would be helpful to move on to a further step in scenario analysis, with vignettes being developed to provide narrative accounts of how KISA professionals conduct their work in the different scenarios. This would be a valuable way of establishing their internal consistency, and further developing ideas about the nature of KISA skills in future environments.

Table 9.2 Three Scenarios Compared

	Common Features	Scenarios		
		1 PC	2 SC	3 OA
General Political Economy	Business as Usual: Assumption of no major long-term economic downturn, no major political or military hostilities in Europe, no severe impact of climate change. (To extent these do ensue, different levels of job growth, different industrial structures.)	Could be facilitated by stable and rapid growth, but self-employed professionals might also grow in number in consequence of lay-offs and industrial restructuring.	Possibly more associated with reduced pace of globalisation, more salience of geographical blocs.	Possibly associated with increased pace of globalisation, more salience of industrial conglomerates etc.
Technology & Infrastructure	Ongoing development and diffusion of new information technology (even if pace of development of hardware slows, still much can be accomplished by way of new software, systems, and implementation strategies.	Variety of "self-organised" social networks established by and for professional groups to enable formation of virtual teams around projects. Much use of open systems and standards.	Localities/regions support cluster development with assistance for technology support. Performance likely to be uneven with some regions adopting advanced and flexible systems, others making less well-informed decisions and locking-in local firms and workers.	"Cartels" develop and diffuse advanced systems to preferred business partners – relatively more use of proprietary systems and standards, but ability to rapidly determine and deploy these.
/cont.				

Table 9.2 cont.	Common Features	Scenarios		
		1 PC	2 SC	3 OA
Generic Skills Issues	Demand for some highly skilled professionals with advanced specialised technical skills; but more generally demand for multiskilled professionals (T- & π- shaped, and wedgies) with interpersonal and managerial capacities.	Relatively less demand for highly skilled professionals without generic skills, since key requirements are being able to find and fit into evolving teams.	Likely to vary across regions, with requirements for skills being typically between scenarios 1 and 3.	Relatively more demand for highly skilled professionals without generic skills, since they can be mobilised within larger organisations. Scope for higher division of labour means also more scope for associate professions to support advanced professionals. Multiskilled managers of specialist workers required.
Technical Skills: Information Technology-related	Increase in all scenarios, especially to extent that economic growth and technology change and rapid. If technological change slows down, then some specialist technology-related skills should be less in demand, as these become more part of general competences.	IT-related skills (including those of users of IT systems) are needed on a wide basis, with capability to work with open standards, and design and integrate systems for one's own work, becoming a premium.	In some regions, IT support provided as a service to clusters on a semi-public service basis; growth in need for user skills may then be diminished.	Slower growth in need for user skills as advanced IT-based support systems diffused within organisational networks (though liable to be learning periods where assimilation of new systems requires more skill than anticipated). .
Technical Skills: Aspects of Professional work other than IT	In all scenarios, increasing demand for advanced professional skills, resulting from challenges and specialised knowledge associated with technical, organisational, and broader socioeconomic change.	Deep knowledge required, but also capacity to combine knowledge from various domains and effect new creative solutions – possibly π-shaped professionals particularly relevant.	In less successful regions, more routine KISA and professional work requirements might dominate; in more successful regions, model might be more similar to scenario 1.	Increased efficiency-led division of labour and in particular introduction of para- and associate professional support to professional workers. Effort to capture specialist knowledge in IT-based support systems. /cont.

Table 9.2 cont.	Common Features	Scenarios		
		1 PC	2 SC	3 OA
Managerial and Basic Skills	Generic skills in great demand reflecting need to bring together many tasks in complex arrangements.	Entrepreneurial skills; interpersonal and especially customer-facing skills important. Teamwork and self-organisation vital.	Regions vary, depending on specialisation and quality of local decision-making. In general, closer to scenario 1 than scenario 3.	Ability to work within large organisation and complex division of labour important.
Work Organisation	In general, likely that organisation will reflect the balance between, and interplay of, two factors. (1) Standardisation and routinisation of established KISAs, accompanied by more modularisation of products; greater and more rigid division of labour between different professional groups and support workers; more use of decision-support systems; on the one hand. On the other, (2) ongoing development of new KISAs, of creative solutions to new needs experienced by clients, and/or creative ways of using KISA specialist knowledge to solve client problems.	Ability to play different roles as virtual organisations arise and succeed each other important.	Regions will need to avoid rigid assignment of roles to established organisations, and allow for new entrants and combinations of organisational capabilities). To the extent that this is not achieved, there is liable to be more routinisation of work and roles.	Liable to be less autonomy for large sets of professionals, as work becomes structured and guided by advanced support systems, and components have to be produced to strict guidelines as to standards and timeliness, etc.
/cont.				

Table 9.2 cont.	Common Features	Scenarios		
		1 PC	2 SC	3 OA
Training	General increased importance of life-long learning as way of providing skills for dealing with changing business environments and KISA needs.	"Portable" credentials important.	Regional skills development programmes, regional training institutions, play central roles.	In-company training and solutions provided by dominant partner liable to be important, not least in providing access to skills in using proprietary systems. Career progress from associate professional to professional liable to be engineered into organisations.
New Professional Roles	New professions associated with: new technologies (nanotechnology and materials, genomics and neurosciences, etc.); new challenges to business and society (environmental, security, etc.); and evolving social requirements (changing tastes and lifestyles, regulatory structures, etc.) Service engineers needed to structure and intregrate proliferating KISAs.	Important role for capacities to weld together virtual organisations: probably development of new organisations offering creation and management of virtual organisations and trust and related services).	Intermediate between scenarios 1 and 3.	Service engineers particularly important in this scenario – especially those who can support modelling knowledge into IT support systems..
Other KISA features	Scenarios 2 and 3 may face similar challenges to do with competition law,	Need systems to establish trust and provide quality assurance between partners.	May or may not opt for open source solutions as scenario 1.	May make strategic use of open source solutions. Branding important.
/cont.				

Table 9.2 cont.	Common Features	Scenarios		
		1 PC	2 SC	3 OA
Relation to Scenarios in Other Studies	Little expression of trends in or EMCC2 high offshoring.	EMCC1: shares elements with KIBS leadership and two-tier KIBS. RAND: elements of autonomy and expertise scenarios.	EMCC1: shares elements with KIBS leadership. RAND: as scenario 1.	EMCC1: elements of KIBS plateau, with KISA internalised in cartels and using high technology support. RAND: elements both of decision support and control scenarios.

10. Modelling KISA

In this section the outlines of a model are presented that is intended to integrate the notion of KISA's as a source of growth in an endogenous growth modelling setting that is designed to accommodate the two main channels through which KISA's may influence an economy's growth performance. On the one hand there are service activities that are widely acknowledged to be the sources of growth them selves, more in particular human capital accumulation (cf. Lucas (1988)) and R&D based product and process innovations (cf. Romer (1990), Aghion and Howitt (1992)) and the majority of the endogenous growth literature following these seminal papers. Other KISA's, like banking, insurance, logistics, ICT-services and the like do not necessarily generate growth in the way that knowledge producing activities do, but they are complementary to these activities in the sense that they facilitate or *support* the realisation of the growth potentials provided by knew knowledge and new products. Thus, we arrive at a distinction within KISA's of growth generating- (R&D) and growth supporting services (all other KISA's).

The model explicitly distinguishes between these two types of KISAs. It builds on the notion of the division of productive tasks enabled through product innovation and knowledge acquisition that is supported by means of ICT-services, management services and the like. We formulate a model that applies to sectors of industry, and that contains the mechanics implied by the distinction between growth generating and growth supporting KISA-activities. Obviously, a more intensive use of KISAs implies a more intensive use of high-skilled workers. Consequently, we distinguish between different skill-levels in the labour force, and the inter-sectoral mobility of labour then determines in part the actual rate of growth of the economy that can be realised, as opposed to the potential rate of growth of an economy that comes from the invention of new products and new processes. We model this by means of an explicit labour market flow-system, to be discussed in more detail in section 2 below, and thus obtain a model that describes growth dynamics that incorporates both long term features (i.e. the growth potential in terms of the economy's performance in innovation terms), and the short and medium run adjustments towards this potential, as they would be influenced by the availability of factors of production, and the availability of labour by skill and by sector in particular. The latter is covered using a labour-market flow system that integrates inflows and outflows of labour by skill onto and out of the labour market, and labour flows between sectors. Such a flow-system enables us, in principle at least, to assess the impact of labour market imperfections in terms of (sectoral) growth foregone, and hence the benefits arising out of labour market policies meant to counteract these imperfections.[50]

Output growth in the one sector, may give rise directly to output growth in other sectors through the forward and backward linkages between sectors. Our model takes these inter-sectoral linkages explicitly into account by means of an explicit input-output framework in which we integrate the KISA-driven growth features of the model. Thus we arrive at a model that can be used to trace the growth consequences of particular labour market imperfections and their policy responses, in a setting where sectors are integrated through the demand for products and services on the one hand, but also through their own demand for factor services and the limited supply of these services, on the other.

[50] We are very grateful to the Research Centre for Education and the Labour Market (ROA), Maastricht University for supplying these labour market data.

Obviously, such an integrated model comes at a price. That price is the loss of detail that is generally considered to be less relevant in a growth setting, like differential income tax rates, a fully specified consumer demand side, and so on. Such issues are typically covered by large simulation models for the short- and medium term. In our case, we neither have the money nor the time available to construct such a model. Instead, our frame of reference is really that of an extended total factor productivity exercise, where the characteristics of long term growth, are obtained from current and past trends in capital stock data, employment data, education data and other inputs like intermediate consumption. To quantify growth, a neo-classical production function is used to describe the contribution to growth of the various inputs considered. In doing so, we intend to focus not just on the long term characteristics of the growth process itself, but also on the transitional dynamics surrounding long term growth, as well as the effects of the non-instantaneous adjustment of labour supply on short and medium term growth.

The set-up of the rest of the section is as follows. In section 2, we provide the outlines of the model. We describe the growth model and the way in which KISA's enter that model. We also provide a short description of the Input-Output-structure of the model and how KISA's fit within that structure. Finally we show how the labour market flow system is specified. Section 3 is concerned with the empirical implementation of the model. It covers the availability of data, as well as issues regarding the calibration of model parameters and the model structure itself. Section 4 then implements the KISAMOD just as a **demonstration model** for the Netherlands, as there is too little time and money available to implement KISAMOD also for other EU-countries. We also define the various scenarios in which the model will be run. Section 5 concludes.

10.1 The Theoretical Model

10.1.2 Overview of the Growth Framework

The growth framework integrates the production structure of the Lucas (1988) model and that of the Romer (1990) model. The former model is based on human capital accumulation as a source of growth. It is relatively straightforward extension of the neo-classical growth model where labour augmenting technical change is endogenised by letting consumers decide upon the amount of time to be allocated to human capital accumulation, in a set-up where they have to face a trade-off between current consumption opportunities lost because of time spent learning against future consumption possibilities gained because of higher productivity (through human capital accumulation). Romer's model, on the other hand, hinges on Love of Variety, i.e. the notion that productive tasks can be made more productive by splitting them up in ever smaller tasks that are correspondingly easier to perform, and that, as a whole, make the overall production process more efficient. Romer provides a particular production function, to model this LOV-feature of the production process. We extend this feature here, in the sense that we make the number of productive tasks not just a function of the level of R&D as in Romer, but also of complementary inputs like management, ICT-services and so on, that are necessary to support this new (sub-) activities.

It should be stressed here that we will focus on the mechanics of the transformation of KISA availability and actual use into growth, rather than on the micro-economic foundations for these transformation mechanisms. This is presently outside the scope of the project. At this stage, we are primarily interested in gauging the

contribution of KISA's to growth, and the interactions between KISA driven growth on the one hand, and labour market supply and demand conditions and imperfections on the other. In order to be able to do this, we take a central planners perspective, in which the planner wishes to maximise the value of net production (or equivalently, value added), conditional on the way in which technology and the availability of factors of production, but also their limited inter-sectoral mobility, determine national production possibilities.

10.1.3 The Formal Input-Output-setting

Input-output analysis describes the working of an economy through the explicit interdependence of its composing sectors. It uses the notion of so-called technical coefficients, that are considered to be stable over time, and that describe the ratio of inputs coming from a particular outside source and outputs by a particular sector. Thus an IO-system integrates heterogeneous sectors of industry in a coherent whole. The heterogeneity of sectors of industry pertains both to the relative importance of various output categories, like firms, private households, the foreign sector and the like and to input-categories. For example, the consumer goods industry delivers to private households, while the capital goods industry primarily delivers to firms. Another source of heterogeneity between sectors is of a technological nature. For example, the production of ice-cream requires different inputs than the production of a truck. Moreover, as regards these inputs, one could make further distinctions that are deemed relevant, particularly these days, namely inputs that could be internally produced (i.e. within the firm/sector), but also outside the firm/sector (outsourcing). As regards the outsourcing of goods/services, one can make a further distinction between outsourced but domestically produced goods and services, and outsourced goods/services that are produced in some foreign country (off shoring). In order to be able to account for these phenomena, we will account for these outsourcing possibilities in a somewhat mechanical way, by allowing in principle for the possibility to occur, but by using exogenous distribution coefficients to describe the actualization of these possibilities.

In defining inter-sectoral IO-relations, we take the Leontief approach that links sectoral gross output to a final demand vector through the so-called Leontief-inverse that depends on the matrix of IO-coefficients, which, in its simplest version are constant by assumption. We will define a variation on this theme, where we allow for variable technical coefficients regarding the primary factors of production and the use of KISA's, whereas the other technical coefficients are assumed to be constants, in principle.

The Simple Leontief Input-Output Model

Let y be a 1 x n vector of gross outputs, while *A* is the n x n matrix of technical coefficients $a_{i,j}$, where $a_{i,j}$ measures the amount of the good/service produced by sector *i* that goes into producing one unit of the good/service produced by sector *j*. Let *f* be the 1 x n final output vector. In that case, we must have for a closed economy that:

$$x_i = \sum_{j=1}^{n} A_{i,j} \cdot x_j + f_i \Rightarrow x = A.x + f \Rightarrow x = (I - A)^{-1} \cdot f \qquad (1)$$

In equation (1), $(I-A)^{-1}$ is the so-called Leontief inverse, which links the demand for different goods to the corresponding required production volumes.

Adding Off-shoring/Competitive Imports to the Simple Leontief-model

Off-shoring is easily incorporated into the simple Leontief setup. Let *M* be the matrix of coefficients $m_{i,j}$ relating competitive imports of a certain good/service to the domestic production of a particular good/service, i.e. $m_{i,j}$ represents the volume of imports of good/service *i* per unit of domestic production of good/service *j*. In this case, equation (1) becomes:

$$x_i = \sum_{j=1}^{n} (a_{i,j} - m_{i,j}) \cdot x_j + f_i \Rightarrow x = (A-M) \cdot x + f \Rightarrow x = (I-A+M)^{-1} \cdot f \qquad (2)$$

From (2) it is clear that a higher off-shoring propensity, *ceteris paribus*, would raise the absolute value of *M*, and hence reduce the volume of domestic production *x* for a given final demand vector *f*. Technical change reducing the absolute value of *A* would also lower *x* for given *f* (thus, in fact, increasing resource productivity).

Introducing KIBS and KISA's in the Input-Output Framework

In the IO-setting outlined above, we will distinguish between KISA producing and delivering sectors (i.e. the R&D sector that provides growth generating services, further abbreviated to KGG-sector, as well as the sector that provides KISA support services (further abbreviated to KGS-sector). Formally, these sectors are KIBS, but they produce KISAs. KISA user sectors, i.e. the sectors consuming the deliveries coming from the KIBS sectors, are themselves producing in-house KISAs. These in-house KISAs may be thought to be necessary in order to be able to absorb the KISA inputs coming from the KIBS, or it may well work the other way around, i.e. the KIBS deliveries complement the KISA in house activities. As we are not in a position to tell which is which, without engaging in additional case-studies, we will simply assume that both possibilities are relevant, and we will model this by means of the assumption of the strict complementarity between in-house KISAs (specifically R&D activity) and KIBS deliveries.

Unfortunately, we only have data at our disposal regarding in-house KISA's with respect to in-house R&D activity (measured by the level of R&D employment distinguished in accordance with educational levels (low, medium and high again). Data about other in-house KISAs are not directly available. However, we do have employment data available by sector of industry distinguished by job-type and job-level. Particularly the high-level administrative and technical jobs will be relatively KISA-intensive. (Changes in) employment levels in these job-categories may therefore be considered to be indicative for non-R&D types of in-house KISA activity. We will come back to this issue below when specifying KISA-driven growth in an endogenous TFP-growth format.[51]

KISA Producing and KISA Using Sectors

[51] TFP stands for 'Total Factor Productivity'. We will explain this concept in more detail later on in this section.

Given the distinction we have made between KIBS/KISA producing sectors and KIBS/KISA using sectors, and given the notion that the output of R&D activity has features that are intrinsically different from other inputs (non-rivalry in particular), it stands to reason that the use of outside-KISAs in KISA user sectors is NOT governed by constant technical coefficients. This is because once one knows how to produce a product or to organise a production process as described in a 'blueprint' obtained through a combination of outside- and in-house R&D, one does not have to spend the R&D resources again if one would want to increase output-levels. Thus the consumption of KISA-services, whether generated outside or in-house, is intrinsically different from the consumption of intermediate inputs like steel and energy, even if they are handled in the same way in a standard IO-setting. In our case therefore, we want the level of consumption of outside KISA-services to be a variable that can be freely chosen by producers in KISA-user sectors, rather than following from the choice of the producer to generate a particular level of production after which KISA consumption would follow from a fixed technical coefficient as with other intermediate consumption categories. This means that we will handle KISA-deliveries as quasi-intermediate deliveries, with variable input-output coefficients.

10.1.4 Extending the Standard TFP-framework with KISA-driven Growth

A standard TFP-setting describes output as the product of the input of an aggregate factor of production (the 'total factor') and the productivity of that aggregate factor, i.e. the so-called 'total factor productivity'. One often uses a Cobb-Douglas production function to describe this setting, purely for convenience. Thus we would have:

$$Y = TFP \cdot TF \equiv A \cdot \prod_{i=1}^{N} x_i^{\alpha_i} \quad with \quad \sum_{i=1}^{N} \alpha_i = 1 \tag{3}$$

where x_i is some input, usually labour and/or capital, N is the total number of inputs, and where *TFP* stands, as before, for Total Factor Productivity, while *TF* stands for the total factor. Moreover, *TFP=A*, while $TF \equiv \prod_{i=1}^{N} x_i^{\alpha_i}$, i.e. the total factor is a linear homogeneous function of all inputs x_i. Total factor productivity growth then refers to the growth in *Y* that comes through growth in *A*, and NOT through growth in all the *N* inputs already accounted for by growth in *TF*.

According to new growth theory, growth in total factor productivity can be linked to R&D activity (cf. Romer (1990), Aghion and Howitt (1992)). As in our case, R&D is a KISA, we would therefore like to link TFP-growth in a sector to that sector's use of external and in-house KISA's. The basic idea is that the level of external KISA use coming from the KGG-sector is a direct indicator of the level of R&D activity generated FOR (and BY) the sector that has obtained these externally produced KISA-services. Because of our assumption of strict complementarity between in-house and external KISA's, we can model TFP-growth as follows.

First, from the EU-KLEMS database, we can obtain (average) TFP-growth measurements by sector. From the IO-tables we can obtain the measurements of the outside KISA deliveries to all sectors of industry distinguished. The ratio of TFP-growth and KISA consumption could be regarded as the measurement of the productivity of these KISA deliveries in generating TFP-growth. As stated before, we now take the position that user-sectors are free (within the resource constraints they

are facing) to choose a particular level of KGG-consumption. By increasing their level of consumption, given the value of the KGG-TFP-growth productivity obtained above, they can increase POTENTIAL TFP-growth proportionally. Realising this growth potential depends on the use of complementary KISA-support services. The latter can be freely chosen again, but they would typically be complementary to in-house KISA-activity, in our case proxied by in-house R&D. Thus, we would get for our TFP-growth module:

$$G(TFP)_s \leq \delta^g_{ss} \cdot KGG_s \quad (4.A)$$

$$G(TFP)_s \leq \delta^g_{ss} \cdot KGG_s \quad (4.B)$$

$$RND_s \geq \varsigma 1_s \cdot KGG_s \quad (4.C)$$

$$RND_s \geq \varsigma 2_s \cdot KGS_s \quad (4.D)$$

In these equations G(x) stands for the proportional growth rate of x. Moreover, KGG_s is the consumption of deliveries by the KISA growth generating sector (the 'RND'-sector) to user-sector s, while KGS_s is similarly defined but then for KISA support services. The $\delta's$ are the corresponding productivities that have been constructed as explained above. The $\varsigma's$ have been obtained in a similar way as the $\delta's$. Equations (4.C) and (4.D) link the level of RND activity in sector s, as proxied by the level of employment of in-house R&D workers in sector s, to the deliveries of outside services. The main idea underlying equations (4.C) and (4.D) is that in-house R&D activity should be sufficient to be able support the TFP-growth coming from a JOINT effort of in-house and outside R&D services and other KISA growth support services (because of the complementarity assumption, in-house KISA activity is by construction considered to be as important as outside activity, until further 'data'-notice).

TFP-Growth and the Growth of Gross Output

The IO-setting outlined above, distinguished between primary inputs and intermediate (produced) inputs. In principle, however, TFP-growth exercises pertain to the growth in value added and the growth in the primary inputs. However, in our case, we prefer to have a link between gross output growth and TFP-growth, since the focus on growth in value added rather than on gross output, explicitly ignores the forward and backward linkages between sectors of industry (since value added is the value of gross output less the value of intermediate use, by definition). These links are important, because by ignoring them, ordinary TFP measurement exercises ignore the labour market adjustment problems associated with differential levels of TFP-growth between sectors. The reason is simply that TFP-growth pertains to labour and capital productivity, and not to the growth of the productivity of intermediate use *per se*. This implies that a one percent growth in TFP in some sector would seem lead to a one percent growth in output by that sector if the level of the primary inputs in that sector would remain the same. However, it would also require one percent more of intermediate consumption to do that, and it would therefore lead to an additional demand for primary factors of production in the other sectors of industry, particularly the ones with strong backward linkages. Consequently, at the macro-level, one percent TFP-growth in some sector of industry, *ceteris paribus*, must lead to less than one percent output growth per unit of the total factor, since growth in output implies growth in intermediate inputs, in turn

implying growth in the demand for primary production factors elsewhere. In our case, therefore, the growth in gross output will be given by:[52]

$$G(X_s) = G(TF_s) + G(TFP_s) \quad (5)$$

Growth in the Total Factor and In-house KISA's

In our case, we have assumed that the total factor in each sector is a Leontief-function of the sectoral physical capital stock and a linear homogenous job-complex, consisting of the 12 jobs mentioned above.[53] The job-complex itself is a Cobb-Douglas aggregate of these 12 jobs, that can readily be re-interpreted as a multi-level job-complex consisting of a sub-complex of KISA-intensive jobs, and KISA-extensive ones. To show how this works, let J_k denote the set of job-indices of the KISA intensive jobs, and J_x the set of KISA-extensive jobs. Let β_i be the exponent of job-class i in the overall job-complex J. Let JK and JX be the sizes of the KISA-intensive and KISA-extensive sub-job-complexes. Then we have, by definition:

$$J = \prod_{i=1}^{N} j_i^{\beta_i} = \left\{ \prod_{i \in Jk} j_i^{\beta_i / \sum_{j \in Jk} \beta_j} \right\}^{\sum_{j \in Jk} \beta_j} \cdot \left\{ \prod_{i \in Jx} j_i^{\beta_i / \sum_{j \in Jx} \beta_j} \right\}^{\sum_{j \in Jx} \beta_j} = JK^{\sum_{j \in Jk} \beta_j} \cdot JX^{1 - \sum_{j \in Jk} \beta_j} \quad (6)$$

Equation (6) shows how we could reinterpret the standard specification of a one-level Cobb-Douglas function as one involving a KISA-intensive and a KISA extensive complex, without having to change the standard approach in a fundamental way.

The job-complex J features together with the capital stock in each sector, as an argument to a Leontief function that generates the total factor, implying that total factor growth must obey the following constraints:

$$G(TF_s) \leq G(K_s) \quad (7.A)$$

$$G(TF_s) \leq G(J_s) \quad (7.B)$$

In equation (7.A) K_S is the capital stock in sector s. That stock is built up dynamically, applying the perpetual inventory stock method, and using the data from the EU-KLEMS database. Hence, we have:

$$K_s(t) = (1 - \mu_s) \cdot K_s(t - 1) + I_s \quad (8)$$

In equation (8), *K(t)* refers to the capital stock in year t, while I_s is gross investment by destination in sector s. Finally, μ_s is the rate of technical depreciation in sector s, as given by the EU-KLEMS database. It should be noted that an increase in the gross output of some sector, therefore requires a corresponding increase in its capital stock, a derived increase in investment by destination, and hence an increase in the output of other sectors too, since they have to deliver the hardware and corresponding services that together make up a unit of gross investment.

---

[52] Note that equation (5) holds only for small values of the growth rates, since it ignores second order effects.

[53] See section 3 for further details on the actual sectoral and job dimensions used in the empirical implementation of the model.

10.1.5 The Labour Market Module

Introduction: In our model, we have adopted the notion that R&D labour is intrinsically different from production labour. Since from a supply side perspective, the only thing that matters is educational attainment, then if R&D is a high-skilled intensive activity, all high-skilled workers would become potential R&D workers, which is obviously not the case. In order therefore to avoid the occurrence of unrealistically high endogenous growth rates, it stands to reason to model the labour markets for production labour and for R&D labour along similar lines, but separately nonetheless, i.e. the R&D labour market and the production labour market do not communicate by assumption.

The Production Labour Market Flow System

As stated above, the model distinguishes different kinds of labour from an educational perspective, and also different kinds of jobs. The educational levels of attainment (further also called skill-levels) we distinguish are low, medium and high, while jobs are distinguished in accordance to type (ADMINISTRATIVE, CARE, TECHNICAL AND SERVICE jobs) as well as corresponding levels (again low, medium and high).[54] Because of labour market inflexibilities, it is possible that similar labour-types do NOT earn the same wage. In the long term, they should, because of labour market mobility. In the short term, however, labour will be only imperfectly mobile between sectors, because of various adjustment costs, not explicitly taken into account, except for their impact on mobility parameters.

We therefore have to specify how mobile different skills are between sectors, i.e. how homogeneous various skills are from the point of view of the different sectors in the economy. To do so we have to state how 'reluctant' the various skills are in acting on better income/employment perspectives by moving between sectors, because of the existence of (further unspecified) adjustment costs. In order to complete the model, we simply assume that the heterogeneity of similar skills from a sectoral perspective can be dealt with by means of a 'proximity' measure that indicates how large a share of employment by skill in the one sector could similarly be employed in another sector. Let us furthermore assume that only a certain fraction of the total employment by skill by sector is actually willing to move to another sector if an opportunity for economic self-improvement arises.

The supply of various skills available for each sector therefore has three different sources: current employment within that sector, current employment in proximate sectors, and current unemployment. We assume that new entrants on the labour market formally start their careers as unemployed. Exit from employment occurs through retirement and unemployment. Retirement includes mortality. In effect, we therefore have two stocks of labour, employed and unemployed, and various flows between those stocks.

Obviously, there are several constraints on these flows. For instance, the flow from unemployment and employment into (other) employment is a 'voluntary' flow by assumption. The flow from employment into unemployment is involuntary, also by assumption. In order to formalise the connection between these stocks and flows, let us define $FL^{E,E}_{s,o,,d,t}$ as the flow from employment in sector of origin *o* into employment in sector of destination *d* of labour of skill type s, while $E_{s,i,t}$ is

[54] For further classification details, see section 3.

employment of skill *s* in sector *i*. $U_{s,t}$ is the stock of unemployed people of skill level *s*. $FL^{E,U}{}_{s,i,t}$ is the flow of skill *s* from sector *i* into unemployment. $FL^{U,E}{}_{s,i,t}$ is the flow of skill *s* labour from unemployment into employment in sector *i*. $^{E}{}_{s,i,t}$ and $^{U}{}_{s,t}$ are permanent retirements of skill type *s* from sector *i* as a fraction of previous employment in that sector or unemployment of a specific skill, respectively. Let $^{E}{}_{s,i,-i,t}$ and $^{U}{}_{s,-i,t}$ be the proximity of skill *s* currently employed in sector *o* (or unemployed) and potentially available for employment in sector *d*. Furthermore, let $^{E}{}_{s,i,t}$ and $^{U}{}_{s,t}$ be the fraction of people with skill *s* that are employed in sector *i* (or part of the unemployment pool) and that are available for employment elsewhere. Finally, let $\Delta L_{i,t}$ $L_{s,t}$ be the number of new entrants of skill *s* to the labour market at time *t*. In that case we should have as constraints on the levels of employment by skill and the '(re-) employment' flows between production sectors:

$$E_{s,i,t} \le E_{s,i,t-1}.(1-\mu^{E}{}_{s,i,t}) + \sum_{o} FL^{E,E}{}_{s,o,i,t} + FL^{U,E}{}_{s,i,t} - \sum_{d} FL^{E,E}{}_{s,i,d,t} - FL^{E,U}{}_{s,i,t} \quad (9.A)$$

$$FL^{E,E}{}_{s,i,-i,t} \le E_{s,i,t-1}.(1-\mu^{E}{}_{s,i,t}) \cdot \theta^{E}{}_{s,i,t} \cdot \pi^{E}{}_{s,i,-i,t} \quad (9.BE)$$

$$FL^{U,E}{}_{s,i,t} \le U_{s,t-1}.(1-\mu^{U}{}_{s,t}) \cdot \theta^{U}{}_{s,t} \cdot \pi^{U}{}_{s,i,t} \quad (9.BU)$$

$$\sum_{d} S^{E,E}{}_{s,i,d,t} \le (E_{s,i,t-1}.(1-\mu^{E}{}_{s,i,t}) + \sum_{o} FL^{E,E}{}_{s,o,i,t} + FL^{U,E}{}_{s,i,t}) \cdot \theta^{E}{}_{s,i,t} \quad (9.C)$$

$$\sum_{i} FL^{U,E}{}_{s,i,t} \le (U_{s,t-1}.(1-\mu^{U}{}_{s,t}) + \sum_{i} FL^{E,U}{}_{s,i,t}) \cdot \theta^{U}_{s,i,t} + \Delta L_{s,t} \quad (9.D)$$

Equation (9.A) states that total employment of a skill *s* in some sector *i* is equal to previous employment in that sector less permanent retirements plus the inflows of that skill from other sectors, including unemployment, less the outflows of that skill to other sectors and unemployment. Equation (9.BE) states that a flow of skill *s* from sector *o* to sector *d* may not be smaller than the fraction both available for employment elsewhere and suitable for employment in sector *d*. Equation (9.BU) is similarly defined for unemployed people. Equation (9.C) states that the total outflows from employment in sector *i* to employment in other sectors may not be larger than is available for employment elsewhere. Equation (9.D) is defined similarly to (9.C) for flows from unemployment into employment, i.e. outflows out of unemployment. The only principal difference between (9.C) and (9.D) is that new entrants into the labour market formally start their careers as unemployed.

Adding the R&D Labour Market Flow System

R&D employment is just a small fraction of total employment[55]. Therefore it does not help much in practice to use research workers to alleviate supply bottlenecks in production work. In addition, the nature of the skills required, even though the levels might be comparable, is very different. If production needs an academic to reorganise the warehouse it is unlikely that an academic from the research laboratory could easily do the job. We therefore treat the markets of production and research workers as two non-communicating vessels. However, the arguments regarding the ability and willingness to move for production workers also holds with respect to research workers, which implies that we can set up a labour market accounting system following the same principles as we have outlined already for production workers.

[55] The OECD main science and technology indicators database shows that R&D employment in the Netherlands is well below 1%.

Denoting employment and unemployment for research workers by adding the superscript *RE* and *RU*, respectively, the system for production workers described above can be used as a 'template' to define a completely analogous system for research workers, which is further not listed here.

Linking Labour Demand and Supply

Equation (9.A) provides the maximum amount of employment by skill and by sector at any moment in time. That level of employment by skill in some sector can be regarded as the pool from which the different jobs in the sector under consideration can be filled. However, job-levels and skill-levels are not necessarily identical, as is apparent from the fact that the sum of employment over job-types for a given job-level does not add up to the level of employment by corresponding skill-level: there is no one-to-one relation between job-levels and skill-levels therefore, which means that skill-levels will have to be distributed over job-levels, in order to be able to match labour supply by skill, to labour demand distinguished by job. In order to make such a match between labour supply in terms of educational levels, and labour demand in terms of job-types and levels, we have devised a special matching procedure that we will explain in more detail below.

The procedure starts from the notion that total employment by sector and by skill functions as a source for allocating labour by skill over the different jobs relevant in a sector. However, high job-levels should preferably be filled by people with high-level education, and if there are not enough high-level education people available, then with the next level of education and so on. Conversely, low-level jobs should be filled by low-skilled people and then further up. The difference between both cases is, however, that it is more conceivable that high-skilled people can fill low-level jobs, than the other way around. We can implement this asymmetry in allocation possibilities by penalizing lower-level education allocations to higher-level jobs by more than higher-level education allocations to lower level jobs. The latter allocations are just relatively undesirable while the former allocations are relatively impossible or at least improbable. Thus, we can set up the following linear programming problem as follows.

Let *P(sk,jl)* be the matrix of penalties associated with the allocation of a unit of labour of skill-level *sk* to a job of level *jl*. In fact, the penalty matrix that we have used contains the following numbers:

Skill/Job-level	**Low**	**Med**	**High**
Low	**0**	**2**	**4**
Med	**1**	**0**	**2**
High	**2**	**1**	**0**

Table 10.1 Skill-allocation Penalties

The matrix shows that a misallocation of the improbable kind is penalised by twice as much as a misallocation of the undesirable kind. Furthermore, a one-stage misallocation (low allocated to medium, for example) is penalised by half the penalty of a two-stage misallocation (low allocated to high, or the other way around). Given the penalty matrix *P*, we can now specify the following objective function:

Minimise $\sum_{sk}\sum_{jt}\sum_{jl} P(sk,jl)\cdot A(sk,jt,jl)+10000*percentage\_slack$ (10)

by optimally choosing the elements of *A* and the value of *percentage_slack*, and where *jt* is a job-type index, and *A* stands for the number of workers of skill level *sk* allocated to jobs of type *jt* and job-level *jl*. The remaining terms in the objective function will become clear below.

Because of numerical rounding errors, the allocation of workers from all the pools of workers by skill do sometimes not add up completely to the total demand for workers. And although the relative error is extremely small (of the order of 1 part in a million), it nevertheless poses numerical problems for the optimisation procedure. Therefore we introduce a slack between supply and demand (that is to say, we make sure that supply is always sufficient to meet demand, but penalise the slack, because we want the percentage slack to be as small as possible (of the order of the actual percentage error), hence the introduction of a very high penalty on the slack.

The constraints of the minimisation problem are maximum out-flow and minimum in-flow constraints, since all jobs must be filled, and none of the pools may be more than exhausted. Thus we get, for each sector:

$$\sum_{jt}\sum_{jl} A(sk,jt,jl) \le (1+percentage\_slack)*S_{sk} \quad (11.A)$$

$$\sum_{sk} A(sk,jt,jl) \ge J_{jt,jl} \quad (11.B)$$

In equation (11.A) S_{sk} is the source of skill level *sk*, measured by the level of employment by skill sk in the sector under consideration. In equation (11.B), $J_{jt,jl}$ is the required number of jobs of type *jt* and level *jl* to be filled.

Given the outcome matrix *A*, the sectoral frequency-distribution F(sk,jt,jl) of a particular skill over all jobs can be obtained by calculating:

$$F_s(sk,jt,jl) = A(sk,jt,jl)/S_{sk} \quad (12)$$

The frequency distributions F_S for all different sectors are then used to link labour supply with demand as follows:

$$J_{s,jt,jl} \le \sum_{sk} E_{sk,s}\cdot F_s(sk,jl,jt) \quad (13)$$

Equation (13) states that the people filling a job come from the different skill-pools in the proportions that would minimise the misallocations of the undesirable and improbable kind.

10.1.5 Closing the Model

The model described above is (or can be made) linear in all its variables, GIVEN last years outcome. This allows us to use relatively efficient Linear Programming procedures that look one year ahead. This provides a quick, but dirty, solution to the problem of using an economy's resources to the best possible use. The 'dirtiness' of the solution comes from the fact that R&D output has an intertemporal effect, that is not properly taken into account in year by year optimisation. After all, once an idea

has been created, one doesn't have to spend the same R&D resources again when using the same idea again the next year (and again, ad infinitum). The jump in output due to TFP-growth is permanent, and therefore we approximate the actual output that can be attributed to the use of R&D resources and those complementary to it, by the present value of the permanent change in output in the sector experiencing the rise in TFP. Since that jump is permanent (at least in a growing economy), we can approximate the present value of R&D output by:

$$PVRND_s = X0_s \cdot GTFP_s / r \quad (14)$$

The central planner's objective function is now defined as the sum over all sectors of net final demand (i.e. total final demand less competitive imports and non-competitive imports) plus the present value of R&D output as given by (14). If we would not account for the intertemporal nature of R&D output in this way, the model would, in principle, be structurally biased against the allocation of R&D resources.[56]

10.1.6 Model Assessment

The model we have described in the previous sections is not an ordinary simulation model that tries to reproduce reality as perfectly as possible. On the contrary, economic reality is full of compromises, adjustment costs, or, generally speaking, imperfections, while our model neglects most of these imperfections. However, we do take the most important ones of these imperfections into account, particularly the ones that would affect the working of the labour market.

The optimisation of the net final output vector (including the correction for the inter-temporal nature of R&D) then proceeds for a given price-vector (i.e. effectively the same price vector as in the base year 2000) that reflects the demand-side. But given this, admittedly, very strongly compressed demand-side, the model shows how available resources could/should be allocated over their various uses to get the best result possible.

In addition to this, the central planners approach gives, in theory, a first best solution, that would be generated by a decentralised economy if it were operating under perfectly competitive conditions without any externalities. This is what EU-policy explicitly aims for, and one could argue therefore, that the outcomes of our model are in line with overall EU-policy. That is not to say that our outcomes are perfect. That would also, and quite importantly, depend on the way in which the demand side is covered.[57] But even if the outcomes are imperfect, we think that they show important interconnections between growth performance at the macro-level and inter-sectoral movements of goods, (KISA-) services as well as labour, that are routinely neglected in more standard partial equilibrium TFP-growth measurement exercises, and that are important nonetheless for explaining the development of aggregate growth and identifying bottlenecks in the aggregate growth process.

[56] However, the R&D labour market is not integrated with the production labour market, and hence R&D workers have nowhere else to go, thus effectively mitigating the bias against using R&D resources from a modelling point of view. The fact remains that leaving the intertemporal nature out, amounts to an understatement of the actual importance of distribution of R&D resources over its various uses.

[57] At present the demand side is taken care of by means of a constant price vector (the vector in the base year 2000, to be precise), but in principle that could be remedied by extending the model from a pure supply driven system to a system in which demand and supply may explicitly interact.

In theory, and somewhat tongue in cheek, one could describe reality as a variation on the central planner's solution. The question is how far this variation is removed from the central planner's solution, and how stable the distance between a variation and the central planner solution would be. If the distance would be relatively stable, then policy induced changes in central planner solutions would be indicative for the percentage changes one could expect for similar policy induced changes in reality. Obviously, further research is needed to establish the stability of the distance between variations in central planner solutions and corresponding variations in reality. But until further notice, we continue to believe that the central planners approach captures much of the flavour of the actual decentralised solution, certainly enough so as to provide us a rough and ready indication of what particular alternative policies may imply for KISA driven growth and the KISA-intensive jobs. The fact remains, however, that in order to 'fore-cast' the future more reliably than we have done in our base-run, we would have to fore-cast the demand-side in a suitable way. Again, this is left for the future.

10.2 Model Implementation: Classification, Data and Calibration Issues

10.2.1 Data and Classification Issues

The model described in the previous section requires a fair amount of data. Two main bodies of data pertain to the overall production structure and the structure of the labour market. The production structure has a sectoral dimension and distinguishes labour demand according to job-levels and job-types, while the supply of labour is distinguished in accordance with levels of educational attainment. The labour market module brings these different dimensions together, by means of the special matching scheme described in the previous section after flows of labour by skill-level have filled the virtual pools from which our matching scheme starts filling jobs distinguished by level and type.

Below we will describe the main data sources for the implementation of the model for the Netherlands. As will become clear below, we have chosen the dimensions and data sources with the aim of maintaining the option of a relatively 'easy' future extension towards the entire EU. For some countries, though, it could still be the case that some data series are incomplete or some sub-sectors are not available, but in principle the coverage can be extended towards the EU.

In order to keep the demonstration model manageable in terms of the convergence properties of the simultaneous block, we kept the number of sectors fairly limited. Again, an extension in sectoral dimensions is possible in principle and mainly limited by the availability of the data. Initially we collected data from 16 different sectors of industry but during the first implementation in the model we faced some convergence problems. In order to find out more about the particularities of the model and the related technical problems that might occur, we decided to limit the sectoral dimension of the present demonstration model to 6 sectors of industry: the primary goods producing sector (further labelled PRM), the manufacturing sector (further labelled IND), the KIBS growth generating services industry (further called KGG), the KIBS growth supporting services industry (further called KGS) and the other services sector, further called OSR. In addition, we have the primary sector containing both agricultural activity and mining and quarrying (further called PRM). Finally the model includes the government as a separate sector (further called GVT).

In order to be able to feed the model at a later stage with data at the European level we decided to use the EU KLEMS database, the harmonized input-output tables as provided by Eurostat, and the European labour force survey (LFS). In this case for the Netherlands we use the Dutch version of the LFS called "Enquete Beroeps Bevolking", EBB. This section briefly discusses the data availability and the sectoral level of detail and the job and skill dimension of the labour market system. In order to be able to link the labour market data to the production structure we use the skill decomposition as available in the EU KLEMS database. Finally this section also presents the incomes shares of all input factors (labour and capital) as well as the correlation coefficients for all types of labour between sectors, that we use as an indicator of the technological proximity between sectors, and consequently the degree to which a worker of a given skill-level in the one sector would be suited for employment in another sector.

The EU-KLEMS database

The EU KLEMS[58] database is contains the data associated with sectoral production structures in Europe. In this production structure the main input factors are capital (K), labour (L), energy (E), material (M) and service inputs (S), hence its name. The main purpose of the database is to support productivity analysis at a sectoral level. Therefore the focus is on these input factors. Moreover, capital inputs are further sub-divided in investments in ICT and in non-ICT capital, while labour is subdivided into three different skill levels (Low, Medium and High). In addition to this, the most important variables included in the database are: Gross output, Intermediate inputs (total, energy, materials, services), value added, employment (employees, persons, hours), compensation of employees, gross operating surplus, taxes, etc.[59] Gross output, intermediate output and value added are defined in current as well as in constant prices as is gross fixed capital formation. Countries included in the database are: Australia, Austria, Belgium, Cyprus, Czech Republic, Denmark, West Germany, Estonia, Spain, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Lithuania, Latvia, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Sweden, United Kingdom, and the United States.[60] Bulgaria and Romania are not yet included. As mentioned above, the demonstration model is based on Dutch data and for the current implementation we only used the Dutch data of EU KLEMS.

Table 10.2 shows the concordance table between the KISAMOD classifications and those underlying the EUKLEMS database. The nature of the production process (primary, industry and services) and the distinction between KISA and non-KISA sectors is the main motivation to come to this classification, apart from the need to keep the number of sectors limited as well as the need to be able to demonstrate the principal working of the model, but also to keep the model manageable given the limited time and resources available for the entire modelling exercise.

Next to the variables mentioned above, the EU KLEMS database also reports on total factor productivity (TFP) growth rates obtained using standard growth accounting practices. The latter implies that TFP-growth is calculated as a residual

[58] Source: EU KLEMS database, March 2008, see Marcel Timmer, Mary O'Mahony & Bart van Ark, The EU KLEMS Growth and Productivity Accounts: An Overview, University of Groningen & University of Birmingham; downloadable at www.euklems.net.

[59] For a complete list of variables see: Timmer, M. O'Mahany, van Ark (2008), op. cit., Appendix Table 1 Variables in EU KLEMS database.

[60] United States is presented in two different sectoral classifications: SIC based and NAICS based.

by subtracting a weighted average of capital and labour inputs from output. This means that all effects caused by other input factors except capital and labour and that all remaining distortions are captured by the TFP-growth measure. This also includes changes in the rate of capacity utilisation. Therefore the outcomes regarding the growth rate of total factor productivity are rather volatile for all sectors and are often (slightly) negative for service sectors. Both the high degree of fluctuation and the negative value of TFP-growth do not fit the theoretical notion that the growth in TFP describes the growth of (disembodied) technical change as a structural phenomenon contributing positively to output growth, *ceteris paribus.* The problem is that *ceteris NON paribus*. Certainly for the sectors experiencing negative TFP-growth while employing a positive level of R&D resources, this would amount to NEGATIVE measured R&D productivity, which would call for negative R&D resource employment rather that the positive levels observed. Apparently R&D inputs are then used to overcome a negative trend in TFP-growth arising out of 'other circumstances' like cyclical factors (or misspecification of the TFP-measurement scheme!). This certainly requires further research and time which we did not have. Hence we have fixed this anomaly by adding one percentage point in all sectors to obtain non-negative TFP-growth rates, before measuring R&D productivity.

Input-Output Tables

The European System of Accounts ESA 95 has established a collection of tables of the input-output framework of the European Member States. Member states deliver data on supply and use tables and on symmetric input-output tables. The latter are subdivided into symmetric input-output tables of domestic production and symmetric input-output tables of imports. The input-output system includes detailed information for a given year on production activities, supply and demand of goods and services, intermediate consumption, primary inputs and foreign trade. These IO-tables show, among other things:

a) the structure of the costs of production and value added generated in the production process
b) the inter-dependencies through intermediate deliveries of industries;
c) the flows of goods and services produced within the national economy and
d) the exchange of goods and services with the rest of the world.

Although data are available through Eurostat, we have used the Dutch version of the input-output table (cf. CBS, several issues) and the data are aggregated to the 6 sectors according to the scheme displayed in Table 10.2 below.
The model is based on constant technical coefficients and therefore we need the input-output structure for one year only. Data for the year 2000 is available for most countries and this year is chosen to quantify the forward and backward inter industry linkages as well as the various components of final demand. These data are completely consistent with the Dutch part of the EU KLEMS database.

KISAMOD		EU KLEMS Database	
PRM	Agriculture, forestry and fishing	A&B	AGRICULTURE, HUNTING, FORESTRY AND FISHING
	Mining and quarrying	C	MINING AND QUARRYING
IND	Manufacturing Industry	D	TOTAL MANUFACTURING
		F	CONSTRUCTION
OSR	Other Services	E	ELECTRICITY, GAS AND WATER SUPPLY
		G	WHOLESALE AND RETAIL TRADE
		H	HOTELS AND RESTAURANTS
		I (Except 64)	TRANSPORT AND STORAGE AND COMMUNICATION (Except Post and Telecommunication)
		J	FINANCIAL INTERMEDIATION
		70	Real Estate, Renting and Business Activities
		71	Renting of machinery and equipment
		N	HEALTH AND SOCIAL WORK
		O	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES
KGG	Kibs Growth Generating	73	Research and development
KGS	Kibs Growth Supporting	64	Post and Telecommunication
		72	Computer and related activities
		74	Other business activities
GVT	Government	L	PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY
		M	EDUCATION

Table 10.2 Concordance KISAMOD and EUKLEMS

European Labour Force Survey (EU-LFS).[61]

The EU-LFS covers all the territories of the Member States of the European Union, the EFTA countries (excluding Lichtenstein), and including Bulgaria, Croatia and Romania.[62] The labour force survey is a household survey and cannot directly be linked to levels of production, employment and other economic statistics described above. However, from the LFS one can obtain the employment status (employed, unemployed, not in labour force) and if a person is employed, the sector of activity (NACE based) is given. Also the occupational details and educational details are obtained. The EU-LFS is based on international classifications (NACE rev. 1 – from 2005 rev.1.1 for economic activity, ISCO 88(Com) for occupation, ISCED 1997 for education).

The LFS comes in various versions from the detailed micro datasets (in general not available) to the anonymised more aggregate datasets. For the wave of 2007, anonymised data is available for all EU27 countries except for Malta and the sectoral level of detail is restricted to 1-digit NACE levels. This implies that some assumptions have to be made to come to a concordance between sectoral employment and the job-level classification. Occupation (ISCO3D and ISCOPR3D) is in the anonymised data-set aggregated at the 2-digits level, but for our analysis a 1-digit level is sufficient. This implies that a job level classification can be made per sector in terms of percentages of the total.

For the present demonstration model we employed the Dutch version of the Labour Force Survey. The data allow for an aggregation to six sectors of industry and the raw data consist of 44 occupations as displayed in Table .[63] The model uses 12 occupations, 4 types (administrative, technical, care and service oriented occupations) at three different levels (low, medium and high). The mapping of the 44 different occupations towards these 12 aggregates is also shown in table 10.3. These

[61] We are very grateful to the Research Centre for Education and the Labour Market (ROA), Maastricht University for supplying these labour market data.

[62] In case of Cyprus, however, the data only refer to the territory under the control of the Government of the Republic of Cyprus.

[63] More detail in terms of sectors of industry is possible but limited to roughly 15 sectors. More detail is not possible due to data limitations mainly due to too few observations.

data are available for the period 1996-2007. The LFS data are scaled such that they match the employment figures as presented in the EU KLEMS database for which we have used employment in hours worked.

The final data we used in the model include per sector of industry three different levels of skills (low, medium, and high) and 12 different occupations. So in total the model deals with 72 different sector specific occupations and per occupation we distinguish entry into and exit out of the labour market as well as stocks of employed and unemployed. Also for the labour market data we initially constructed these data for 16 sectors of industry, so including 192 sector specific occupations. Therefore, an extension towards, for instance, 16 sectors is possible, at least from a data perspective for the Dutch version of the model.

	LOW				MEDIUM				HIGH			
	ADM	CAR	TCH	SER	ADM	CAR	TCH	SER	ADM	CAR	TCH	SER
1 Elementary occupations				X								
2 Lower non-specialists occupations				X								
3 Lowerlevel teachers in sport				X								
4 Lower agricultural occupations			X									
5 Lower mathematical and scientific occupations			X									
6 Lower technical occupations			X									
7 Lower transport occupations				X								
8 Lower (para) medical occupations		X										
9 Lower administrative and commercial occupations	X											
10 Lower security occupations				X								
11 Lower care occupations		X										
12 Mediumlevel teachers in transport and sport								X				
13 Medium agricultural occupations							X					
14 Medium mathematical and scientific occupations							X					
15 Medium technical occupations							X					
16 Medium transport occupations								X				
17 Medium (para) medical occupations						X						
18 Medium administrative and commercial occupations					X							
19 Medium legal, public services and security occupations								X				
20 Medium linguistic and cultural occupations								X				
21 Medium social and welfare occupations								X				
22 Medium care occupations						X						
23 Higher teaching professionals												X
24 Higher agricultural occupations											X	
25 Higher mathematical and scientific occupations											X	
26 Higher technical occupations											X	
27 Higher transport occupations												X
28 Higher (para) medical occupations										X		
29 Higher administrative and commercial occupations									X			
30 Higher legal, public services and security occupations												X
31 Higher linguistic and cultural occupations												X
32 Higher social and welfare occupations												X
33 Higher care occupations										X		
34 Higher qualified managers									X			
35 Scientific teaching professionals												X
36 Scientific agricultural occupations											X	
37 Scientific mathematical and scientific occupations											X	
38 Scientific technical occupations											X	
39 Scientific (para) medical occupations										X		
40 Scientific economics, administrative and commercial occupations									X			
41 Scientific legal and public services occupations												X
42 Scientific social and welfare occupations												X
43 Scientific qualified managers									X			

Table 10.3 Labour Force Data and KISAMOD Aggregation Scheme

10.2.2 Calibration Issues

Calculation of Income Shares and Technological Proximity

Obviously, labour of a certain skill level employed in the one sector of industry is not necessarily a perfect substitute for labour of the same measured skill-level in another industry. This depends both on the level of aggregation of skill-levels, and on the nature of the activities performed in the different sectors. The level of aggregation of skills is given to us, since that is implied by the use of EU-KLEMS to be fairly

aggregate (low, medium and high, to be more precise). But for the similarity of production activities within sectors we have devised a special measure that is an indicator of the technological proximity between sectors, and therefore the implied proximity in job-contents for people of the same skill-level employed in different sectors.

In order to arrive at these proximity measures, the coefficients of the production function need to be determined, and, following common practice, we use the income shares of all type of labour and of capital to determine these coefficients as shown in table 10.4. Since there is no capital stock data available for the R&D sector, i.e. our KGG-sector, we assumed that, for the proximity measurement purposes, output is purely based on labour input for this sector. From table 10.4 we see that the primary sector is highly capital intensive (utmost right column) following by other services, the manufacturing industry and finally the government and the KGS sector. Also remarkable from the table is that higher administrative and higher technical occupations are most important in the KGG sector whereas medium technical and medium administrative occupations have a high share in the primary and industry sectors.[64] As expected, higher administrative occupations are important for the production in the growth supporting sector, KGS.

	LADM	LCAR	LSER	LTCH	MADM	MCAR	MSER	MTCH	HADM	HCAR	HSER	HTCH	CAP
PRM	0.1%	0.0%	1.6%	11.0%	1.4%	0.1%	0.2%	29.4%	7.2%	0.0%	1.0%	1.3%	46.6%
IND	1.5%	0.1%	5.3%	12.7%	7.0%	0.6%	0.6%	22.5%	9.8%	0.2%	2.3%	6.5%	30.8%
OSR	4.1%	2.0%	5.3%	1.1%	10.5%	6.6%	1.9%	3.5%	13.3%	5.7%	5.2%	1.1%	39.6%
GVT	2.4%	0.3%	2.9%	1.5%	13.4%	0.6%	2.3%	2.4%	14.2%	1.2%	34.1%	3.2%	21.6%
KGG	0.9%	0.0%	2.0%	2.0%	9.7%	0.0%	2.8%	4.5%	29.6%	6.9%	7.4%	34.3%	0.0%
KGS	2.3%	0.1%	6.7%	1.0%	13.1%	0.2%	2.3%	4.8%	34.7%	0.1%	5.5%	9.3%	19.9%

Table 10.4. Sectoral Income Shares by Job Category and Capital

The labour market flow system is based on the degree of suitability of a worker for another sector. The implicit assumption is that workers gain sector specific knowledge and skills during the time they work in a sector which would make them more suitable for a potential move towards a workplace in the same or a similar sector than to an entirely different sector. We therefore use similarities/differences in the 'shape' of the production function as a measure of the proximity between different sectors in order to model 'taps' on the potential sizes of the flows between sectoral stocks of employment and unemployment (by 'last' sector of employment) in the labour market flow system (see also section 2, for more theoretical details). Table 10.5 displays these technological correlation figures, indicating, for instance, that the primary sector and the manufacturing industry are rather similar with a correlation coefficient nearly equal to one.

[64] This follows even if one compares the normalized job-coefficients, i.e. the original labour shares divided by the sum of all labour shares (i.e. excluding capital costs therefore), in order to account for the lack of capital contributions to output in case of the KGG sector.

	GVT	IND	KGG	KGS	OSR	PRM
GVT	1.000	0.638	0.564	0.737	0.754	0.638
IND	0.638	1.000	0.489	0.726	0.848	0.984
KGG	0.564	0.489	1.000	0.793	0.457	0.414
KGS	0.737	0.726	0.793	1.000	0.797	0.678
OSR	0.754	0.848	0.457	0.797	1.000	0.876
PRM	0.638	0.984	0.414	0.678	0.876	1.000

Table 10.5. Correlation Table/Technological Proximity

Figure 10.6 shows the same data as in Table 10.5 in a radar-plot and from this figure the differences of production structures between sectors become even more clear. Workers in the growth generating sector (KGG) are highly specialised and can switch to a job in the growth supporting sector relatively easily but not so easily to the other sectors. Also the workers in the primary sector, for instance, can easily switch to the manufacturing industry, a bit less easy to the other service sector, followed by the growth supporting sector, the government and finally the growth generating sector. The same holds true for workers in the primary sector.

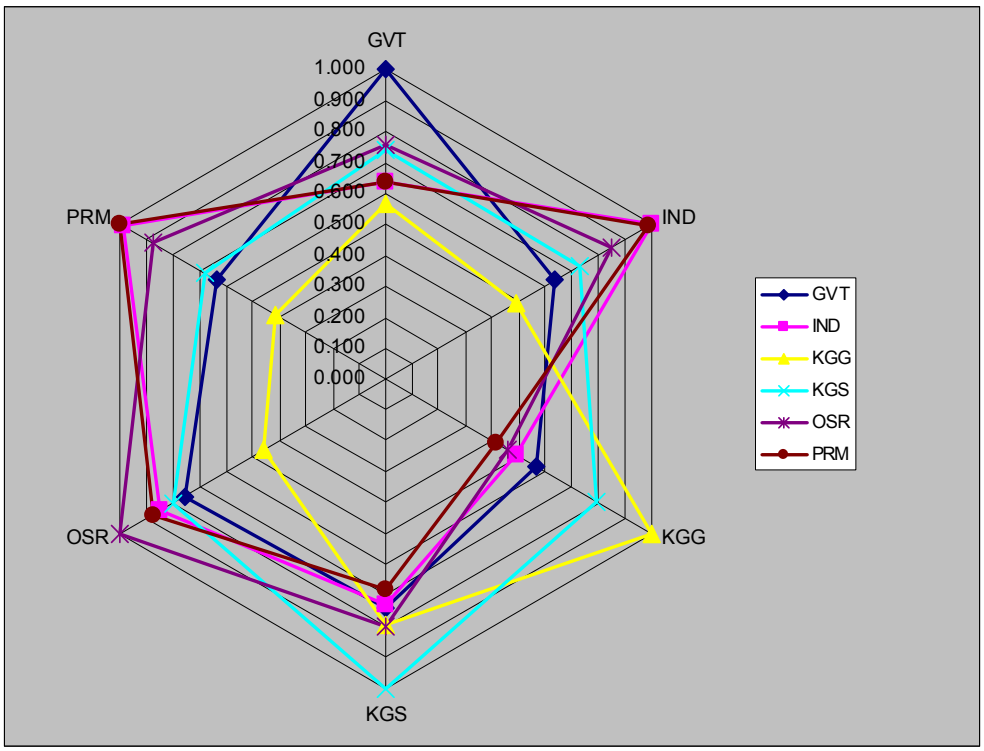


Figure 10.6. Technological Proximity Measures

Further Model Parameter Calibrations

The parameters of the model have been obtained through calibration rather than estimation. This pertains to such concepts as the productivity of R&D workers given by the δ-parameters, but also to the ratio's of in-house R&D activity to KGG and KGS services obtained by the KIBS user sectors (as given by the ς-parameters (see section 2). Because the OSR sector tended to grow far too fast with these rough calibrations, we have halved the corresponding δ-parameter for the OSR sector.

Because the EU-KLEMS data doesn't provide capital data for the KGG-sector, not including the use of capital for the KGG sector in the model would provide a virtual productivity advantage for the KGG sector, since it's expansion would not require the input of additional capital resources, whereas that would indeed be the case for the other sectors. In order to remove this 'unfair' advantage for the KGG-sector we have postulated a capital-output coefficient equal to 1.5, and a capital depreciation rate equal to 0.1. In combination with the level of gross output in 1999, we can obtain a corresponding value of the capital stock for the year 1999 which we used to endogenously build up capital requirements for the KGG-sector in accordance with the perpetual inventory stock method (see section 2).

As regards the labour market flow system, we have postulated exit-rates by skill and sector all equal to 3 percent, and entry rates equal to 1 percent. These rates need to be rooted more carefully in the labour market data in future work on the model.

As regards the willingness of people to move from unemployment and employment into employment, we have used values of 0.3 and 0.5 in the case of production labour and RND labour. In combination with the proximity measures these number s amount to a maximum percentage outflow out of employment and unemployment of approximately 20 and 30 percent per year. Again, additional information is needed for further calibration of these numbers.
The rate of discount has been set equal to 5 percent.

Further Model Structure Calibrations

In addition to the parameter calibrations, we have calibrated the structure of the model to some extent. For example, we noticed that the OSR sector contribution to total value added was structurally falling over time, whereas that of the IND sector was structurally rising. In reality, the opposite is the case, apparently, if we take the basic structure of the model to reflect the 'truth', because OSR has become more important from a production (AND consumption) point of view whereas IND has become less important. Since we have 'modelled' the demand side by including a constant price-vector, we apparently underestimated the contribution of OSR to the final users of production and overestimated the usefulness of IND goods. Consequently, we decided to introduce exogenous valuation variables equal to 1 in 2000 and falling at a rate of 2 percent per annum for IND goods and increasing at a rate of 2 percent per annum for OSR goods.

In addition to this, we have taken care that government services are derived services rather that an activity the economy would be willing to specialise in, even if the government would become very productive indeed for some reason. Fortunately, this situation does not occur in our model, since apparently the government sector is not very productive. However, government services are to a large extent complementary to other activities taking place. Consequently we would want to have government production grow roughly at the rate of growth of the rest of the economy. To achieve this, we have constrained government growth in gross output to be at least equal to 1 percent. This often proved to be a binding constraint, suggesting that a smaller government would enable the objective function to increase.[65]

Calibration Assessment

[65] But this is due to the fact that the final output of each sector is a perfect substitute for the output by each other sector, whereas government services are in part complementary to economic activity in general.

The model contains many technical relations, and is dynamic on two accounts: capital is accumulated, and the same goes for research output. Still, the number of calibrations conducted is limited, whereas the calibrations themselves have been relatively rough and ready. For our scenario-analysis we have run the model over a period of 10 years (see the results in the next section), but we have also performed far longer runs than this (up to 30 years) without any problems. This suggests that the basic framework of the model provides a relatively stable background for more precise calibrations and extensions of the model with respect to its demand-side.

10.3. Scenario-Analysis with KISAMOD

10.3.1 Introduction

In this section we present the outcomes of our scenario-analysis using KISAMOD. We first briefly summarise the two broad scenarios we have implemented in KISAMOD. We provide some theoretical background about what kind of model reactions to expect for the given scenarios. Then we provide some factual background for the Netherlands, after which we describe the outcomes by scenario in more detail. The section ends with some concluding remarks.

10.3.2 Scenario Outline

Two of the scenarios described in the main text of the report have been chosen for implementation in KISAMOD. These are the 'cartel' scenario and the 'local concentration' scenario, which are briefly summarised below.

Scenario 1: KISA providers as knowledge cartels

Knowledge based firms are predominantly organised in cartels or clusters. Clusters may be geographic in extension but are technology or product centred in dynamics. Cartels are organisation-based and may be focused on a central product. As cartels are brand-led – the leading partner may have a core technology or only a market presence – in either case the boundaries of the cartel leader are often shifting, as high-value processes are bought in or developed and low-value processes are sold off or out-sourced. The cartel is a collection of suppliers along the value chain which is dominated by the ability of the cartel leader to sell the products which bear its mark. Nokia, BMW, VW, currently have a fixed product range but Philips, Unilever, IBM, are examples of generalists.

In such a scenario the highly focussed knowledge intensive firms exhibit high labour productivity and therefore (other things being equal) employment will gradual decline in the direct KISA jobs. More focussed and more effective services will on the other hand lead to a more competitive position in intensive KISA using sectors. Therefore the overall productivity growth (TFP-growth) is 0.5% higher than in the base scenario.

Scenario implementation: The cartel scenario has been implemented in KISAMOD in two different ways. First, cartelisation gives rise to organisational productivity increases, modelled here as an exogenous contribution of 0.5 percentage points to otherwise endogenous TFP-growth. (This extra TFP-growth would come from indivisibilities in research that would have less of an impact in a cartelised world where firms are larger and pockets are correspondingly deeper.) The outcomes corresponding to this experiment are labelled 'X1', which is short for experiment 1. A

further experiment, labelled 'X3' also attributes additional exogenous TFP-growth to the amount of 0.5 percent in KISA user sectors, the underlying idea being that higher productivity in the KIBS sectors leads to better KIBS products/services that are more fitting to the users needs, and hence provide higher quality productive services to those users, resulting in productivity increases for those users.

Scenario 2 Regional Concentration
Scenario 2, the outcomes of which have been labelled 'X2' is based on the notion of external economies of scale that are so important to understanding the working of local concentrations like 'Silicon Valley', for example. The main idea is that such local concentrations reduce information costs, and enable the pooling of scarce labour resources, resulting in a more efficient use of these labour resources, and correspondingly higher labour mobility between firms within sectors as well as sectors that are relatively close together (cf. the proximity measures described in section 3).

Scenario implementation: The scenario is implemented by raising the mobility of labour through an increase of the willingness to move for both production and R&D labour between firms and sectors. In our case, it will be especially the willingness to move between sectors that are technologically close that will have to lead to the freeing of scarce production labour and RND resources, simply because they will be under-utilised for shorter periods of time.

10.3.3 Corresponding Model Reactions: Theoretical Considerations

The cartel scenario is implemented in the form of TFP-growth shocks (see above), while the local concentration scenario has been implemented in the form of more flexibly operating local labour markets. In both cases, scarce resources are freed-up and these would be put to the best use possible, leading to additional growth and output. In the cartel scenario this happens instantaneously, as productivity growth, for a given level of output, means a lower demand for inputs, hence temporarily un(der)-utilised labour that can be redistributed over alternative uses, for example in other sectors. As this takes time, growth will not immediately take place to the fullest potential extent possible. First the allocation of resources has to adjust to the new incentives. In the 'local concentration scenario', scarce labour resources will be underutilised for shorter periods of time, hence, per unit of time, there is effectively more labour available, and consequently more output can be produced.

Generally speaking, the models reaction to these shocks can be understood from the definition of output as the product of total factor productivity and the size of the total factor. In addition, the contribution to sectoral output by R&D activities follows immediately from the way in which endogenous growth theory prescribes to specify the R&D production function. With some modifications, we have followed this prescription in setting up KISAMOD. In short, we have that:

$$Y_i = TF_i \cdot TFP_i = TF_i \cdot TFP0_i \cdot (1 + G(TFP_i)) = TF_i \cdot TFP0_i \cdot (1 + \delta_i \cdot RND_i) \quad (14)$$

In this equation, *i* is a sector index, *Y* is output, *TF* is the size of the total factor, and *TFP* is again total factors productivity. *TFP0* stands for the level of TFP in the previous period, while *G(x)* stands for the proportional growth rate of *x*. Finally, *RND* stands for the volume of R&D aimed at/taking place within the sector under consideration, while δ_i is the corresponding value of RND-productivity.

Equation (14) implies that aggregate TFP will be given by:

$$TFP = \sum_i Y_i / \sum_i TF_i = \sum_i Y_i / TF_i \cdot TF_i / \sum_j TF_j = \sum_i TFP_i \cdot TF_i / \sum_j TF_j \qquad (15)$$

Equation (xx) shows that aggregate TFP depends on the values of sectoral TFP and the way in which resources in the form of the sectoral 'total factors' are distributed over sectors. This also holds for TFP-growth, *mutatis mutandis*. Consequently, aggregate TFP-growth can arise out of changes in total factor productivity but also in the sectoral distribution of resources. Consequently, any policy action that would have an impact either TFP-growth directly or on the inter-sectoral distribution of resources may be expected to have growth effects.

In our case, there is an additional factor to take into consideration. As we are using a non-forward looking central planners approach to solve the model, it follows that the optimum way of distributing resources is to strive for the equalization of real marginal benefits of a particular resource over sectors. But equation (x) implies that:

$$\partial Y_i / \partial TF_i = TFP_i \qquad (16.A)$$

$$\partial Y_i / \partial RND_i = TF_i \cdot TFP0_i \cdot \delta_i \qquad (16.B)$$

Both equations above underline the complementary character of growth in total factor productivity and in the total factor, even though they are, technically speaking, substitutes: investment in total factor productivity growth, raises the level of TFP in the next period (that is what research is supposed to do, after all), and a higher level of TFP raises the marginal product of the total factor again, invoking, *ceteris paribus,* growth in the total factor in turn. The model may thus be expected to generate a tendency both for cyclical growth, and corresponding cyclical adjustments in the allocation of resources, but also a tendency for path dependencies coming out of these self-reinforcing growth cycles. Nonetheless, there are also counteracting forces at work, since growth in KISAMOD requires resources that have to come from elsewhere and that therefore entail opportunity (growth-) costs.

10.4 Some Factual background

Figure 10.7 exhibits the share of employed people in direct KISA and NON-KISA services in the total of employed people in the Netherlands. As a matter of fact the long term growth rate of NON-KISA employment beats the growth rate of KISA employment, but cyclical factors affect especially non-KISAs , while KISAs are much less affected by cyclical variations during 1987- 2007.

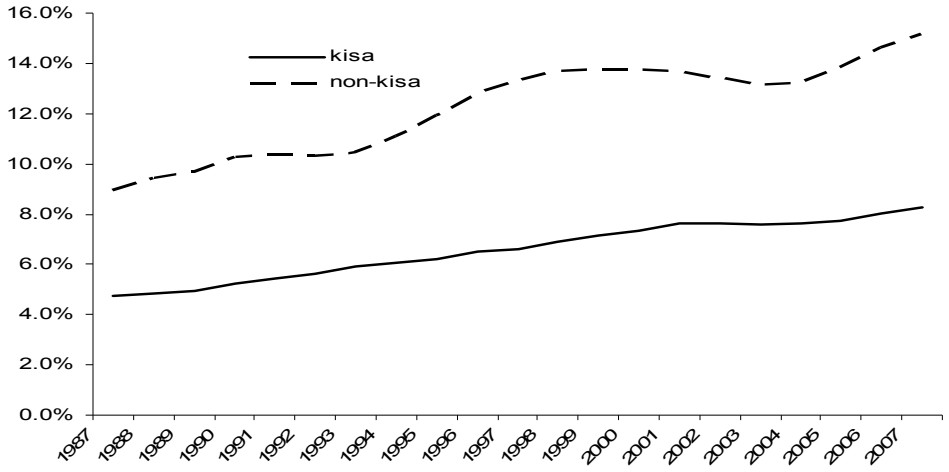


Figure 10.7 KISA and NON-KISA employment-shares
Source: Statistics Netherlands, NACE_72_73_74_details

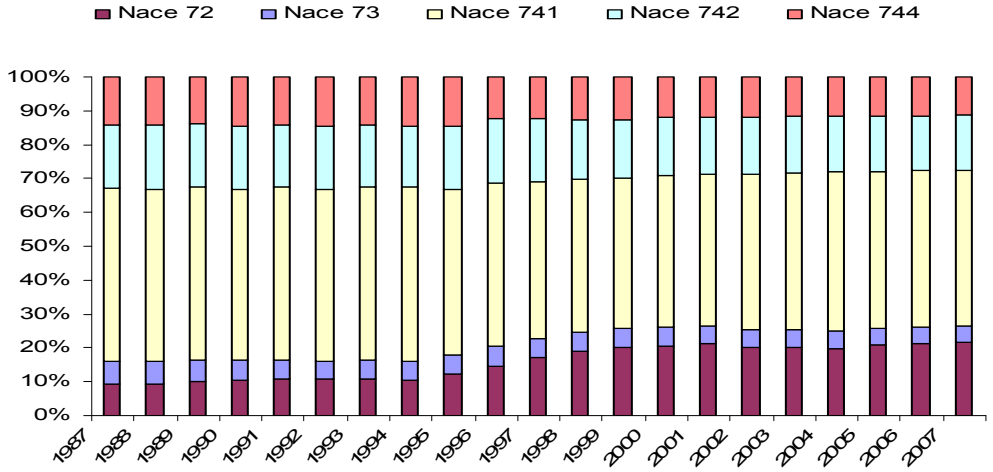


Figure 10.8 Composition of direct KISA service in % of total
Source: Statistics Netherlands, NACE_72_73_74_details

Direct KISA employment increased by more than 4% annually especially in Computer services etc. (NACE 72) (8.7% growth p.a.) and there reached a share of 21.7% from 9.2% in 1987(see figure 10.8). However, the bulk of direct KISA employment is located in legal and accounting activities (NACE 741) and this share declined from 51.2% to 46%. The shares of advertising and market research employment (NACE 744) and architects and engineers (NACE 742) show similar declines (to 11.1% from 14.2% and to 16.3% from 18.6%).

10.4.1 Scenario Outcomes

However important KISA's may be thought, or even defined, to be, it is still undeniably the case that direct KISA employment is very limited in size in the Netherlands (i.e. of the order of just a few percent. That goes for RND-labour *a fortiori*. This means that scenario X1 can only have fairly limited effects, as only little resources will be freed. Scenario X2 may be expected to have a larger impact *a priori*. However, one should realise that in scenario X2 only the flows on the labour market that were constrained by the limited willingness to move of labour, will be

affected, and one could therefore expect that adjustment through inter-sectoral mobility would generally be quicker. One should realise, however, that quicker adjustment in R&D flows may, however, have permanent effects, as even a one-time shock in R&D will permanently raise the level of TFP.

TFP-Growth

The outcomes for TFP-growth in the Base Run (labelled X0 in the Figures to follow) have been plotted in Figure 10.9. We see that the R&D sector itself (labelled KGG) does not experience any TFP-growth, which makes sense, as TFP-growth itself is knowledge intensive, and replacing knowledge workers by TFP would seem to amount to a bootstrapping operation. Ultimately, the knowledge has to come from someplace real. However, the KGS sector does show TFP-growth, while the same goes for the industrial sector and for other services. We also see that from year 5, the OSR sector gains in importance, while the IND looses some of its momentum. Aggregate TFP-growth is increasing over the years from about 1.1 percentage points per year to 1.5 percentage points after 10 years of simulation. The government sector (GVT) and the primary sector (PRM) both show moderate TFP-growth rates that are even falling in the case of GVT.

In Figure 10.10 we have plotted the percentage point differences between scenario X1 and X0. The differences in TFP-growth with respect to the base run are 0.5 percentage points for the KIBS sectors and far less for the user sectors. Note too that the reallocation of labour resources mentioned above is going on for some time, before some noticeable second order reallocations in RND resources occur. In fact, it is these reallocations in the total factor that improve the return to RND in the OSR sector, leading to a decrease in RND activity in IND, while activity in the other sectors remains largely unchanged. Note too that this induced reallocation between OSR and IND structurally raises the aggregate growth rate of TFP, even though by only a few hundreds of a percentage point. Note also that the difference between both scenarios in terms of TFP-growth show a tendency to disappear

In Figure 10.11 we show the percentage point differences between X2 and X0. It should be noted that while the general reallocation pattern between sectors is similar to that in Figure 10.10 there is also a striking difference in that before year 5 TFP-growth in OSR is actually positively affected, while that of IND is slightly negatively affected. Both impacts change in sign from year 5 though. Another striking feature is that better labour market flexibility tends to disfavour TFP-growth in the KISA support sector KGS, but also the GVT sector and IND in the medium and long run.

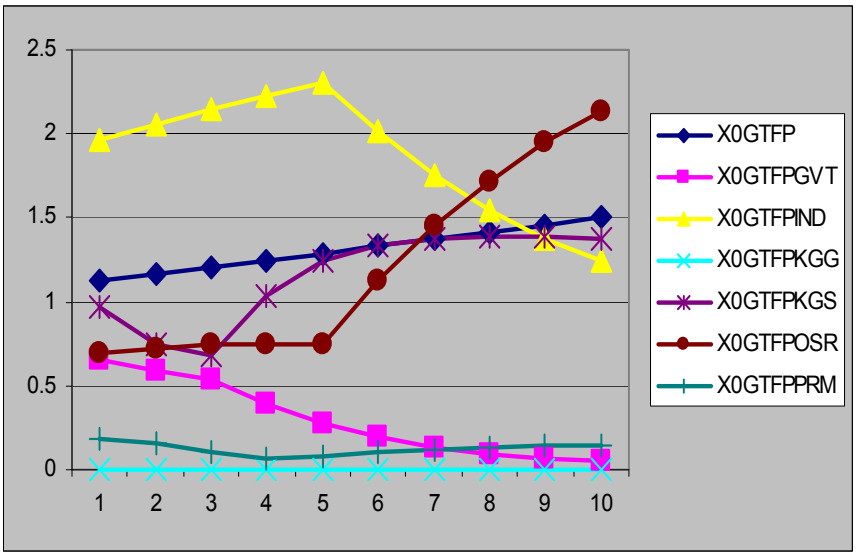


Figure 10.9 TFP-Growth in the Base Run

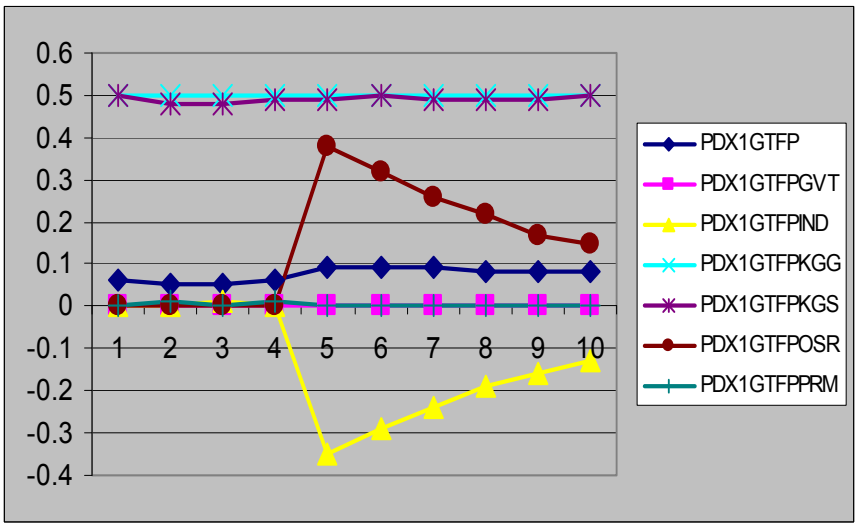


Figure 10.10 Percentage Point Differences X1-X0

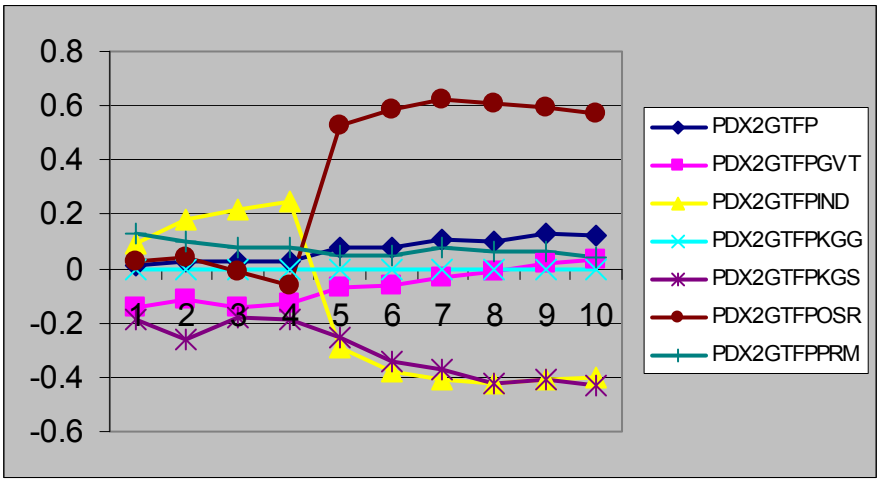


Figure 10.11 Percentage Point Differences X2-X0

In Figure 10.12, we show the outcomes of X3. As expected, only very little second order reallocations of resources take place, as the impact of 0.5 percentage extra TFP-growth in all sectors at the same time in X3 does not fundamentally alter reallocation incentives in that sector, even though labour resources are freed up to the same proportional extent everywhere. We see, however, that some marginal reallocation does take place, as aggregate TFP-growth is 0.01-0.02 percentage point above the 0.5 percentage point economy-wide shock that we have applied. In particular some reallocation is taking place between PRM and KGS, while the other sectors remain unaffected. This is a nice illustration of the tendency of the model to allocate resources to first best uses first and then to use second best alternatives if the first best uses are exhausted.

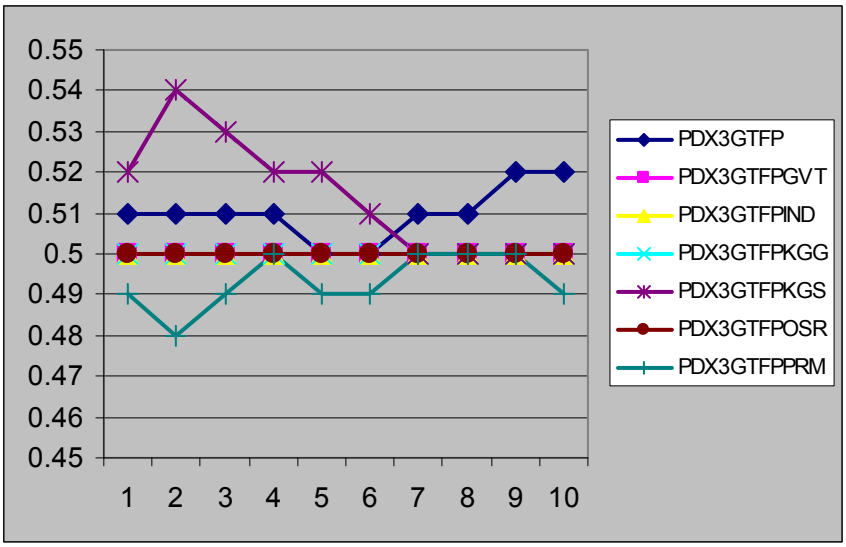


Figure 10.12 Percentage Point Differences X3-X0

Value Added

The corresponding outcomes for value added are depicted in Figures 10.13 – 10.15. Figure 10.13 contains the distribution of value added over the sectors in X0 and X1. We see that this distribution changes only slightly. Moreover, even though the OSR sector experiences a significant increase in TFP-growth from time 5 in X1, its share in value added drops slightly below the base run. This is consistent with the reduction in the total factor that is enabled by TFP-growth and that 'earns' the value added. The same holds for IND, *mutatis mutandis*.

Labour mobility in the 'local concentration' scenario provides much more diverse results, but as with TFP-growth, the overall pattern is similar to that of TFP-growth (cf. Figure 10.11). We see that the only consistent 'winner' is the KGS-sector in this case, since its share in value added rises by about half a percentage point, i.e. by almost 10 percent of its level in the base run.

The X3 outcomes are shown in Figure 10.15. We see that in the absence of any serious reallocation incentives, the OSR sector has a tendency to grow larger while the other sectors grow smaller in terms of their contribution to value added. Still, the differences between the base run and the experimental run are at most 2 percentage points over a period of 10 years (for the OSR sector).

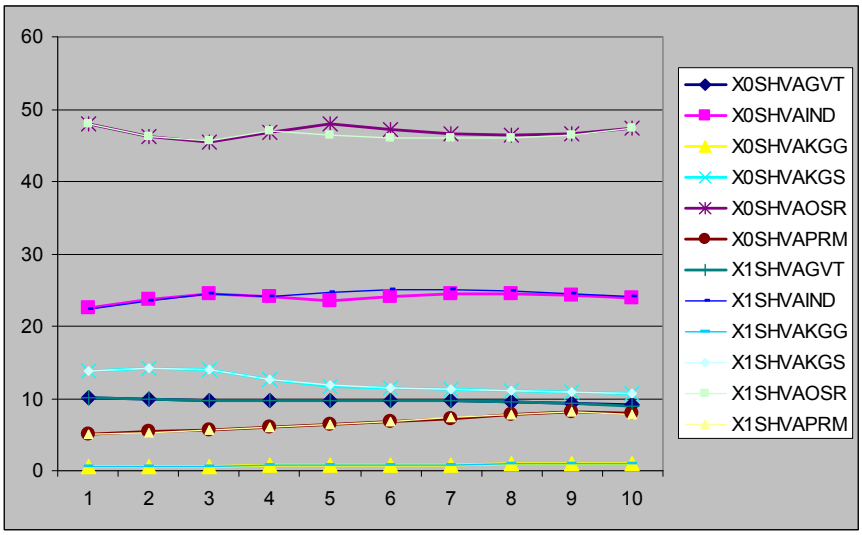


Figure 10.13 Value Added Distribution X0 and X1

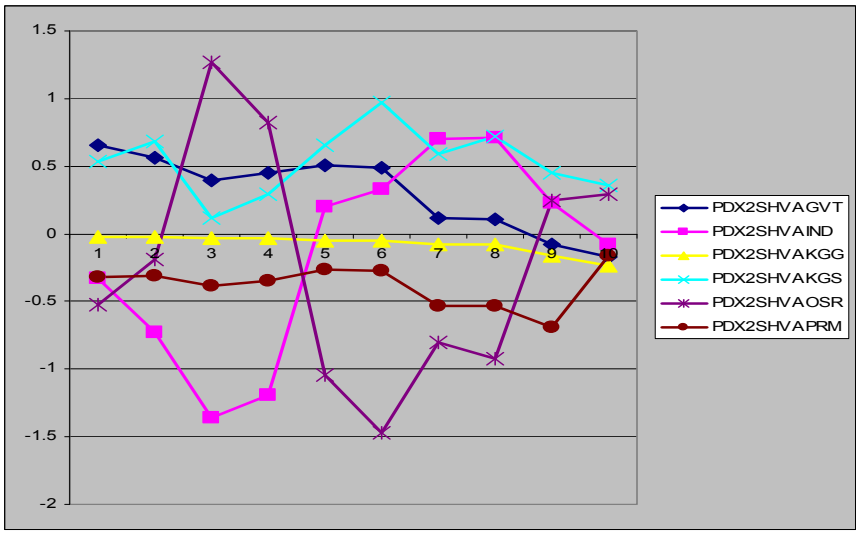


Figure 10.14 Percentage Point Diff. Value Added Distribution X2-X0

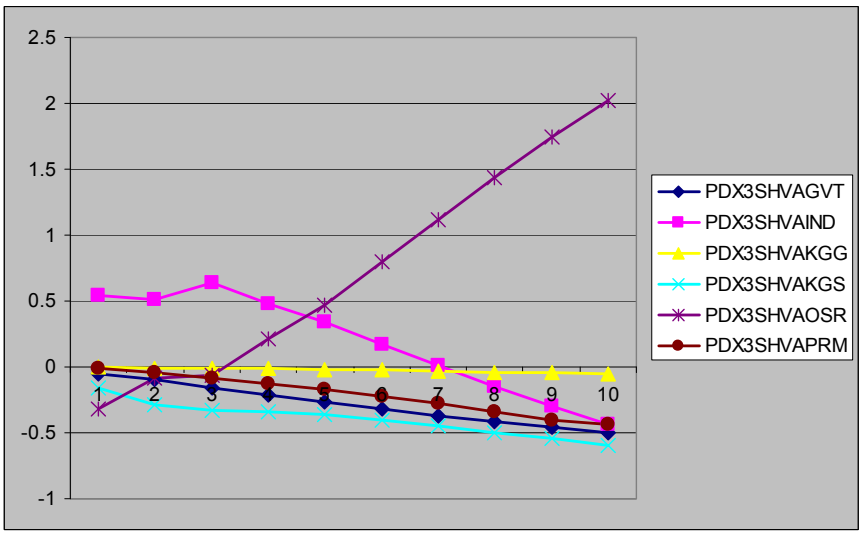


Figure 10.15 Percentage Point Diff. Value Added Distribution X3-X0

Total Factor

In Figure 10.16 we show the impact of the various experiments on the percentage deviation of the total factor by sector relative to the base run. We see that in X1, the total factor in KGS and KGG fall by roughly as much as TFP-growth has exogenously risen (0.5 percentage point per year), and the IND and OSR sector both gain. But in X3 OSR gains, while IND first gains and then looses. Apparently, if there are more resources to redistribute, the initial productivity differences between IND and OSR are blown up, and the self-reinforcing cycle of TFP-growth inducing TF adjustments that in turn induce TFP-growth changes, etcetera, favours the OSR sector over the IND sector.

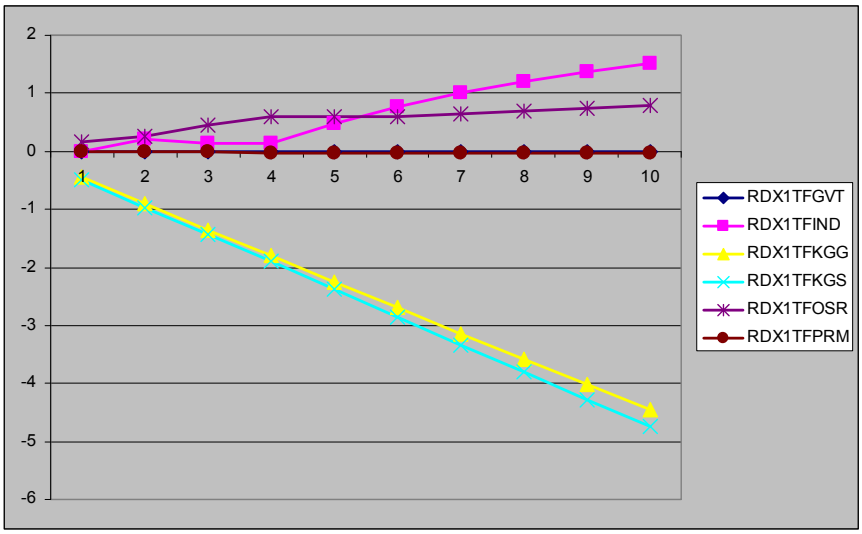


Fig 10.16 % Relative Differences X1/X0 Total Factor

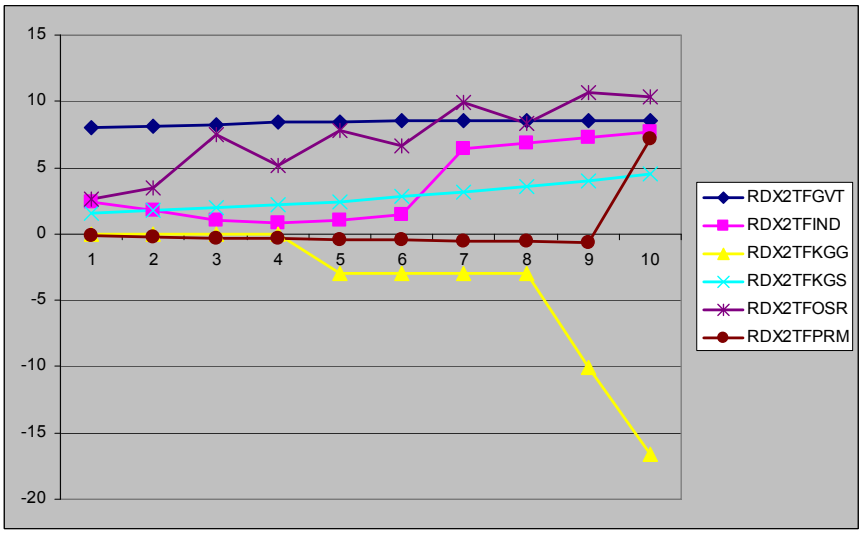


Fig 10.17 % Relative Differences X2/X0 Total Factor

In experiment X2, we see that increased labour mobility would draw away resources from KGG in particular, made possible by a drop in deliveries to final demand by the KGG sector, and therefore to the direct contribution of KGG to total value added. Instead, the KGG sector contributes more through intermediate deliveries that generate growth in the user sectors. Also note that increased labour mobility allows the total factor to increase by a significant amount in almost all sectors, rising from a

few percent in the beginning of the simulation to in between 5 and 10 percent at the end of the simulation.

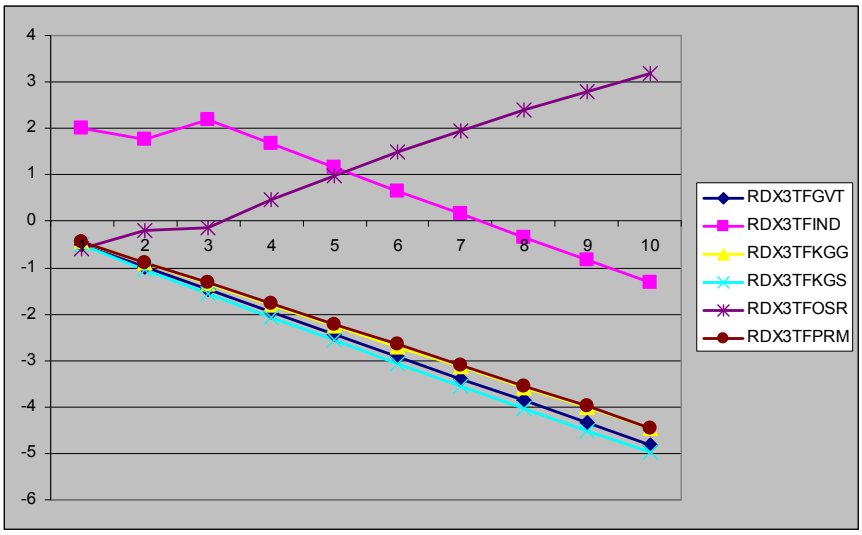


Fig 10.18 % Relative Differences X3/X0 Total Factor

The Unemployment Rate

In Figure 10.19, we show the corresponding results for the unemployment rate, measured in percentage points. URATEPTOT is the total unemployment rate of production workers, while URATERTOT is the total unemployment rate for RND workers.

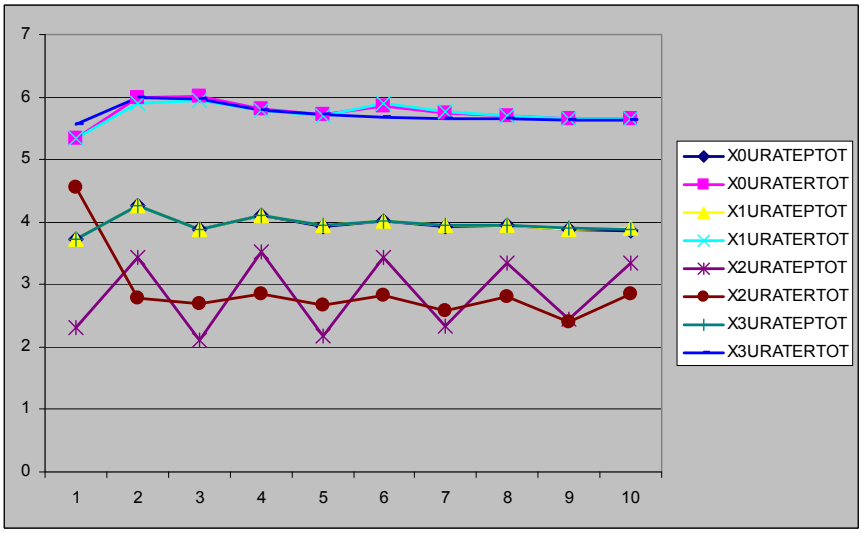


Figure 10.19 Unemployment rates X0-X3

Figure 10.19 nicely illustrates the working of the model. First it should be noted that the rate of unemployment for RND workers in the base run is above that of production workers. From a modelling perspective, this is due to the fact that RND workers have fewer employment options than production workers. This is because RND workers always have to work in fixed proportions with other RND workers, while production workers can be substituted against other workers, because of the use of the Cob-Douglas production function, which is common practice in growth settings.

It is only when we perform experiment X2 that the unemployment rates of RND and production workers are on average equally low, but we see that lowering the rate of unemployment by increasing labour mobility does indeed introduce a relatively outspoken cyclical component in both unemployment rates due to 'overshooting' relative to our a priori notion of a smooth development in unemployment rates. Also note that the amplitude of the cycles grow smaller over time in case of production workers, and seems to be increasing over time while both cycles seem to be in phase. This seems to corroborates our a priori assessment of cyclical growth in connection with the simultaneous complementarity (same phase) and substitutability (counter-moving amplitudes) of the cycles. In experiment X3 we see little change in the unemployment rate relative to X1, a phenomenon we have seen before.

The Sectoral Distribution of In-house R&D

In Figures 10.20 – 10.22 we show what happens with relative R&D activity in all sectors of industry except for the KGG and PRM sector in which nothing really happens. We see that the pattern of R&D activity in the base run X0 closely resembles that of the pattern of TFP-growth shown above. This is to be expected as TFP-growth is proportional to both KGS and KGG deliveries as well as in-house R&D activity, by construction. But what is striking in the Figure is that in X1 the general pattern of change over time is still the same, only the moment at which fundamental changes take place is brought forward in time. For example, the trade-off between TFP-growth in OSR and in IND becomes clearly visible in period 4 in X1 rather than in period 5 in X0. However, we see that both in X0 and X1 there is still a tendency for the R&D distribution to converge to the same values over time. So freeing up labour resources, even though they amount to relatively little in X1, still allows the economy to make the optimising switch from industrial activity towards NON KISA service activities a bit earlier than before.

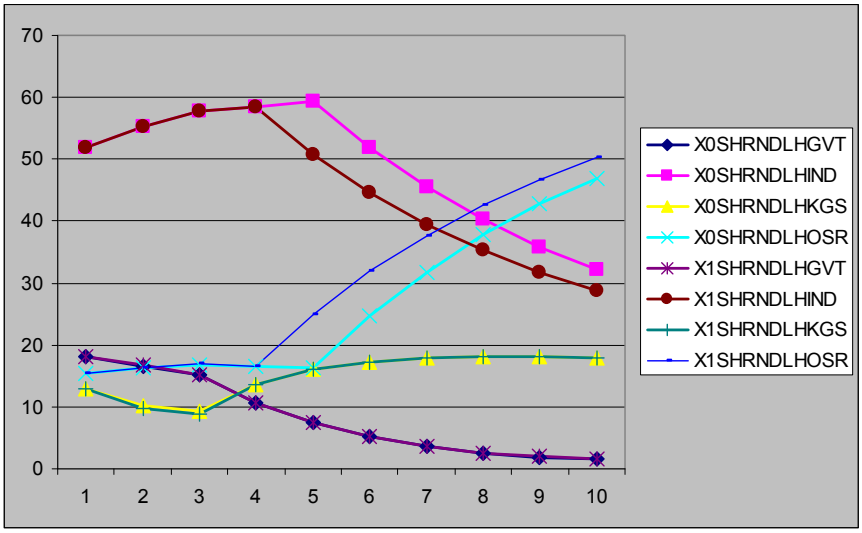


Figure 10.20 In-house R&D-labour distribution X1-X0

The same observations apply, *mutatis mutandis*, to experiment X2. Here too we see that the switch from IND to OSR comes a year earlier. In addition to this we see that the initial distribution is 'blown' up to some extent: large sectors having become larger and smaller sectors smaller still. This is in line with the fact that a more flexible labour force, including the R&D labour force, allows an economy to specialise more fully on its comparative advantage, i.e. initially on IND activities and later on in OSR

activities. Nonetheless, the switch in revealed comparative advantage remains the same; it is still OSR that takes over from IND and not some other sector.

Finally, we show the results of experiment X3. It should be stressed here that the results are not identically the same as in X0, even though Figure 10.22 seems to indicate this. Deviations are there, but they are very small indeed. This is because the extra TFP-growth has been implemented as an extra exogenous addition to TFP-growth, rather than a shock in R&D productivity itself.

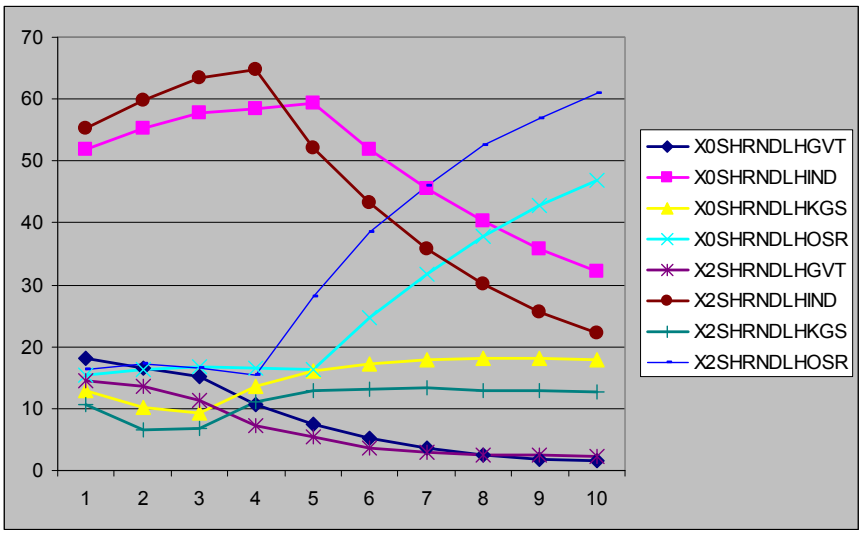


Figure 10.21 In-house R&D-labour distribution X2-X0

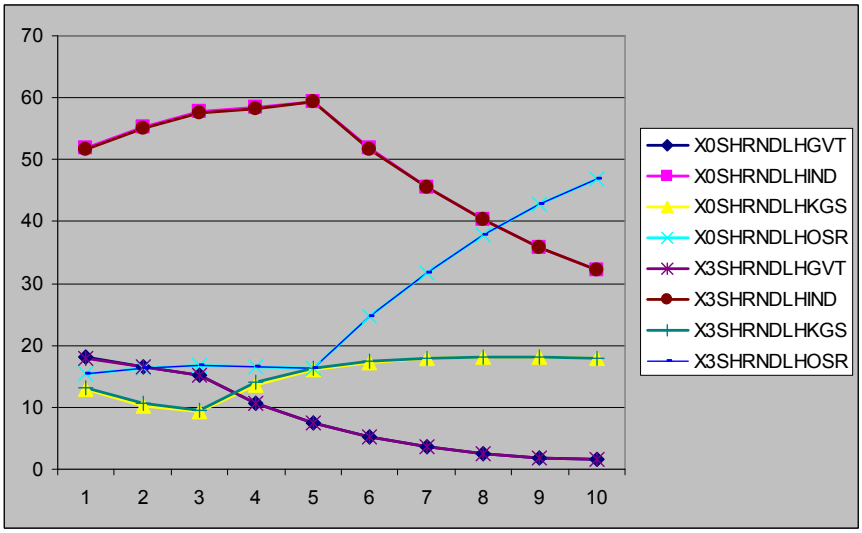


Figure 10.22 In-house R&D-labour distribution X3-X0

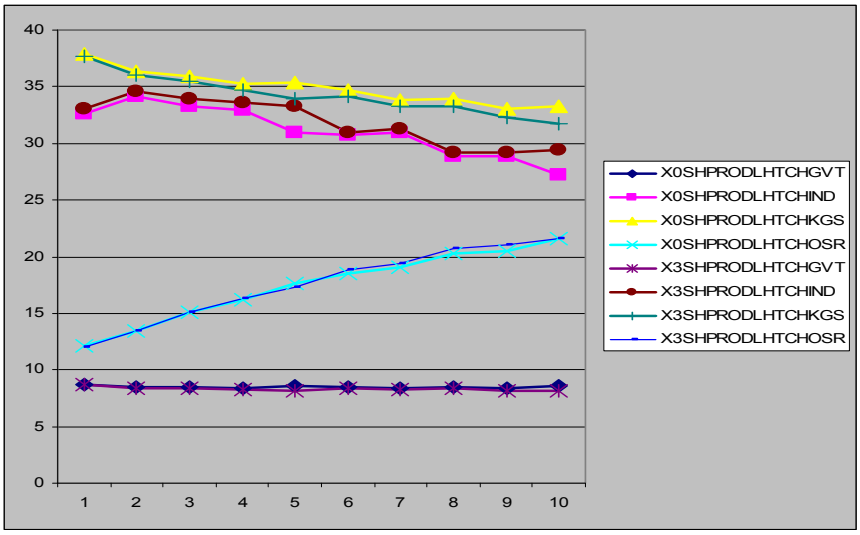


Figure 10.23 Sectoral Distribution High Technical Jobs X3-X0

This leaves the marginal benefits of doing R&D unchanged, and consequently nothing much happens in the allocation of in-house R&D workers. This is not the case with production workers, though, although here too the differences are small, as can be seen in Figure 10.23 in which we depict changes in the sectoral distribution of higher technical jobs over the most important sectors.

Labour Market Flows

Finally, we show some graphs to illustrate the flows of labour over the labour market measured in absolute values. We depict inflows into and outflows out of a sector of production labour by educational level from and to employment and unemployment, i.e. flows of people already on the labour market, and therefore involved in re-allocations. We will show just a few of these flows for illustration purposes, and only for experiment X1 for the sectors that are most seriously affected, i.e. IND, OSR and KGS.

In Figure 10.24 we show how indeed the jump in TFP-growth for OSR corresponds with an inflow of R&D workers. Indeed in X1 that inflow comes one period earlier than in X0. The counterpart of inflows into these sectors is outflows out of these sectors. These are depicted in Figure 10.25.

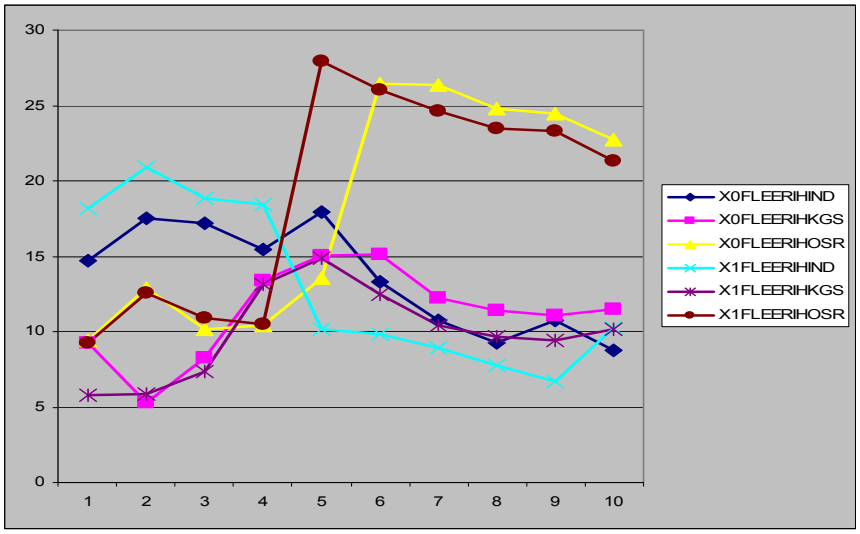


Figure 10.24 Inflows of In-House R&D Workers X1-X0

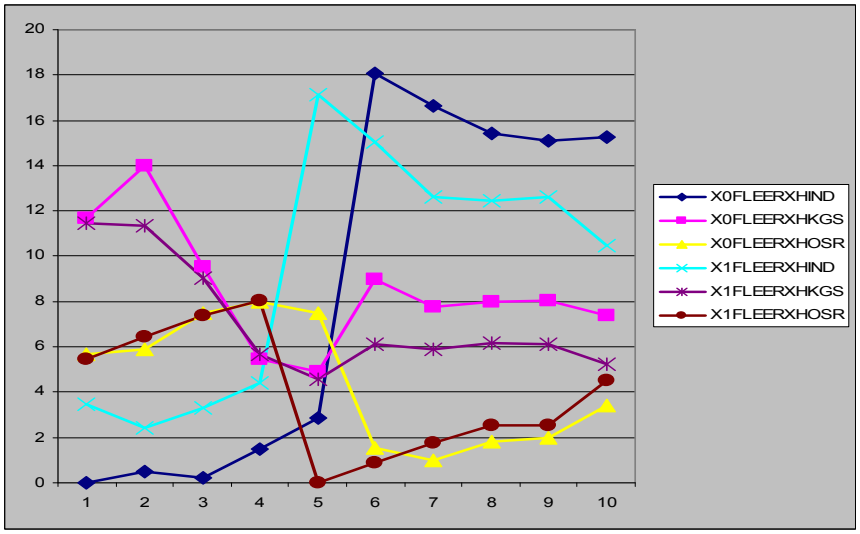


Figure 10.25 Outflows of In-House R&D Workers X1-X0

We see that low inflows in Figure 10.24 are associated with high outflows in Figure 10.25 and the other way around, as expected. In fact, in Figure 10.25 we see that outflows out of OSR in X1 hit the horizontal, while inflows hit their maximum value at the same time. Thus growth becomes limited indeed by the inflow into OSR from other sources.

This illustrates the potential value added of using a labour market flow system as we have done. We are able to identify which sectors are hurt by the lack of growth generating resources. In our case not just by scanning the graphs of all the labour market flows, but more conveniently by studying the system of shadow prices that is associated with a linear programming system as KISAMOD is. Because of time- and money constraints, we have not been able to make any positive use of this feature of the model yet.

10.5 Concluding Remarks

In this section we have shown the outcomes of our simulations with KISAMOD. We have run two scenarios: the 'cartelisation' and the 'local concentration' scenarios. We have shown how TFP-growth leads to the release of resources in the short run, since for a given level of output, TFP-growth coincides with negative input growth. These inputs are therefore released by the sectors experiencing TFP-growth, and they are consequently available for use elsewhere. However, we have also shown that TFP-growth raises the marginal product of the total factor itself, thus increasing the incentive to allocate more of the sectors that experience TFP-growth. In the same way, a larger total factor increases the marginal product of R&D resources geared at raising TFP in that sector. Thus TFP- and TF-growth become complements even though they are substitutes from a technical point of view.

The scenario-analysis shows the value added of the KISAMOD-system in that it provides a general equilibrium perspective on TFP-growth as opposed to the usual partial equilibrium TFP-growth measurement exercises one usually encounters. The general equilibrium perspective underlines the notion that the resources that generate growth have alternative uses, and that the generation of growth in the one sector goes at the expense of growth in another sector. Also, the realisation of a growth potential provided by TFP-growth takes time, and ordinary resources like production labour and capital. It takes time because these ordinary resources are not instantaneously available at the spots where their return would be highest. Indeed, people are sometimes reluctant to move towards new jobs, thus implying the existence of labour market rigidities that would reduce the return to investment in R&D, and hence would therefore tend to spill-over into research rigidities as well. Removal of such labour market rigidities results in extra growth and lower unemployment on average, as we have seen in experiment X2. It also adds a definite cyclical component to our unemployment and labour market flow outcomes. This might actually be true (we do not have any real data on disaggregated labour market flows, so we can't check this), or the alternative is to change the model set-up into one in which we would allow the central planner to have perfect foresight, and thus avoid instances of temporary overshooting. The cost of doing this is that the model becomes enormously more simultaneous (namely also simultaneous over the time dimension), and consequently future integration of several country-models for the EU25 become significantly more complicated.

10.5. 1 Conclusion

In this section we have described the construction of a model that integrates insights coming from new growth theory about R&D as the source of growth, and the role of KISA's, whether produced in-house or obtained from an outside sector in the growth process. R&D itself is a KISA, and as such the increased consumption of KISA's may be expected to be a direct indicator of productivity growth, or at least productivity growth waiting to happen. In our model, we distinguish between different sectors of industry: those that are KISA producing (and therefore are KIBS-sectors) and those that are KISA using (but also in-house KISA producing). We model these intersectoral relations using a modified standard input-output framework, with two main modifications. The first modification is that the use of outside KISA's (i.e. usually registered as intermediate consumption by the user sector) is treated differently from other intermediate consumption items. The reason for this is that the knowledge embodied in these KISA services does not vanish when it has been consumed (that is to say, obtained and paid for). In fact, if the KISA-consumption refers to obtaining a 'blueprint' for a new product, that blueprint can be used time and

again, without having to pay for its future use again and again. This underlines the special role that knowledge accumulation plays in the growth process. Hence KISA consumption is not like ordinary intermediate consumption. Rather, its consumption level depends on the growth rate that KISA users desire to achieve, and consequently we have implemented KISA consumption as an explicit decision variable in our model that drives potential TFP-growth in the user-sectors on the one hand, and that requires R&D resources as well as the use of complementary KISA support services to realise that growth potential. Growth in output implies growth in intermediate consumption, and hence differential growth rates imply reallocations of primary inputs among the different sectors of industry. This is not a problem if all markets would be completely flexible, but in reality that is hardly the case. First, fixed capital is sector specific and hence hardly mobile between sectors (apart from generic machines like computers, etc.). But secondly, labour used in the one sector is not immediately suited to be used in another. Thus, growth is limited to the extent that sectors are able to flexibly interchange their inputs. These adjustment problems are routinely ignored in partial equilibrium TFP-growth exercises.

To take these adjustment problems into account, we have added a labour market flow system to our amended input-output model that serves to link the sectoral demand for labour distinguished by job-level and job-type to available sectoral supply of labour by level of educational attainment. This flow system describes the available supply of labour by sector in function of the various pools present in the model, and the flows between them. The pools present are those of employed people, and unemployed people, as well as the working population at large and the permanent exit pool. Available supply by sector is then by definition previous employment plus inflows less outflows. Inflows come from new entries, other sectors or unemployment. Outflows are into employment in other sectors, unemployment or exit. The employment pools by sector and by skill are then used to meet the demand for these skills as implied by the demand distinguished by job-type and job-level. We have devised a special procedure to be able to obtain the matching scheme that translates employment by skill into corresponding employment by job.

We have added a separate labour market module for R&D labour, as it is principally different from ordinary production labour, and as it is numerically small relative to production labour employment (presently of the order of 1-2 percent). A similar labour market flow system has been devised for the R&D labour market. In combination with our assumption that the consumption of KISA services requires complementary in-house R&D activity and that TFP-growth in turn depends on the level of KISA consumption, the mobility of R&D labour becomes an important factor in determining sectoral TFP-growth rates. This also pertains to the mobility of production labour, as sectoral TFP and the size of the total factor multiply each-other to get sectoral output. This means that a higher level of output will raise the return to future R&D, but also that a higher level of TFP-growth, raises the return to the total factor and hence the underlying primary inputs. TFP-growth and ordinary TF-growth therefore go hand-in-hand, implying that production labour market inflexibilities are not to be ignored in the design of policies aimed at improving growth performance.

The model is implemented using Dutch data for 6 sectors of industry, 12 occupations and for 3 different skill levels. These dimensions are chosen for two reasons: data availability and technical model manageability. As regards data availability, we have chosen to take a potential extension towards the EU25 into account from the outset, and therefore we have employed databases that are available for (almost) all member states of the EU. The dimensions with respect to occupations and skill levels cannot easily be extended because of limited data availability. The number of sectors

can be extended, however, towards, for instance, 16 sectors of industry as we have done initially, but because of time- and money constraints we have had to reduce this number to 6 here to keep the model manageable in practical terms. With more time and resources available, and given the experience gained with the demonstration model, an extension in the number of sectors of industry seems both possible and desirable. This would greatly enhance the insights one can obtain from the model in terms of sectoral detail but also in terms of the interactions between sectors.

The parameters of the model are calibrated so as to roughly reproduce the Dutch economy in terms of output and (un-)employment over the period 2000-2009. These model outcomes are subsequently used as the base run that functions as the frame of reference for a comparison with the outcomes of a number of scenario simulations.

To demonstrate the working of the model and to be broadly in line with the other sub-trajectories of the project, we have compiled two scenarios: the 'cartelisation' and the 'local concentration' scenarios. The cartelisation scenario is based on the view that knowledge based firms are predominantly organised in cartels which are collections of suppliers along the value chain and which are dominated by the ability of the cartel leader to sell the products which bear its brand. In such a scenario the highly focussed knowledge intensive firms exhibit high labour productivity and therefore (other things being equal) employment will gradual decline in the direct KISA jobs. More focussed and more effective services will on the other hand lead to a more competitive position in intensive KISA using sectors. Moreover, firms in a cartelised world are bigger and have deeper pockets, reducing for them the negative productivity growth effects of indivisibilities in research. Consequently, they themselves are more productive, and the users of their products/services are too.

The local concentration scenario is based on the notion of external economies of scale. The main idea is that such local concentrations reduce information costs, and enable the pooling of scarce labour resources, resulting in a more efficient use of these labour resources, and correspondingly higher labour mobility between firms within sectors as well as sectors that are relatively close together.

One of the main characteristics of the model is the formalisation of the notion of scarce resources with a special focus on KISA based labour. If resources are released in one sector they become available to other sectors. However, the actual migration of workers from one sector to another depends on the relative importance of the sectors in terms of the extra value added of more workers and on the possibility and willingness of workers to migrate from the one sector to another. In the cartel scenario we have shown how growth in total factor productivity, growth in technology, leads to the release of resources in the short run since in such situation less inputs are needed for a given level of output. This gives rise to (short term) reallocations of labour and/or (short term) unemployment due to technological change. The inputs that are released by those sectors experiencing growth in technology are subsequently available for use elsewhere or become temporarily unemployed. However, we have also shown that growth in total factor productivity in a sector raises the marginal product of input factors, thus increasing the incentive to allocate more inputs to those sectors that experience growth and thus to increase output of these sectors, relative to other sectors of industry. In this way the scenario-analysis shows the value added of the model in that it provides a general equilibrium perspective on growth of total factor productivity as opposed to the usual partial equilibrium growth measurement exercises. Also, the realisation of a growth potential provided by technological change takes not only time but also resources like production labour and capital. It takes time because these non-KISA resources are

generally not instantaneously available at the spots where their return would be highest.

The local concentration scenario highlights the consequences of removing labour market rigidities. These rigidities enter the model because workers have sector specific experience and are only perfect substitutes for other workers in as far as these are faced with the same technologies and have the same kind of experience as a result. Workers may also be reluctant to switch to another sector of industry, because of private adjustment costs. Removal of such labour market rigidities results in extra growth and lower unemployment on average, as we have seen in the local concentration experiment.

The model thus clearly underlines the importance of the interaction between labour market allocations and growth potentials, but it also highlights the importance of KISA workers and non-KISA workers. R&D can be performed either in-house or by the R&D sector, but both types of activities are essentially competing for the same labour resources. We illustrated the potential value added of using a labour market flow system and we are able to identify which sectors are affected by the lack of growth generating resources. In principle the model comes with a full set of shadow-prices, even though we haven't presented them here. These shadow prices indicate how big the increase in the objective function would be (in our case net output) for an increase by one unit of a limiting resource. High shadow prices thus indicate important bottlenecks in generating additional output, i.e. growth. Thus, the shadow-price system generates valuable policy information regarding the existence or future occurrence of bottlenecks, and the maximum cost of potential policy measures geared at the alleviation of these bottlenecks. However, for now, we must leave the implementation of this shadow-price system for the future.

11. Challenges for research & practice

11.1 Manchester Workshop: Needs for Further Work

Members of the workshop were asked, in the final stages of the Manchester meeting, to consider the implications of the scenario discussions for:

Research (what do we need to know about KISAs, knowledge, etc.? What sorts of research might be needed?)

Policy (regulations, cluster development, innovation policy, etc.)?

Training and education (what skills are required, what sorts of training is appropriate?)

Managers (what do KISA and KISA users need to consider and do?)

After a brainstorming session, in which a very large number of items were entered into the groupware system, and a brief discussion of the themes that arose, we again undertook a series of voting exercises designed to see to what extent there were shared views as to the most important issues under each of these headings. The results are summarised below.

11.1.2 Research

Some 25 suggestions were made for areas that research should concentrate on. In order of the votes they received in an exercise using the groupware, the top eleven of these (receiving more than a quarter of the votes each, and in order of the votes cast) were:

The nature of labour relations in KIBS

We still need a more fine-grained typology of KIBS/KISA (preferably non-sectoral)

Research into new transaction systems that are congruent with the new business models that are emerging outside the existing payment, credit, accounting frameworks.

Organization of work (labour relations) inside firms building global (European) network

Research on the impact of KISA on employability of HR; differentiated by SMEs and big firms.

What are the dynamics of existing KISAs and how are these evolving/co-evolving with policy and technology?

Significant research in the development of the semantic web, folksonomies and trust.

Traditional location choice theories need to incorporate socio-cultural elements because they become more and more important

Type of KISA that are more related to innovation; e.g. routine KISA or network KISA.

Research into new networks/clusters of KISA

Research on "business cycles" in the KIBS sector. How do KISAs transform from customized to standardized? Which are the relevant conditions for standardization? What are the impacts?

11.1.3 Policy

Some 17 policy proposals and issues were suggested in the brainstorming. In the voting exercise, the following 8 emerged as most important (in order of votes, all those with more than a quarter of participants casting a vote for the topic):

Protection of privacy/private data policy
Policies that facilitate the use and co-production of KISA as an informal (possible non-commercial) process.
more flexible arrangement for labour market in service sector
We need to educate and train innovation policy makers on the role of KIBS and KISA in innovation networks
We need the recognition that KIBS may play an important role in diffusing knowledge in innovation systems
Reducing barriers to entry
What are the implications of offshoring on trust and security when networks of KIBS may involve transferring personal and other sensitive data amongst many links in a network?
Promote awareness of KISA in traditional industry sectors and among HR departments in big firms and business owners in SMEs.

11.1.4 Training and education

Out of 18 items resulting from the brainstorming, the participants of the Manchester workshop voted that the top 7 points about needs for skills and training appropriate for the future KISAs (these are those items receiving more than a quarter of the participants' votes) are:

More hybrid skills will be needed in the future, various forms of learning (by doing, by interacting etc) will gain importance, as customised KISAs will always be very important
Flexibility in training, e.g. off the job training, informal training needs to be recognised in the qualification systems to guarantee higher participation in KISA, especially in SMEs.
New e-skills (semantic web, networking, etc.)
More creative and personalized education
Training for "T-shaped" specialists, i.e. deep knowledge in one discipline, but able and knowledgeable enough to cooperate with other disciplines.
The diffusion of KISA is in many ways dependent on the capacity of people to invent, co-create and refine the services that help to define who they are (identity) and their quality of life. These are not "techno" or credentialed "skills" but subjective learning-by-doing wisdom that depends on experimentation that entails both success and failure.
Emphasis on ways of developing autonomous learning

11.1.5 Managers

In this final task, there were acute time pressures being felt. Probably due to this, only 13 suggestions were captured here. 7 of these were voted for by more than a quarter of the participants, and these are reproduced below as indicating messages which received strong endorsement from the workshop. They include several topics for research, and several where training or strategy need to be developed:

Managing networks (not only organisation and people, but also resources, data, etc.)
Virtual management
Broader appreciation of context especially at sector boundaries
Develop capacity for faster adoption of new technologies
Managers must devolve more and develop high trust relationships with their knowledge workers

Smarter forms of knowledge management as not to reinvent the wheel too often

How to develop and implement labour retention strategies

11.2 Amsterdam Workshop: Future Research Needs

11.2.1 Areas of Uncertainty

At the end of the second workshop, a brainstorming exercise generated suggestions for critical areas of, and approaches to, research in the area. The brainstorming was accomplished through writing notes onto post-its, and the notes below are based on these workshops (together with some notes from the ensuing discussion). We have grouped these under a set of headings, as indicated in the table below. (In some cases, where multiple points were put onto a post-it: these may have been separated leaving some elements appearing rather disconnected. Please accept apologies for any misunderstandings as to what was meant by specific points, and please feel free to suggest alternative ways of grouping the points. We have retained the original formulation of these points, except for some tidying of spelling, etc. Some points fall under more than one heading; these are asterisked.)

Following the listing of topics in this table, we go on to present a more discursive account of these suggestions and comments. This involves a degree of reflection on the ideas as listed, and may not completely capture the underpinning concepts and frameworks being used, so further insights were requested from participants in an email version of these notes. We asked readers to respond to these ideas, by suggesting more specific points for research, specific areas of importance where research might be able to reduce uncertainty and inform policy and practice. At the moment of writing, feedback from this request has only been provided by a few people, and will thus not be explored further in the present note. Box 11.1 lists the suggestions made by participants:

Box 11.1 Future Directions for Work, captured in the Amsterdam Workshop

Research approaches:
Deep case study research Use anthropological approaches to services research Combining macroeconomic research with qualitative methods More interdisciplinary and international services research Organising new topics in Virtual Networks * Building up centres for service excellence (Regional Concentration scenario)* Research along value chain including different actors/companies Require detailed and deep case studies of different types of KIBS firms to gain empirical knowledge about what skills, knowledge, etc. are used in different jobs (& occupations) Top 3 occupational codes are too limited to describe knowledge intensive activities – need research how to correct this In order to establish the implications of the shift towards knowledge intensive service activities on skills elements, profiles and emerging skills need to have more clarity about how the nature of work is changing, what people are actually doing in their jobs, specific tasks and characteristics of knowledge work Measurement of activities in KISA by tracking employees' use of time instead of numbers of jobs*
Understanding KISA
Need for intra-disciplinary *(?? we think this is a misreading of "interdisciplinary")* research on how KISA providers interact with customers in B2B relations and with policy makers Relation between business models and skill profiles * Need to look at behaviour of inactive firms and their skill requirements International developments in competences due to path dependency developments – cultural difference –

levels of development

Skills Profiling

Evolution of skills profiles in closed innovation cartels versus those in open innovation systems (methods: map skill sets through user surveys: map trends by iterating user surveys) – testing hypothesis that closed innovation systems evolve towards open systems – more permeable boundaries - skills profile converge

Competence mapping in KISA using competence framework (to be developed)and examine compatibility with any EU developments and global*

Allocation schemes of KISA competences to skills (by type/skill level)and jobs – use LP methods to minimise a priori misallocation of high skilled hours to low skilled jobs

Identify the most important competence maps in KISA for the purposes of innovation and renewal

Relation between business models and skill profiles *

Change in KISA

Effect of user-producer trends on KISA activities/skills (method large user surveys)

Find out whether growth or shrinkage of sectors of KIBS and KISA can be directly correlated with cyclical or long term growth patterns

Analysis of how consultancies grow by diversifying their product range, selling new services to existing clients, whether skills mix is the same as in stand-alone businesses in these sectors

How quickly are new needs arising from regulation (safety, ecology, worker rights, consumer rights) absorbed into "normal" firm activities and how does this affect short-run need for consultancy and special agencies

What are the KISA needs which would result if government policy on generating entrepreneurial skills and new small business growth take effect?

Explore baseline of ICT skills – do they evolve quickly – does the 2.0 generation have much higher inherent social ICT skills – what does this mean for additional e-skills*

Impact of Web 2.0 techniques and culture on skills and competencies*

New business approaches

Organising new topics in Virtual Networks scenario*

Building up centres for service excellence (Regional Concentration scenario)*

How should teams within KISA be formed in order for them to be more creative

Research the web created platforms that enable KISA provision in open platforms and ownership platforms of firms to identify key skills that actors need: ormer could be done with case studies that enable generalisations on certain dimensions

Research on serendipitous services which provide solutions for unknown problems

Statistical Needs

Overcome statistical divide between manufacturing and services

Collaboration between statistical bureaus about measurement of KISAs (job, task descriptions plus)

Competence mapping in KISA using competence framework (to be developed)and examine compatibility with any EU developments and global*

The core concepts used here for skills and competences are not standardised across Europe nor are they internationally compatible – notwithstanding the work (of for example EQF/NQF, TRACE, ECVET, Euro Occupations, DISCO, e Competence, Euro pass, e-Skills) need to develop ontologies for greater data interoperability - more research on how to progress a core set of agreed common terms and definitions (re competence, skills, attitudes, capability) needed – so that smoother data gradation and semantic associations can be agreed

Measure KISA competence composition of job in difficult sectors of identity [*or probably: "in different sectors of industry"!*]

Measurement of activities in KISA by tracking employees' use of time instead of numbers of jobs*

Track changes in job descriptions by sector over time and implied KISA competence consequences

.

Training and Skill Development

The relation of education and skills needed in KISA in future to identify the most important types of skill shortages and explore how to respond

Skill development and accelerated organisational changes

Development of social and behavioural skills within the educational systems

What are the drivers for people to learn new skills (motivation)

Map skill sets in 16-25 age groups and see whether there is an impending skills revolution (method suggested user surveys)

Explore baseline of ICT skills – do they evolve quickly – does the 2.0 generation have much higher inherent social ICT skills – what does this mean for additional e-skills*

Impact of Web 2.0 techniques and culture on skills and competencies*

How can time waste reduction (this is described as meaning unemployment) be achieved by means of skill diversification (at personal and societal level)

Foresight approaches

More case studies in those KIBS that are considered extremely typical for each scenario

As KISA competences are in part derived demands, scenarios should be specified in broader terms than just KISAs

Not sure how helpful it is to focus on different scenarios and skills profiles, knowledge based activity, its drivers and implications in general need to be further explored: through case studies and collection of primary data. Existing data is too limited and allows only a narrow approach

Explore future of KISA by using weak signals and wild cards for getting out the out-of-the-line development and what-if scenarios

11.2.2 A More Discursive Account

The following section attempts to synthesise the main points flowing from the material listed above. These points have been combined into a more fluid narrative, which has meant attempting to link points together and explicate some of the issues that they jointly raise. We apologise for any misrepresentation, so feel free to comment on, critique, or elaborate these narratives. We have also inserted some further ideas developed in the course of the synthesis of this material and preparation of this report. These are identified as such by statements such as "we can further speculate that…" and the like.

It may also help to put these points into a little context, since they followed a day of fairly detailed discussion of KISA-related issues. One of the main points to be made in the Amsterdam (and the Manchester) workshop was that the KISA concept stresses *activities*. While there are KIBS, and key professions, that specialise in KIS activities, such activities may be performed more widely. For example, a clerical worker may be involved in fairly sophisticated elements of building a website; a service worker may find themselves giving technical support to a client; a builder may be making architectural or engineering decisions. (One interesting question is whether and/or where and when such KISA aspects of other jobs are growing.) Many KIS professionals are liable to find themselves undertaking KISA that are formally associated with other professions, too. If KISA are the focus of analysis then it may be insufficient to focus on KIBS and KIS professions. This, of course, depends upon what sort of study is being undertaken, for what reasons The focus for a study of general workforce skills and training needs is liable to be different from that required for industrial sector or cluster analysis, for example.

Another important point was that we should think about "skill profiles" in addition to thinking about specific skills. People with high levels of competence in engineering, law, and so on are required, and without them all sorts of economic activities will be hindered. But often what is important is the combination of skills that an individual possesses (we *might* also think about such combinations at the workgroup or firm level, but such a combination is quite a different phenomenon). Thus the workshop increasingly discussed the sorts of skill profile – combinations of professional expertise and other skills – required from KISA workers.

Research approaches

The points being stressed here reflected the perceived need for quite fundamental, exploratory research to understand KISA phenomena and develop better concepts and instruments. Case studies were emphasised, including case study work that extends beyond the boundaries of a given organisation to encompass much of a value chain. Interdisciplinarity was also emphasised, together with the need to use insights and methods from disciplines neglected in this context (such as anthropology). Bridging the gaps between disciplines and approaches such as modelling and macrostatistics on one hand, and qualitative and case study work on the other, is a major challenge. This may be confronted by establishing interdisciplinary centres of research excellence into services and KISA, and perhaps

by using virtual networks. The latter can be particularly useful for linking scattered researchers dealing with new themes and topics, and more international links and comparisons are required. (Whether virtual networks, in their present form at least, can really allow bridges to be built across disciplines, is less clear.)

Building on the comments about KISA as activities that were mentioned above, the points were also made that we need better analytic tools than, for example, the top 3 ISCO occupational codes. We need to examine activities themselves and their distribution across work and business processes (perhaps by time budget analysis or similar approaches), and to understand what the specific tasks involved are, what skills are actually being employed, and so on. Additionally, research needs to get to grips with skills that are acquired through social development – and how the baselines for such skills change with changes in household activities and social life, and with policies other than those in education and training (e.g. computer awareness and literacy programmes that are conducted as parts of innovation and diffusion policies). More broadly, returning to the issue of "tacitness". There are issues concerning the acquisition of skills - through practice, through formal training, and through other means. There is a need to understand how these sources of skill and competence creation evolve, and how their practices and results combine.

Understanding KISA

More specifically, a number of particular points of enquiry were discussed, where such approaches would be relevant. These include exploration of the interactions of KISA providers (KIBS and specialists within firms) with their clients, especially business clients (though we might build on work dealing with service-customer relations developed in service management and marketing literatures, and practice, for example). Relations to policymakers were also mentioned as a topic of enquiry – this would seem to be important when considering, for example, the role of KISA in innovation processes which policy may seek to promote, the relevance for training and cluster policy, etc. Each of these topics could be taken up with an international perspective, not least since B2B relations and business-policy relations are liable to differ from country to country. The point was also made that we need to understand international differences in terms of skill profiles, reflecting the history (path dependence) of industry, industry structure, professions and training institutions.

Continuing with the skill theme (which is taken up further below) it was pointed out that we need much better knowledge concerning the relations that exist between business models and skill profiles. (Business models here would presumably include such features as pursuit of core competences and leaner organisations, the use of offshoring, strategies for customer engagement and corporate networking). It was also suggested that we look at "inactive firms" – by which might be meant relatively non-innovative firms, and/or of firms making little use of KIBS or internal KISA – and consider their skill requirements. This could, for example, involve asking whether there are unmet KISA demands in these firms (for instance, due to limited availability of KIBS or professionals in specific regions) and how these could be met; whether KISA "shortages" are implicated in slow growth or low innovation; how KISA "shortages" are perceived and responded to by the firms themselves.

Skills Profiling

We mentioned above the suggestion that research explore the relations that exist between business models and skill profiles. Inspired by the scenario discussion at the workshops, one further proposal for specific research was exploration of how skills profiles evolve in relatively closed "innovation cartels" versus their evolution in more open innovation systems (with the hypothesis being, for example, that closed

innovation systems evolve towards open systems with more permeable boundaries, and that their skills profiles will thus converge). A method proposed here was to map skill sets through user surveys, repeated so as to assess trends (could a panel approach be employed?).

The notion of "competence" and "competence maps" was also articulated. This is a complicated area. Are we correct in understanding the following: in the most general sense competences are the factors needed for achieving desired results in a specific job or work role in a particular organization. These factors derive from combinations of knowledge, skills, and attributes (KSAs) usually described in terms of specific behaviours, and are demonstrated by successful performance in those jobs or work roles. Attributes include: personal characteristics, traits, motives, values or ways of thinking that impact an individual's behaviour. Knowledge refers to an organized body of information usually of a factual or procedural nature which, if applied, makes adequate performance on the job possible. Skills refer to the proficient manual, verbal or mental manipulation of data or things. Skills are usually measured by a performance test where quantity and quality of performance are tested, usually within an established time limit. Examples of proficient manipulation of things are skill in typing or skill in operating a vehicle. Examples of proficient manipulation of data are skill in computation using decimals; skill in editing for transposed numbers, etc. Ability refers to the power to perform an observable activity at the present time. This means that abilities are evidenced through activities or behaviours that are similar to those required on the job, e.g., ability to plan and organize work.

A competence framework is required (this is related to the discussion of statistics below), and this can be used to map KISA competences and to identify the most important competence maps in KISA for the purposes of innovation and renewal in these activities. Some questions arise however. Is a competence map a list of an individual's competencies that represent the factors most critical to success in given jobs, departments, organizations, or industries? Is competence mapping a process used to identify and describe competencies that are the most critical to success in a work situation or work role? The notion is that such frameworks can be used to relate the competences required of KISA workers to the types and levels of skills they possess – which can allow us to move between the "normative" definitions of skills (as supplied, for example, by the O*Net scheme, which asks what skills are required for good performance of an occupational role) and "empirical" ones (such as assessments of what qualifications and accredited skills actually are possessed by a sample of workers). More effective mapping could lead to more effective allocation of staff, too, as mismatches between required and possessed competences could be minimised.

Change in KISA

A large number of specific questions concerned changes in KISA and related skills. One important driver of change is technology development, which leads to new KISA demands, and also to new techniques for use within KISAs. (Surprisingly, no specific questions were posed on these themes – though they have been addressed in several previous studies, there would seem to be much more to know about new technology-related challenges and opportunities.) The role of exposure to social networking and other "Web2.0" systems was, however, seen as important to investigate in terms of its potential impact on skills and competences (and, we would add, on development of KISA networks and networking practice.) The growing e-skills of the population, associated with public programmes and diffusion of new applications, will have major implications for skill requirements and skill utilisation at work (for instance, we could speculate that many current IT-related KISA will be

carried out by non-IT professionals; that client demands on KISA will be influenced by their experience of other services delivered or mediated online….). There are many issues to investigate here, with implications for e-skill training and KISA training, design and practice more generally.

In addition to technological change, numerous other factors that can influence KISA were indicated.

On the **demand** side, one topic was how to understand the evolution of KISA requirements as influenced by regulatory changes (of many kinds), how these requirements are translated into activities within business, and how these activities become routinised and embedded in business practice, together with the implications for external KISA input from KIBS and specialised agencies. Regulations are important in creating needs for new KISA (notably, environmental services); the financial crisis of 2008 has been attributed in part to innovative products and modes of business designed to sidestep regulatory constraints. A related set of topics arises from other types of policy that can impact upon firms, for example government policy on generating entrepreneurial skills and new small business growth. Analysis of how KISA and KIBS change over the course of economic cycles was also indicated (in this context, the current economic downturn should provide a powerful test case – and one that could be contrasted with, for instance, 911 and the dot com bubble).

On the **supply** side, one suggestion was to examine the shift in portfolio of KIBS firms. The particular topic suggested was analysis of how consultancies diversify their product range by using the knowledge base established from existing clients to sell them new services (and the implications that this has for their skills mix). Equally, there may be KIBS that are specialising and/or moving into new niches – and non-KIBS firms that are making moves into supplying KISA or bundling them with existing services (e.g. logistics firms moving into strategy consultancy, office cleaners moving into value-added waste management and thence into environmental services). Finally, there are themes that bridge supply and demand sides, such as analysis of trends in user-producer relationships where KISA are concerned, and what these means for the nature of the activities conducted and the skills required for them. (This was one instance where large user surveys were mentioned as a tool, rather than emphasising case study work.)

New Business Approaches

The points noted above can be extended to focus on management issues that arise in the context of KISA and change in KISA. One issue raised was the need for research on how to form more creative teams in KISA; and another concerned so-called "*serendipitous services*", KISA which provide solutions for unknown problems – perhaps as new solutions developed on-the-job in activities for specific clients, or possibly new service opportunities spotted in the course of scanning the business environment. Both of these might be related to the notion of (action research on) setting up centres of service excellence. Ion this context, in contrast with the earlier mention of centres of excellence, we are not referring so much centres of service research, but centres for practice, learning, shared services, training – and innovation. It may also be related to the notion of virtual networks for KISA and KISA managers, which forms another research topic. This topic could be approached in various ways – one specific suggestion was to work on web-based open platforms enabling KISA provision (case study work suggested) and the ownership (and IP?) dimensions of this, with their implications for skill requirements for actors of various kinds to succeed in such environments.

Statistical Needs

A general point here was that we need to overcome the statistical divide between manufacturing and services – which presumably reflects the quantitative divide (there are typically more, and more detailed, statistics on manufacturing activities than on services) and the qualitative one (many statistical instruments have been designed with manufacturing processes in mind, and service processes are overlooked, assimilated into inappropriate categories, or allocated to a "residual" "not elsewhere classified" group). The last issue in particular calls for more research into how the characteristics of services can be conceptualised and represented statistically. This has been said often enough, but remains an important issue: we need to explore KISA development across knowledge society – in all occupations and sectors – and in the informal economy and in social activities. Statistical work is only part of the story here, since there is also need for more conceptual development: but data are critically required to help sharpen and test concepts.

A second point stressed was the need for collaboration between statistical bureaux on developing statistics for KISA-related issues – including KISA skills. We could extend this, perhaps, to suggest that collaboration might also extend to relevant business and practitioner communities (just as accountants have been productive contributors to debates about how to measure intangible assets, and IT professionals to discussion of e-skills). Some of the proposals for future study were relatively straightforward – for example, tracking job descriptions (from advertisements, job evaluations, other sources?) over time and across sectors, so as to assess KISA changes. Some were more challenging, such as the notion of measuring KISA activities by tracking employees' use of time (rather than simply counting numbers of jobs).

The issue of competence mapping was raised again in relation to statistics. One set of requirements for development in statistics was seen as being the standardisation across Europe (and more widely) of core concepts used for assessing skills and competences: research is required to progress a core set of agreed common terms and definitions to achieve "smoother data gradation and semantic associations" (which presumably includes the task of relating together data using different levels of aggregation and cross-cutting classification schemata). Much is unknown about skill composition in specific firms and workplaces – statistical work tends to deal with "fragmented data" (isolated individuals), or "aggregated data" (sectors or regions). Some progress has been made on relating these levels of analysis to specific firms, but this is not something that regular statistical analysis is very comfortable with.[66] What was agreed is that we need improved European efforts to map and understand skills – the EQF[67] was seen as a step in the right direction, even if focused on qualifications.

In the KISA context, the competence composition of jobs in different economic sectors should be explored (does the same job title mean the same thing in terms of KISA practice, for example in KIBS firms in KISA user firms of various kinds? We could, for example, hypothesise that non-professional jobs, like those of clerks, might involve more KISA content in KIBS firms than in other sectors….). The question of

---

[66] For instance, the SCELI (Social Change and Economic Life) study in the UK in the 1990s: for books from this study, see http://www.oup.com/us/catalog/general/series/SocialChangeandEconomicLifeIniti/?view=usa
The fact that this is still regarded as state of the art in such research does indicate that these approaches are challenging to implement and certainly not routine research – the same is true of time budget approaches, it should be noted.

[67] EQF is the European Qualifications Framework – see, for example http://ec.europa.eu/education/policies/educ/**eqf**/**eqf**08_en.pdf

what changes are underway in competence consequences also rises to the fore. In addition to mapping such changes, statisticians will need to establish how they can maintain enough flexibility in their systems to allow for the rapid signalling of the emergence of new skills, professions and industries. Our reading of the suggestions from the workshop is also that it was proposed that research examine how statistical systems are constructed and operate in practice, so as to better explore how effective modifications can be made in them.

Training and Skill Development

One major outcome of the various lines of work described above is the provision of better intelligence on which to build and restructure training systems, whether these involve formal educational institutions, private training initiatives, or on-the-job training. (In the workshop it was remarked that training might also stem from non-commercial everyday activities – and also that professional KISA training might feed back into such activities, an example being the development of websites and the like for community purposes in one's spare time).

One set of topics for research concerns the formal training institutions. The extent to which current educational facilities provide for the skills requirements of KISA was one area for research, with the point being made that some sort of future-oriented analysis is required in order to identify the most important future needs and potential skill shortages, and the most relevant responses to these perceived challenges. This may imply restructuring some elements of educational systems do that they may be more effective in promoting social and behavioural skills as well as those to do with specific technical and managerial issues. "Skill diversification" (at personal and societal levels) was suggested as being one way of reducing unemployment (or periods of unemployment?), so ways of achieving this – and establishing the most effective forms of diversification – should be researched. A related topic is the skill development issues associated with the accelerated organisational changes that many commentators believe to lie ahead of us. We here move into topics concerning the training and skill development roles of KISA users and KIBS themselves (and note that "training" may not be a very appropriate term – "mentoring" and other conceptualisations may be used in these organisations and professions, and capture some important features of the creation of knowledge, know-how, and other competences).

Other topics deal more with the individuals whose skills are being developed. Research was suggested into the motivational drivers that encourage people to learn new skills (in particular contexts). This is arguably something that changes across cohorts. In addition to the question as to whether drivers are evolving across cohorts, there was one research topic suggested: to examine how far younger age groups possess distinctive skill sets associated with their coming of age after the IT/Internet evolution, to explore in what ways there might be an impending "skills revolution" (or other types of change in capabilities, expectations and motivations).

Foresight approaches

Finally, a number of suggestions were made concerning the sorts of Foresight approach that might be most relevant for addressing changes of the sort being discussed in the workshop. The workshop employed a scenario approach, asking participants about skill requirements in different scenarios. Judgements about these were very much made as a result of (inevitably) partial expert knowledge. Thus one suggestion was that we need research to inform Foresight, in particular case study research into KIBS/KISA that typify the trends associated with each of the scenarios being considered. (While early instances of something may not always be a good

guide to what it will look like when mature, they can usefully illuminate key features and dynamics, and critical problems that will have to be resolved if the scenario is to be realised.)

Some reactions to the scenario approach used in the workshops also suggested ways that research might move forward. One comment questioned whether the most useful scenarios are those derived from an analysis of KISA, or whether more general scenarios of economic and industrial development would be appropriate, given that requirements for KISA derive from these. (Demand-side drivers were considered in preparing the scenario analysis, but the scenarios developed in the Manchester workshop did not emphasise these elements.) Another suggestion was that the future of KISA could be explored by analysis of weak signals and wild cards – these would allow for more adventurous scenarios to be developed (though care would be needed to create or present scenarios in such a way as to minimise incredulity). There was also some scepticism expressed as to whether scenario analysis really illuminates important features of KISAs, their drivers and implications. Case studies and primary data collection are required, given the weaknesses of existing data.

In addition to the workshop discussions, we note from other Foresight work that a great deal of rapid development is taking place around the neuro- and cognitive sciences. This is liable to have implications for many service activities – for example, providing information for organising service experiences. But in the context of KISA skills, it is important to note that in the longer-term there may be profound implications for learning and capability development. It may not be possible to download skills though a pill or implant for the foreseeable future. But, for instance, cognitive enhancement techniques may become available that enable people to acquire skills more rapidly, or even to develop particular types of ability that proved difficult for the individual (e.g. to process and learn mathematical procedures that were previously opaque), How such potentials are regulated, made available and used are important topics for further analysis. It goes without saying that new KISA are also liable to arise to support such applications of new technology – and dealing with the consequences of this application.

11.2.3 Other Points Arising

The previous subsection very largely built upon the ideas generated in the two workshops (especially the second). However, a number of other possible lines of work, noted in the course of the study, also emerge as potentially fruitful areas for further research.[68] These include:

KISA and KIBS Definitions:

This study has mainly been centred on a limited set of KISA (those corresponding to the standard NACE72-74 categories of TKIBS and PKIBS – which actually cover a huge variety of activities). How far are the conclusions appropriate to telecommunications, financial, and other CKIBS services? Research is needed that examines these KISAs is terms similar to those used for other KIBS and

[68] In the course of literature review work we also came upon a couple of provocative "horizon-scanning" studies dealing with future needs for research in skill and higher education areas: see Coffield (2004) and Connor (2004). These studies are only partly relevant to the current project, but are worth consulting in their own right, and suggested some of the ideas set out below. These studies make numerous good points about the need to assess policy interventions in the training and higher education spheres.

KISA, and that is able to explore the business services provided by these "missing" sectors and occupations.

Thinking About Skills and Skill Profiles In addition to the numerous points raised above about better ways of conceptualising and measuring skills and skill profiles, a number of other issues are raised:

How far are economic problems really a skill shortage issue, or a problem to do with employers' identification of skill requirements (e.g. do they recognise that particular types of skill could benefit their innovation effort?) and use of skills that they have (e.g. are workers being assigned jobs, or given too many tasks, that are well below what they could accomplish with their capabilities?)

How far do education and training institutions identify and accommodate the evolving demands for particular classes of skills, in particular those in emerging and growing KISA?

How are skills and training policies and programmes initiated and evaluated? How far do they identify KISA as an area for attention? Are these policies and programmes integrated within, or in conflict with, other policies aimed at boosting innovation, lifelong learning, restructuring higher education, and the like; and policies implemented at other levels of government?

Secondary and New Data.

Census and Labour Force Survey data should be analysed in more detailed to allow us to explore the patterns of distribution of KISA occupations across the economy.[69] These data could be related to input-output and other statistics to provide some insights into trends in insourcing/outsourcing KISA, though the levels of aggregation of the latter tables limit their usefulness. It would thus be of value to develop more specialised surveys of insourcing/outsourcing by firms (and public sector organisations), which could be related to skill assessments (at least within the companies concerned).[70]

The European Working Conditions Survey proved to be useful in exploring the knowledge-intensity of work, as reported by employees. It would be helpful to extend the analysis presented here so that we could investigate, for example, the experiences of different KISA occupations, the experiences of different KIBS sectors. One benefit of this would be the opportunity to examine how far nominally similar KISA professions are alike or divergent when conducted in different sectors, countries, by workers of different age, gender, educational background, and so on. The EWCS was not designed with skill issues to the fore, of course, and ideally new survey questions would be introduced, or a completely new instrument used. But even without this there is scope for further secondary analysis of this survey (and in some countries, probably other surveys[71]).

Modelling.

The model developed in this study is highly exploratory and only calibrated for one country, and one statistical definition of KIBS. It would clearly be important to

[69] The Higgs et al (2008) study of creative and financial KISA is a good model here.

[70] Alajkääskö (2006) reports on a rare study about firm use of external and internal services.

[71] Historically, for instance, some countries have made use of the Labour Force Survey to investigate issues such as computer diffusion and use, providing useful insights to accompany those obtained from standard firm-level studies.

explore whether similar results and main messages are achieved when further model development is undertaken for other locations, and the results of sensitivity analysis and taking other KIBS into account. Extending the model to be able to deal with KISA in addition to KIBS would also be of great value.

The demonstration model implemented for the Dutch economy clearly provides insights into the importance of KISA and non-KISA for economic growth. Because of its general equilibrium nature, the model shows that growth comes at a price in terms of additional demand for the resources generating a growth potential (i.e. R&D resources) and induced demand for production resources geared at realizing that growth potential. The model underlines that the demand for production resources and for growth generating resources are complementary in nature: higher R&D driven TFP raises the return to production labour, and higher inputs of production labour increases the return to R&D efforts. The research also provided insights into the limitations of the model and of the data available to 'feed' the model. Some of these limitations are due to the explorative nature of the project and the limited resources available, while others are due to external circumstances such as data availability. Further research could consider the following subjects:

Statistical information

To get a better understanding of KISA produced in all sectors of the economy, the current occupational detail does not allow for a clear separation of KISA and non-KISA More detailed data is needed about the "own" KISA production in the sectors of economic activity. Currently only R&D activities are directly measured. Future Labour Force Survey data could overcome this. However, this kind of data needs to be available for all sectors

Labour statistics should incorporate more detail as regards the quality of labour. Existing (macro) indicators as life long learning should be available per sector of economic activity and per occupational group and other indicators should be added. Examples of these new indicators are the use of certain management practices and the pursuance of continuous innovation.

KISAMOD extensions

Data on total factor productivity growth in EU KLEMS conflicts with the intrinsic nature of total factor productivity growth. EUKLEMS measures a growth residual, rather than total factor productivity growth. Since, in the case of the Netherlands, total factor productivity growth in the services sector is often slightly negative, the EUKLEMS interpretation of the growth residual as a measure of technical change is clearly conflicting with theory. This is probably due to cyclical disturbances, which need to be filtered out of the Total Factor Productivity-growth measurements present in EUKLEMS. Further research is needed on this issue (this can/should be made a part of future versions of KISAMOD).

The implementation of a shadow price system will highlight the importance of bottlenecks on the labour market in terms of skill shortages in more detail for growth performance. It will provide information regarding the degree of growth foregone through such bottlenecks, and the benefits that policy measures would generate. These benefits would at the same time provide a ceiling for the costs of the policy measures geared at alleviating the bottlenecks. Comparison of costs and benefits would enable the prioritisation of alternative policy measures.

Further elaboration of a price system and a feedback mechanism through a demand system. The current model does not handle domestic and imported prices endogenously and also changes in income and in prices do not lead to

changes in demand. Further development of the model could include extensions into his direction to emphasize the role of technology and innovation on prices and on relative demand.

Further elaboration of off-shoring practices. Endogenous off-shoring provides a possibility to alleviate the pressure on domestic resources, apart from also providing a short-term threat to the employment perspectives of these domestic resources.

Implementation of the (extended) KISAMOD for different EU-countries and linkage between of these models through bilateral trade relations and flows between national-labour markets. The latter is important, considering the complementary nature of R&D resource use and the use of 'ordinary' production factors, like production labour and capital.

Issues raised by Scenarios. Each scenario suggests specific topics to study, and the bullet points below identify some research questions:

What are the key skills, practices, intermediaries, and technical facilities required for self-organising networks to develop on a bottom-up, professional community basis? How are divisions of labour negotiated within such communities, and how far do individual nodes get frozen into specific roles? Is there a danger of "bottom-up" organisation failing to produce or provide support for visionary leadership, such that radical innovations are rendered less likely – or will the converse happen, with networks competing around original solutions?

What is the scope for local and regional action – in improving the supply of skills, the retention of knowledge-intensive skills within the region, the ways in which local industry expresses demand for and uses skills, inducing and supporting skill-intensive and innovation-promoting activities such as R&D and other forms of creative knowledge development? What can we learn about best practice and pitfalls in action at such levels?

How are KISA activities managed, and how far are they organised on an in-house basis (within large firms) or on the basis of close long-term relationships within established industrial groups? How far are these groups of similar composition, and how do they negotiate around competition law?

Across all scenarios – Which KISA are most likely to see more or less realisation of the trajectories of the three different scenarios? What is the role of standards in KISA services? What are the implications of these strategies for job creation, for equity and diversity, for the performance of KISA-using firms? What is the role of professional organisations? What are the impacts of offshoring liable to be, and how important could emerging economies be as a source of demand for KIBS and KISA outputs?

11.3 Conclusions

A large number of research questions, spanning a wide range of topics, has been spelled out above. Prioritisation and selection from this list is difficult, and needs to be related to the objectives of would-be users of research. The general points about key research approaches have been made clearly from the workshops, however: the need for interdisciplinary approaches, the value of comparative study, and so on.

We hope that the ideas set out here can be used as a basis for (or one input into) wider discussions about research priorities in the several overlapping fields concerned in this project: the analysis of skills in firms, public organisations, and the knowledge economy more generally; the explication of KIBS and KISA and their roles; and the ways we can go about thinking about long-term developments in the economy and in technological innovation and organisational change. These fields are all vital ones, where demands for knowledge are liable to become evermore pressing, even if the economic upsets being experienced at the time of writing prove to be persistent ones. Even if we see a greater loss of KISA jobs now than in previous downturns, the issue of KISA skills remains on the agenda. Indeed, it is arguable that effective use of KISA and associated skills is going to be a substantial part of the solution to deflation and low growth, in addition to yielding benefits for sustainability and quality of life.

12. References

Ahlqvist, T, 2003, Keys to Futures: Societal Reflections on Developing Key Technologies and Their Impacts on Human Qualifications Helsinki, Ministry of Trade and Industry, Finland

Alajkääskö, P., The Demand for Services: External but Local Provision, Statistics in Focus - Industry, Trade and Services, 26/2006, Eurostat, Luxembourg, 2006. Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-NP-06-026/EN/KS-NP-06-026-EN.PDF

Becker, G (1993, 1964) Human Capital, 3rd Edition, Chicago UCP

Bosworth, D., & Wilson, R., 2005, Sectoral Management Priorities: Management Skills and Capacity (Report to the Sector Skills Development Agency), Coventry, University of Warwick, Institute for Employment Research

CEC, 2002 Innovation tomorrow - Innovation policy and the regulatory framework: Making innovation an integral part of the broader structural agenda, European Commission, DG Enterprise, Innovation Papers No. 28, Luxembourg: Office for Official Publications of the European Communities, 2002. (CEC, 2002), pp 32-52.

CEC, 2007, Employment in Europe 2007, Luxembourg: Office for Official Publications of the European Communities, 2007. (CEC, 2007)

CEDEFOP (2008) Future Skills Needs in Europe available at

http://www.trainingvillage.gr/etv/Projects_Networks/Skillsnet/Work/pubwork.asp

Coffield, F. (2004) "Scanning the English Horizon for Lifelong Learning and Skills" in Coffield, F., Connor, H., Desforges, C., Gray, J., Murphy, R., and Payne, J., (eds) Future Research Priorities: Horizon Scanning Papers produced by members of the DfES Research Advisory Panels, Research Report RR599 DfES Publications, Nottingham

Connor, H. (2004) "Higher Education and Lifelong Learning: Horizon scanning" in Coffield, F., Connor, H., Desforges, C., Gray, J., Murphy, R., and Payne, J., (eds) Future Research Priorities: Horizon Scanning Papers produced by members of the DfES Research Advisory Panels, Research Report RR599 DfES Publications, Nottingham

Elias P *(1999),* Redefining Skill, Warwick IER

EMCC, 2005, Knowledge-intensive business services: Trends and scenarios, Dublin: EMCC at European Foundation for the Improvement of Living and Working Conditions; available at

http://www.emcc.eurofound.eu.int/content/source/eu05016a.html

EMCC, 2006a, Trends and drivers of change in the knowledge-intensive business services sector: Four scenarios, Dublin: EMCC at European Foundation for the Improvement of Living and Working Conditions, EF/06/79/EN available at http://www.emcc.eurofound.eu.int

EMCC, 2006b, Trends and drivers of change in the European knowledge-intensive business services sector: Mapping report, Dublin: EMCC at European Foundation for the Improvement of Living and Working Conditions, EF/06/40/EN available at http://www.emcc.eurofound.eu.int

Graz, J.-C., E. Hartmann, M. Heires, N. Niang and A. Sutlian, The Emerging Power of Services Standards in the Global Political Economy, Paper presented at the ECPR Standing Group on International Relations 6th Pan-European Conference on International Relations, Turin, 12-15 September 2007

Higgs, P., Cunningham, S, & Bakhshi, H., 2008, Beyond the creative industries: Mapping the creative economy in the United Kingdom London, NESTA (NESTA - National Endowment for Science Technology and the Arts, Technical report, January 2008) available at http://www.nesta.org.uk/assets/pdf/beyond_creative_industries_report_NESTA.pdf

Hill, T. P., 1977, "On Goods and Services" Review of Income and Wealth vol. 23 pp315-338

Johnson, S., & Winterton, J., 1999, Management Skills. National Skills Task Force Research Report No. 3, Department for Education and Employment, 1999

Kox, H. (2002) Growth challenges for the Dutch business services industry: international comparison and policy issues The Hague, CPB Netherlands Bureau for Economic Policy Analysis

Korte, S., Rijkers-Defrasne, S., Braun, A., & Zweck, A., 2008, New Professional and Business-Related Services: Status and Prospects Brussels, European Parliament (ITRE) IP/A/ITRE/ST/2007-03

Layard, R, McIntosh S & Vignoles A "Britain's Record on Skills (2001) in Blundell, R et al (ed) Seeking a premier league economy Chicago, University of Chicago Press

Merton, R, 'The machine, the worker and the engineer', Science 105 1947, reprinted Merton 1968 pp.616-627, see p.618

Miles, I., 2005, "Knowledge Intensive Business Services: Prospects and policies", Foresight vol 7 no 6 pp39-63

Miller, A.R., Treiman, D.J., Cain, P.S., & Roos, P.A. (1980), Work, jobs, and occupations: A critical review of occupational titles, Washington, DC: National Academy Press

OECD 2006, Innovation and Knowledge-Intensive Service Activities Paris: OECD

O'Mahony, M & Bart van Ark (ed) (2003) EU Productivity and competitiveness:an industry perspective, European Commission, ISBN 92-894-6303-1

O*NET, 2006. New and Emerging (N&E) Occupations: Methodology Development Report, Washington, DC: The National Center for O*NET Development

Penn, R. & Holt, R., 2000, Skills Issues in Other Business Services - Professional Services, London DFES (HMSO): Skills Task Force Research Paper 16

Petersen, A.W., Revill, P., Ward, T., and Wehmeyer, C., 2004, ICT and e-business skills and training in Europe, CEDEFOP

RAND-Europe, 2006, Changing professions in 2015 and beyond, Luxembourg, European Commission, European S&T Foresight Knowledge Sharing Platform, EUR 21966, ISBN 92-79-02664-X, available at

http://ec.europa.eu/research/conferences/2004/foresight/index_en.html

Riddle, D., 1986, Service-Led Growth Praeger, New York

Rodgers, R. & Waters, R., 2001, The Skills Dynamics of Business and Public Service Associate Professionals, London DFES (HMSO): Skills task force research report RR302

Roos, P.A. & Treiman, D.J. (1980), DOT scales for the 1970 Census classification. In A.R. Miller, D.J. Treiman, P.S Cain, & P.A. Roos (Eds.),Work, jobs, and occupations: A critical review of occupational titles, Washington, DC: National Academy Press

Shu, X., Fan, P-L., Li, X., & Marini M. M., "Characterizing Occupations with Data from the Dictionary of Occupational Titles" Social Science Research, Volume 25, Issue 2, June 1996, Pages 149-173

Skills Task Force (2000a) Skills for all: Proposals for a National Skills Agenda: Final Report of the National Skills Task Force, DfEE, Sudbury

Skills Task Force (2000b) Skills for all: Research Report from the National Skills Task Force, DfEE, Sudbury

Snower D in Booth, A and D, Snower (eds) (1996) Acquiring Skills. Market failures, their symptoms and policy responses, Cambridge: Cambridge University Press

Toivonen, M. (2004) Expertise as Business: Long-term development and future prospects of knowledge-intensive business services (KIBS) Helsinki: Helsinki University of Technology, Doctoral dissertation series 2004/2; available at: http://lib.hut.fi/Diss/2004/isbn9512273152/

US Department of Labor 1993 p.6 The New DOT: a database of occupational titles for the 21st century: Washington DC

J Winterton, M Parker, M Dodd, M McCraken and I Henderson (2000) Future Skill Needs of Managers (Employment Research Institute and York Consulting Limited) Research Brief 182 DFEE

Zaring, O. et al (2001) Creating Eco-efficient Producer Services Göteborg: Gothenburg Research Institute available at

http://www.suspronet.org/download.asp?File=documents\creatingefserv1.pdf&Name=creatingefserv1.pdf